Montana Department of
ENVIRONMENTAL QUALITY

Final –
Jefferson River Metals Project Area TMDLs and Water Quality Improvement Plan

December 2014

Steve Bullock, Governor
Tom Livers, Director DEQ

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TABLE OF CONTENTS

Appendices

List of Tables

LIST OF FIGURES

ACRONYM LIST

Acronym	Definition
AAL	Acute Aquatic Life
AML	Abandoned Mine Lands
ARM	Administrative Rules of Montana
BLM	Bureau of Land Management (U.S.)
BMP	Best Management Practice
CAL	Chronic Aquatic Life
CECRA	[Montana] Comprehensive Environmental Cleanup and Responsibility Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CMC	Chicago Mining Corporation
CWA	Clean Water Act
DEQ	Department of Environmental Quality (Montana)
DMR	Discharge Monitoring Report
DNRC	Department of Natural Resources & Conservation (Montana)
DOI	Department of the Interior (U.S.)
DQO	Data Quality Objective
EPA	Environmental Protection Agency (U.S.)
EQIP	Environmental Quality Incentives Program
FWP	Fish, Wildlife & Parks (Montana)
GIS	Geographic Information System
GSM	Golden Sunlight Mine
HHS	Human Health Standard
IR	Integrated Report
JRWC	Jefferson River Watershed Council
LA	Load Allocation
MARS	Montana Aquatic Resources Services, Inc.
MBMG	Montana Bureau of Mines and Geology
MCA	Montana Code Annotated
MOS	Margin of Safety
MPDES	Montana Pollutant Discharge Elimination System
NLCD	National Land Cover Dataset
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PEL	Probable Effects Level
PWS	Public Water Supply
RIT/RDG	Resource Indemnity Trust / Reclamation and Development Grants
SMCRA	Surface Mining Control and Reclamation Act
TMDL	Total Maximum Daily Load
TPA	TMDL Planning Area
TSS	Total Suspended Solids
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service

Acronym	Definition
USGS	U.S. Geological Survey
VCRA	Voluntary Cleanup and Redevelopment Act
WLA	Wasteload Allocation
WRP	Watershed Restoration Plan
WWTP	Wastewater Treatment Plant

DOCUMENT SUMMARY

This document presents metals total maximum daily loads (TMDL) and a framework water quality improvement plan for several waterbodies in the Jefferson River TMDL Project Area. TMDLs are included for the upper and lower segments of the Jefferson River, the Jefferson Slough, and three tributaries to the upper segment of the Jefferson River: Big Pipestone Creek, Little Whitetail Creek, and Whitetail Deer Creek. **Figure 1-1** contains a map of the project area and the impaired waterbodies.

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.

The Jefferson River TMDL Project Area is located in west central Montana, and is defined by the boundary of the Jefferson River watershed (hydrologic unit 10020005). The Boulder Mountains to the northwest, the Highland Mountains to the west, the Tobacco Root Mountains to the east and the Bull Mountains to the north east surround the Jefferson River watershed and create the drainage divides for surface flows to the Jefferson River. This metals TMDL project only includes the upper and lower segments of the Jefferson River and several tributaries to the upper segment of the Jefferson River (**Figure 1-1**), encompassing approximately 1,284 square miles and mainly falling within Madison and Jefferson Counties. None of the tributaries to the lower segment of the Jefferson River are included in this project. DEQ recognizes that there are other pollutant impairments in the project area (**Table A-1** in **Appendix A**); however, this document only addresses metal causes of impairment.

Metals TMDLs

Elevated concentrations of metals may impair the support of designated beneficial uses. Elevated concentrations can have a toxic, carcinogenic, or bioconcentrating effect on biota within aquatic ecosystems; humans and wildlife can suffer acute and chronic effects from consuming water or fish with elevated metals concentrations; and agricultural uses may be affected from high concentrations in irrigation or stock water, as it is toxic to plants and animals. Fourteen metals TMDLs are provided for six waterbody segments in the Jefferson River TMDL Project Area (**Table DS-1**), for aluminum, arsenic, cadmium, copper, iron, 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 identified as being affected by metals will be restored. For streams in Western Montana, the most sensitive use assessed for metals is drinking water and/or aquatic life.

Metals loads are quantified for point sources such as MPDES permitted dischargers, natural background conditions, abandoned mines, and diffuse sources (e.g.,-Human caused activities that increase erosion of mineralized soils). The metals TMDLs require reductions in metals loads ranging from 0% to 84%, 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 most water quality improvement measures described in this document is based on voluntary actions of watershed stakeholders. Ideally, local watershed groups and/or other watershed stakeholders will use this 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 TMDL implementation and future monitoring. This document includes a monitoring strategy designed to track progress in meeting TMDL objectives and goals, and to help refine the strategy during its implementation.

Although most water quality improvement actions 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. WLAs for metals are included for: two suction dredge operations and the town of Whitehall wastewater treatment plant (WWTP) on Big Pipestone Creek; a permitted stormwater discharge to the Jefferson Slough; the town of Twin Bridges WWTP along the upper segment of the Jefferson River; and a suction dredge operation in the lower segment of the Jefferson River.

Table DS-1. Impaired Waterbodies and Their Impaired Uses in the Jefferson River TMDL Project Area with Completed Metals TMDLs Contained in this Document

Waterbody and Location Description	TMDL Prepared	TMDL Pollutant Category	Impaired Uses
Big Pipestone Creek Headwaters to mouth (Jefferson Slough), T1N R4W S11	Arsenic	Metals	Drinking Water
Jefferson River Headwaters to confluence of Jefferson Slough	Iron	Metals	Aquatic Life
	Lead	Metals	Aquatic Life
Jefferson River Confluence of Jefferson Slough to mouth (Missouri River)	Copper	Metals	Aquatic Life
	Lead	Metals	Aquatic Life
Jefferson Slough Jefferson River to the mouth (Jefferson River)	Arsenic	Metals	Drinking Water
	Cadmium	Metals	Aquatic Life
	Copper	Metals	Aquatic Life
	Zinc	Metals	Aquatic Life
Little Whitetail Creek Whitetail Reservoir to mouth (Whitetail Deer Creek)	Aluminum	Metals	Aquatic Life
	Copper	Metals	Aquatic Life
	Lead	Metals	Aquatic Life
Whitetail Deer Creek Headwaters to mouth (Jefferson Slough)	Aluminum	Metals	Aquatic Life
	Lead	Metals	Aquatic Life

1.0 PROJECT OVERVIEW

This document presents an analysis of water quality information and establishes total maximum daily loads (TMDLs) for metals impaired waterbodies in the Jefferson River TMDL Project Area. The Jefferson River watershed (hydrologic unit 10020005) is divided into two TMDL planning areas (TPAs): the Upper Jefferson TPA and the Lower Jefferson TPA. The upper TPA includes the upper segment of the Jefferson River and its tributaries; the Lower Jefferson TPA includes the lower segment of the Jefferson River and its tributaries. The Jefferson River TMDL Project Area encompasses the full boundary of both planning areas; however, this metals TMDL project only includes the tributaries in the Upper Jefferson TPA and both segments of the Jefferson River. None of the tributaries within the Lower Jefferson TPA are included in this project (**Section 1.2**, **Table A-1** in **Appendix A**). **Figure 1-1** below shows the boundaries of both TPAs and the waterbodies with metals pollutant listings included in this project. This document also contains a summary of restoration strategies and potential funding sources for removal of metals contamination.

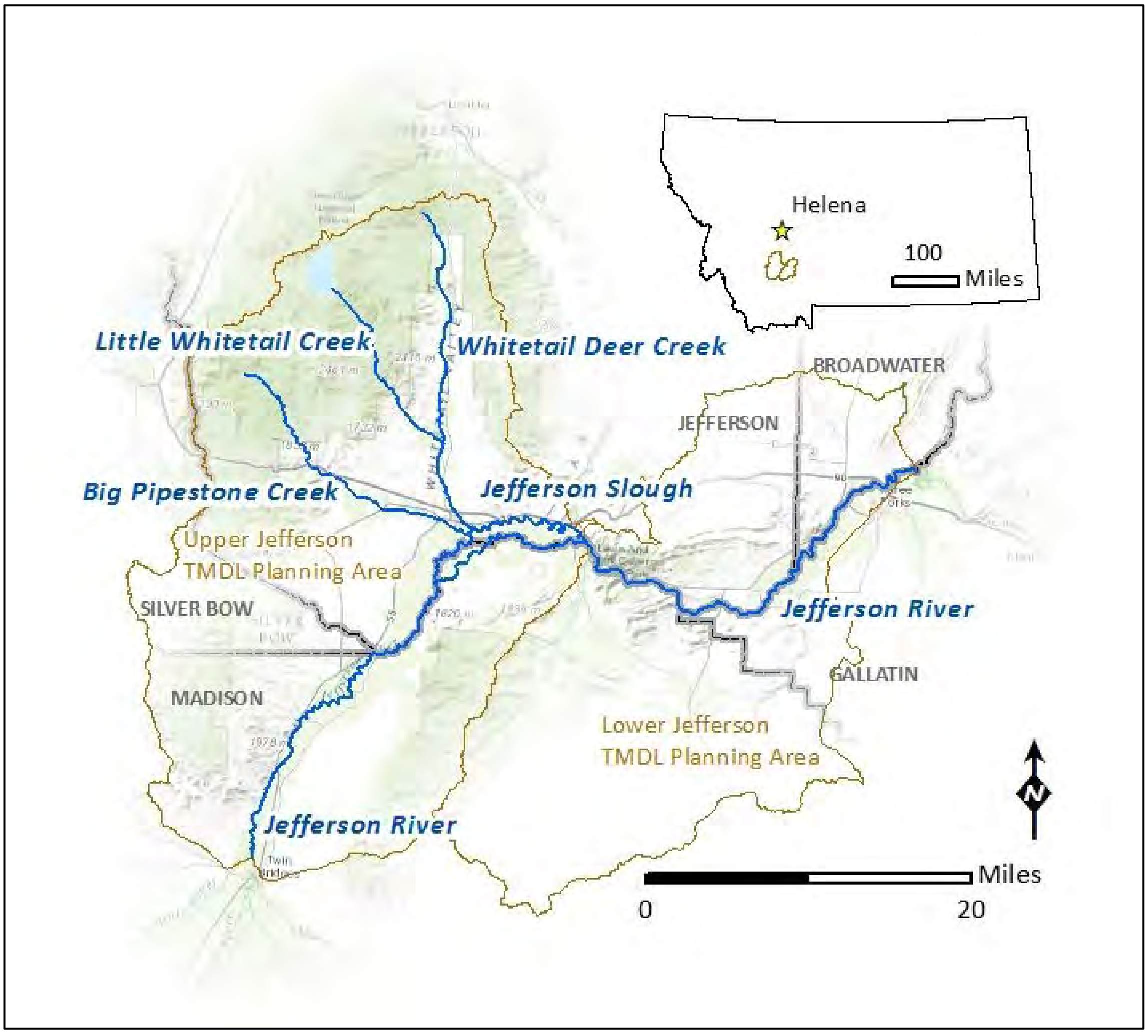

Figure 1-1. Location of the Jefferson River TMDL Project Area

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 waterbody. 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 Jefferson River 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, 2012). **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 TMDLs 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 **Section 7.0** 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, 2012) that are addressed in this document (also see **Figure 5-1**). TMDLs are completed for each waterbody – pollutant combination, and this document contains 14 TMDLs, addressing 14 pollutant impairments (**Table 1-1**).

This metals project includes Big Pipestone, Little Whitetail, and Whitetail Deer creeks and the Jefferson Slough within the Upper Jefferson TMDL Planning Area, as well as both segments of the Jefferson River. There are five tributaries within the Lower Jefferson TMDL Planning Area with metals impairments that are not included in this project: North Fork Willow, South Willow, Willow, and Norwegian creeks, and the South Boulder River (**Table A-1** in **Appendix A**).

Sediment TMDLs were previously completed for six tributaries in the Upper Jefferson TPA in 2009 (Big Pipestone, Cherry, Fish, Hells Canyon, Little Pipestone, and Whitetail creeks) (Starr and Kron, 2009), and a temperature TMDL for the upper segment of the Jefferson River is being completed in 2014 (Montana Department of Environmental Quality, 2014). **Table A-1** in **Appendix A** includes impairment causes within the Jefferson River TMDL Project Area with completed TMDLs, as well as non-pollutant impairment causes that were addressed by those TMDLs.

DEQ sometimes develops TMDLs in a watershed at varying phases, with a focus on one or a couple of specific pollutant types. Metals impairments in the Lower Jefferson TPA will be addressed in a future project, as well as additional sediment, temperature, and nutrients pollutant impairments in both the upper and lower Jefferson TPAs (**Table A-1** in **Appendix A**).

Table 1-1. Metals Impairment Causes in the Jefferson River TMDL Project Area Addressed within this Document

Waterbody and Location Description [1]	Waterbody ID	Impairment Cause	Impairment Cause Status	Included in 2012 Integrated Report [2]
Big Pipestone Creek Headwaters to mouth (Jefferson Slough), T1N R4W S11	MT41G002_010	Arsenic	Arsenic TMDL contained in this document	No
Jefferson River Headwaters to confluence of Jefferson Slough	MT41G001_011	Iron	Iron TMDL contained in this document	No
		Lead	Lead TMDL contained in this document	Yes
Jefferson River Confluence of Jefferson Slough to mouth (Missouri River)	MT41G001_012	Copper	Copper TMDL contained in this document	Yes
		Lead	Lead TMDL contained in this document	Yes
Jefferson Slough Jefferson River to the mouth (Jefferson River)	MT41G002_170	Arsenic	Arsenic TMDL contained in this document	No
		Cadmium	Cadmium TMDL contained in this document	No
		Copper	Copper TMDL contained in this document	No
		Zinc	Zinc TMDL contained in this document	No
Little Whitetail Creek [3] Whitetail Reservoir to mouth (Whitetail Deer Creek)	MT41G002_140[3]	Aluminum	Aluminum TMDL contained in this document	No
		Copper	Copper TMDL contained in this document	No
		Lead	Lead TMDL contained in this document	No
Whitetail Deer Creek [3] Headwaters to mouth (Jefferson Slough)	MT41G002_141[3]	Aluminum	Aluminum TMDL contained in this document	Yes
		Lead	Lead TMDL contained in this document	Yes

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

[2] Impairment causes not in the "2012 Water Quality Integrated Report" were recently identified and are included in the 2014 Integrated Report

[3] The assessment units (waterbody IDs) for Little Whitetail Creek and Whitetail Deer Creek are incorrectly defined in the 2012 Water Quality Integrated Report (see **Table A-1** and **Figure A-1** in **Appendix A**). This table and this document reflect the corrected and redefined assessment units as they are identified 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. The TMDL components are summarized within the main body of the document. Additional technical details are contained in the appendices. In addition to this introductory section, this document includes:

Section 2.0 Jefferson River TMDL 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 Jefferson River TMDL Project Area.

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

Sections 5.0 Metals TMDL Components:
Includes: (a) a discussion of the affected waterbodies and the effect of metals on designated beneficial uses, (b) the information sources and assessment methods used to evaluate stream health and metals source contributions, (c) metals water quality targets and existing water quality conditions, (d) the quantified metals loading from the identified sources, (e) the determined TMDL for each waterbody, (f) the allocations of the allowable metal load to the identified sources.

Section 6.0 Non-Pollutant Impairments and Future TMDL Development:
Describes non-pollutant impairments that could potentially be contributing to water quality impairment and how TMDLs in this project area might address some of these concerns. This section also provides recommendations for combating these problems, and a short discussion on future TMDL development to address additional metals, nutrients, sediment, and temperature impairments.

Section 7.0 Water Quality Improvement Plan and Monitoring Strategy:
Discusses water quality restoration objectives, a strategy to meet the identified objectives and TMDLs, and describes a water quality monitoring plan for evaluating the long-term effectiveness of the "Jefferson River Metals Project Area TMDLs and Water Quality Improvement Plan."

Section 8.0 Stakeholder and Public Participation:
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 JEFFERSON RIVER TMDL PROJECT AREA DESCRIPTION

This section provides a general overview of the physical, ecological and cultural characteristics of the Jefferson River TMDL Project Area. Unless otherwise noted, geospatial data used for the figures and accompanying discussion is obtained from the Montana Geographic Information System (GIS) Portal (http://gisportal.msl.mt.gov/geoportal/catalog/main/home.page).

2.1 PHYSICAL CHARACTERISTICS

The following information describes the physical characteristics of the project area.

2.1.1 Location

This metals project includes selected streams located within the Upper Jefferson TMDL Planning Area (TPA) (Big Pipestone, Little Whitetail, and Whitetail Deer creeks), as well as Jefferson Slough and the entire length of the mainstem Jefferson River. This project area description, therefore, focuses on these specific areas within the Jefferson River watershed.

The Jefferson River extends from the confluence of the Big Hole and Beaverhead rivers to the mouth where it joins the Missouri River (**Figure 2-1**). Elevation ranges from approximately 4,600 feet at the confluence of the Big Hole and Beaverhead rivers to 4,260 feet at the mouth of Jefferson Slough, and 4,040 feet at the mouth of the Jefferson River.

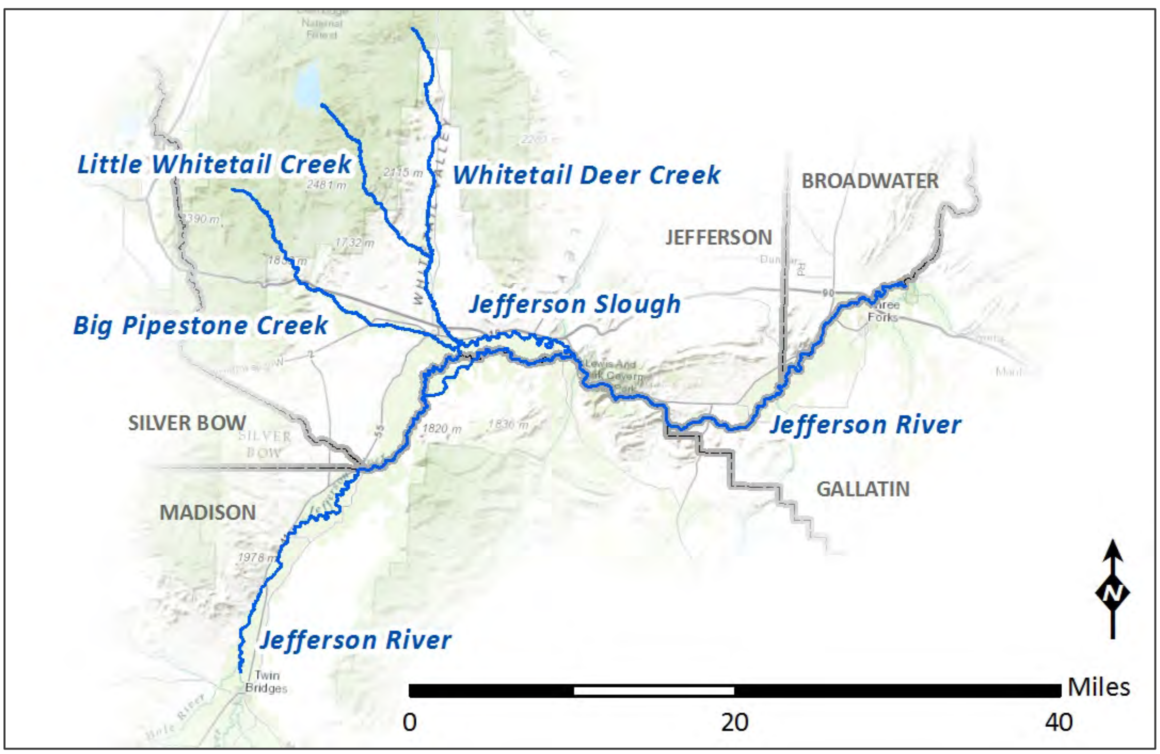

Figure 2-1. Location of Metals TMDL Segments

2.1.2 Hydrology

The confluence of the Beaverhead and Big Hole rivers marks the start of the Jefferson River. The Jefferson River flows north through the Jefferson Valley and turns eastward south of Whitehall and Cardwell. Prominent tributaries to the Jefferson River include Hells Canyon Creek, Beall Creek, Cherry Creek, Fish Creek, Big Pipestone Creek, Whitetail Deer Creek, and the Boulder River (via Jefferson Slough). The Jefferson River has a distinct mainstem, but there are many anastomosing channels that diverge and converge. Many of these converge on the Jefferson Slough, which flows into the Jefferson River at the point where the river leaves the valley and enters the canyon. This point represents the downstream end of the Upper Jefferson TPA. U.S. Geological Survey (USGS) gages located in the project area are summarized below in **Table 2-1** and illustrated in **Figure 2-2**.

Table 2-1. USGS Gage Stations on the Jefferson River and Selected Tributaries

Station ID	Station Name	Active?	Area Drained (miles^2)
06026500	Jefferson River near Twin Bridges	Yes	7,632
06027000	Jefferson River near Silver Star	No	7,683
06027200	Jefferson River at Silver Star	No	7,683
06034500	Jefferson River at Sappington	No	9,277
06036650	Jefferson River near Twin Bridges	Yes	9,532
06028000	Big Pipestone Creek near Whitehall	No	108
06029000	Whitetail Creek near Whitehall*	No	31
06029500	Little Whitetail Creek near Whitehall*	No	91
06030000	Whitetail Creek at Whitehall	No	179

*The names of these gages are reversed and in error

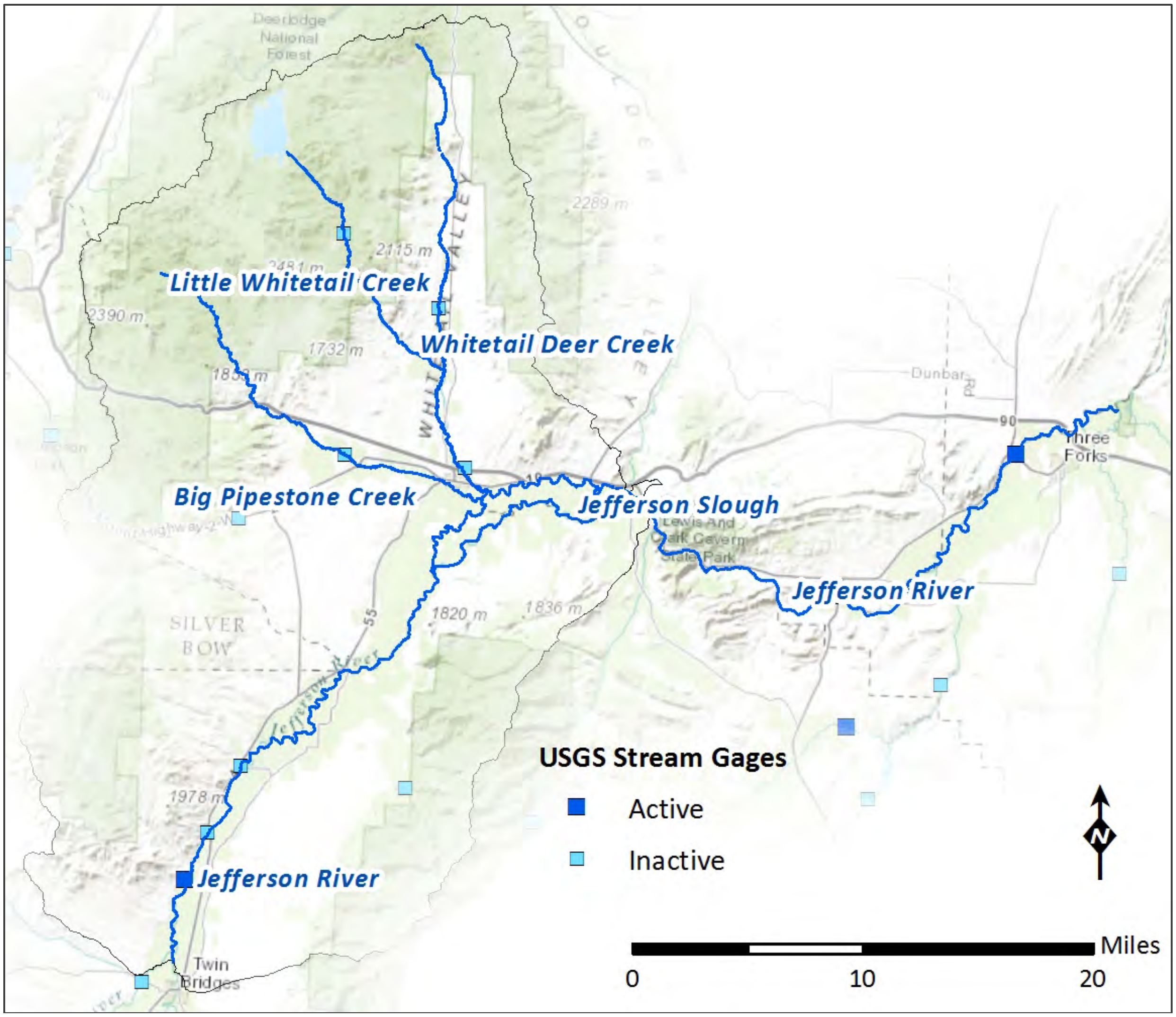

Figure 2-2. USGS Gages

Streamflow in the Jefferson River follows a hydrograph typical for the region (**Figures 2-3** and **2-4**). Flow in the Jefferson River is highest in June. May and June are the months with the greatest amount of precipitation and snowmelt runoff. Streamflows during the 2011 spring runoff season where higher than normal. Peak flows during runoff were in the 98^{th} to 99^{th} percentile range. At the regional level, spring 2011 runoff was the highest in 82 years. Streamflow begins to decline in July, reaching minimum flow levels in August and September when many tributary streams go dry. Streamflow generally begins to rebound in October and November when fall storms supplement the base-flow levels. Example hydrographs are provided below, based on the gages near Twin Bridges and Three Forks. The influence of irrigation withdrawals is apparent in comparison of the troughs between hydrographs. Low flows at the Three Forks gage are considerably lower than at Twin Bridges, despite the larger drainage area.

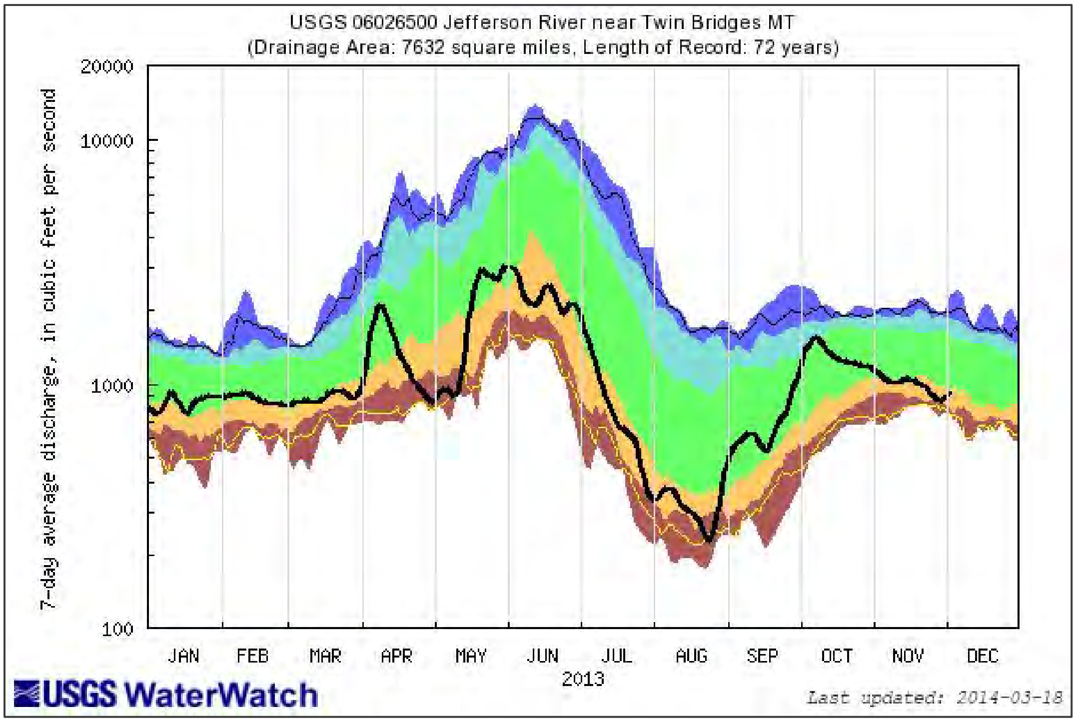

Figure 2-3. Hydrograph at Beaverhead River near Twin Bridges

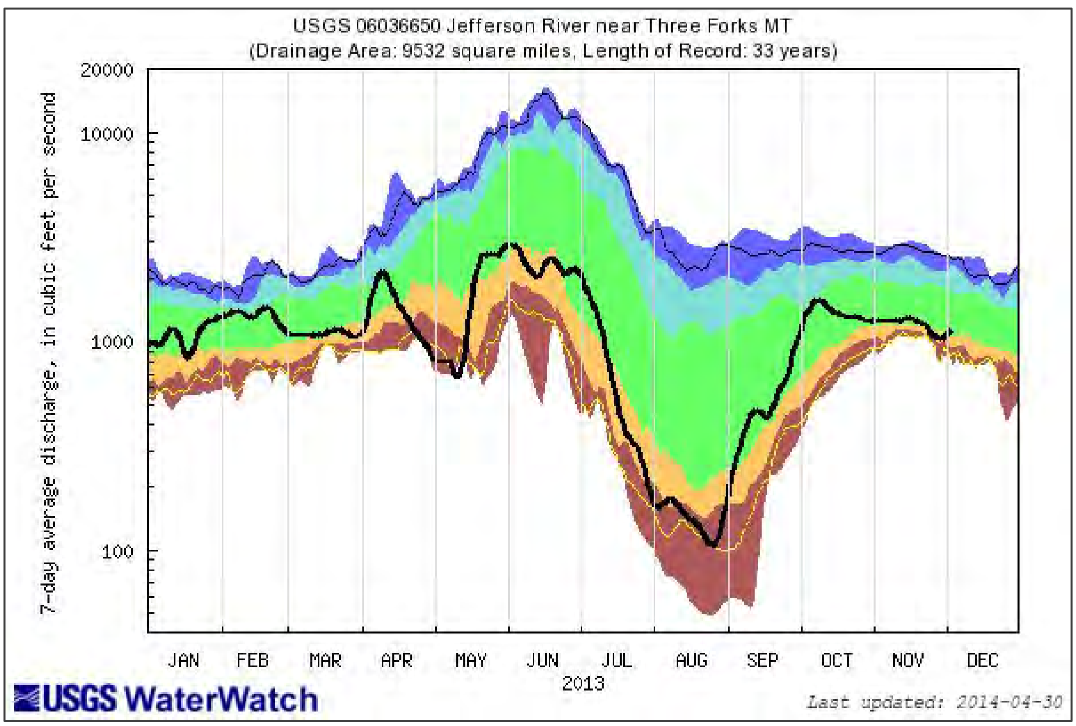

Figure 2-4. Hydrograph at Jefferson River near Three Forks

Explanation - Percentile classes							
lowest-10th percentile	5	10-24	25-75	76-90	95	90th percentile -highest	Flow
Much below Normal		Below normal	Normal	Above normal	Much above normal		

Montana Fish, Wildlife & Parks (FWP) maintains a list of Montana streams that support important fisheries or contribute to important fisheries (i.e., provide spawning and rearing habitats) that are significantly dewatered. Dewatering refers to a reduction in streamflow below the point where stream habitat is adequate for fish. The two categories of dewatering are "chronic" – streams where dewatering is a significant problem in virtually all years and "periodic" – streams where dewatering is a significant problem only in drought or water-short years. The list was initially prepared by FWP in 1991 and was revised in 1997, 2003, and most recently in December 2011 (Montana Fish, Wildlife and Parks, 2011) (http://fwp.mt.gov/gisData/metadata/dewateredStreams.htm). The revised list includes a total of 297 streams and 2,921 stream miles that are chronically dewatered and 108 streams and 1,562 stream miles that are periodically dewatered.

The Jefferson River is classified as chronically dewatered from its headwaters to mouth. According to the Statewide Fisheries Management Plan (Montana Fish, Wildlife and Parks, 2013):

> Water quality and quantity is severely impaired during drought years when water recedes from structural habitat along the shoreline, and water temperature approaches 80°F. Quality tributaries able to provide suitable trout spawning and rearing habitat are rare.
> Over the past 25 years, priority habitat enhancement efforts have focused on flow improvements during summer irrigation, tributary restoration projects to enhance spawning and rearing habitat, and encouraging sound floodplain function practices during permit review processes. Participation in the implementation of the Jefferson River Drought Plan with the Jefferson River Watershed Council and water users has been the primary tool for preventing acute dewatering of the river. (Page 233)

2.1.3 Climate

The project area includes the intermontane Jefferson Valley, surrounding uplands, and the Jefferson River Canyon. The climate in the valley is typical of higher-elevation intermontane basins east of the Continental Divide, with mild summers and cold winters (Kendy and Tresch, 1996). Average precipitation ranges from just under 10 inches per year at Twin Bridges to 13.5 inches per year at Cardwell. May and June are consistently the wettest months of the year and winter precipitation is dominated by snowfall. Climate summaries from Twin Bridges and Cardwell are provided below in **Table 2-2**.

Table 2-2. Climate Summaries

Twin Bridges (248430)							Period of record: 6/1/1950 to 2/28/2013						
	Jan	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**August**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
Ave Max (°F)	34.6	40.2	47.8	57.1	66.8	75	84.3	82.3	72.5	60.4	44.3	35.1	58.4
Ave Min (°F)	11.4	14.9	20.8	27.6	35.4	42.3	45.7	43	35.4	27.5	19.2	12.2	28
Ave Total Precip (in.)	0.24	0.21	0.46	0.85	1.65	1.94	1.02	0.99	0.94	0.59	0.37	0.28	9.54
Ave Total Snow (in.)	1.5	1.9	1.8	0.9	0.1	0	0	0	0	0.3	1	0.8	8.3
Ave Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0
Cardwell (241500)							Period of record: 5/1/1978 to 4/30/1991						
	Jan	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**August**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
Ave Max (°F)	37.4	43.1	50.7	60.9	68.3	78.7	86.2	84.6	73.5	63.2	45.4	36.3	60.7
Ave Min (°F)	12.5	15.7	23.3	29.3	37.3	43.9	48.3	45.6	37.1	28.7	20.4	11.8	29.5
Ave Total Precip (in.)	0.41	0.4	1.18	1.28	2.67	1.84	1.32	1.22	1.6	0.7	0.54	0.41	13.56
Ave Total Snow (in.)	3.2	2.5	7.9	1	0	0	0	0	0.5	0.8	4.2	4.1	24.2
Ave Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Climate summaries are provided by the Western Regional Climate Center [http://www.wrcc.dri.edu/]

2.2 Ecological Profile

The following sections describe the ecological profile of the project area.

2.2.1 Ecoregions

These waterbodies flow through the Middle Rockies Level III ecoregion, and across four Level IV ecoregions: dry intermontane sagebrush valleys, Townsend-Horseshoe-London-sedimentary hills, and the Townsend Basin. Additionally, the watersheds for these streams include three more level IV ecoregions: alpine zone, dry gneissic-schistose-volcanic hills, and Tobacco Root Mountains. Ecoregions are mapped in **Figure 2-5**.

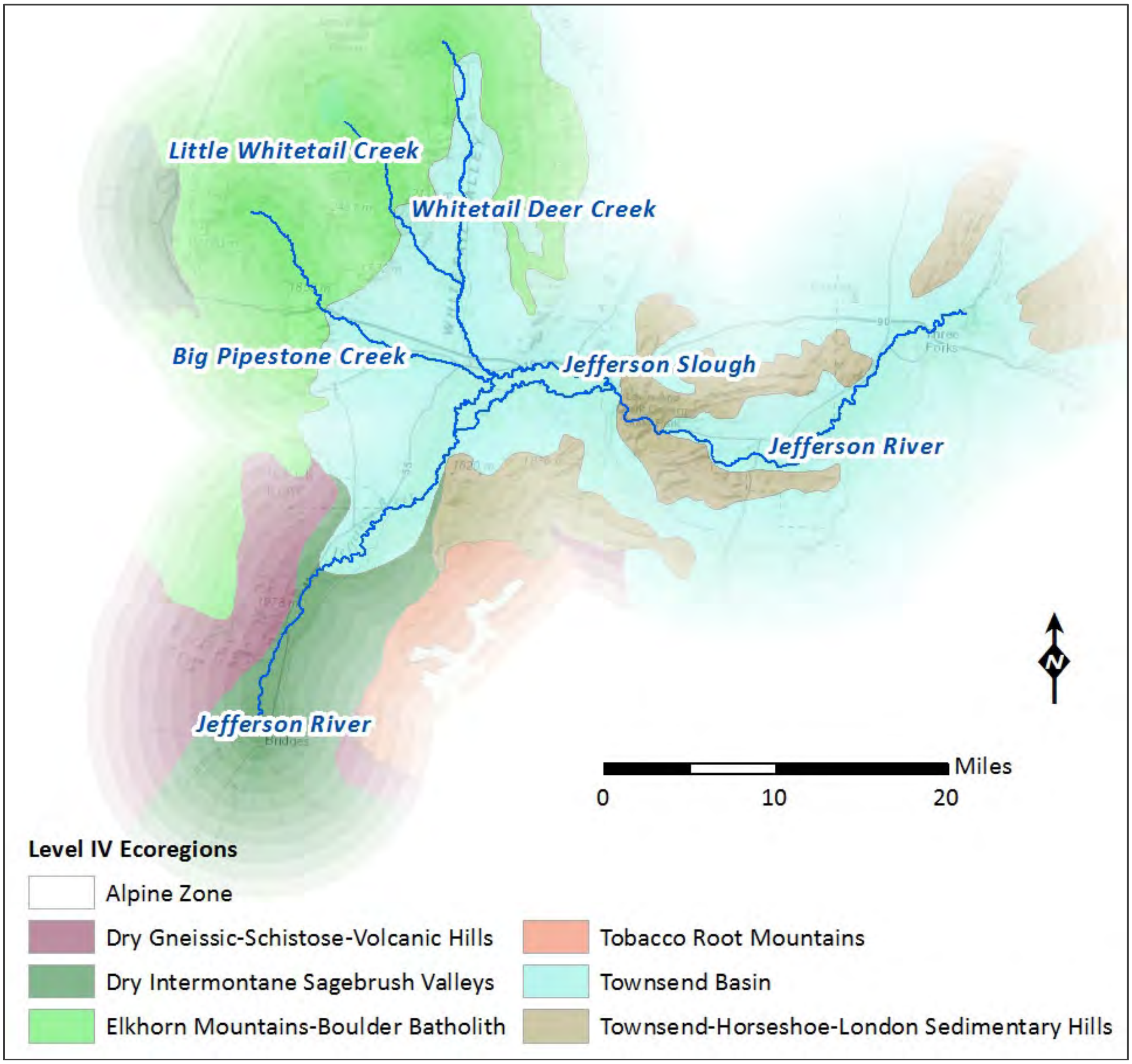

Figure 2-5. Level IV Ecoregions

2.2.2 Land Cover and Land Use

Land use and land cover data are provided by the National Land Cover Dataset (NLCD). The NLCD is a 16-class land cover classification scheme applied consistently across the conterminous United States at a spatial resolution of 30 meters (Fry et al., 2011). The 2006 NLCD is mapped in **Figure 2-6**.

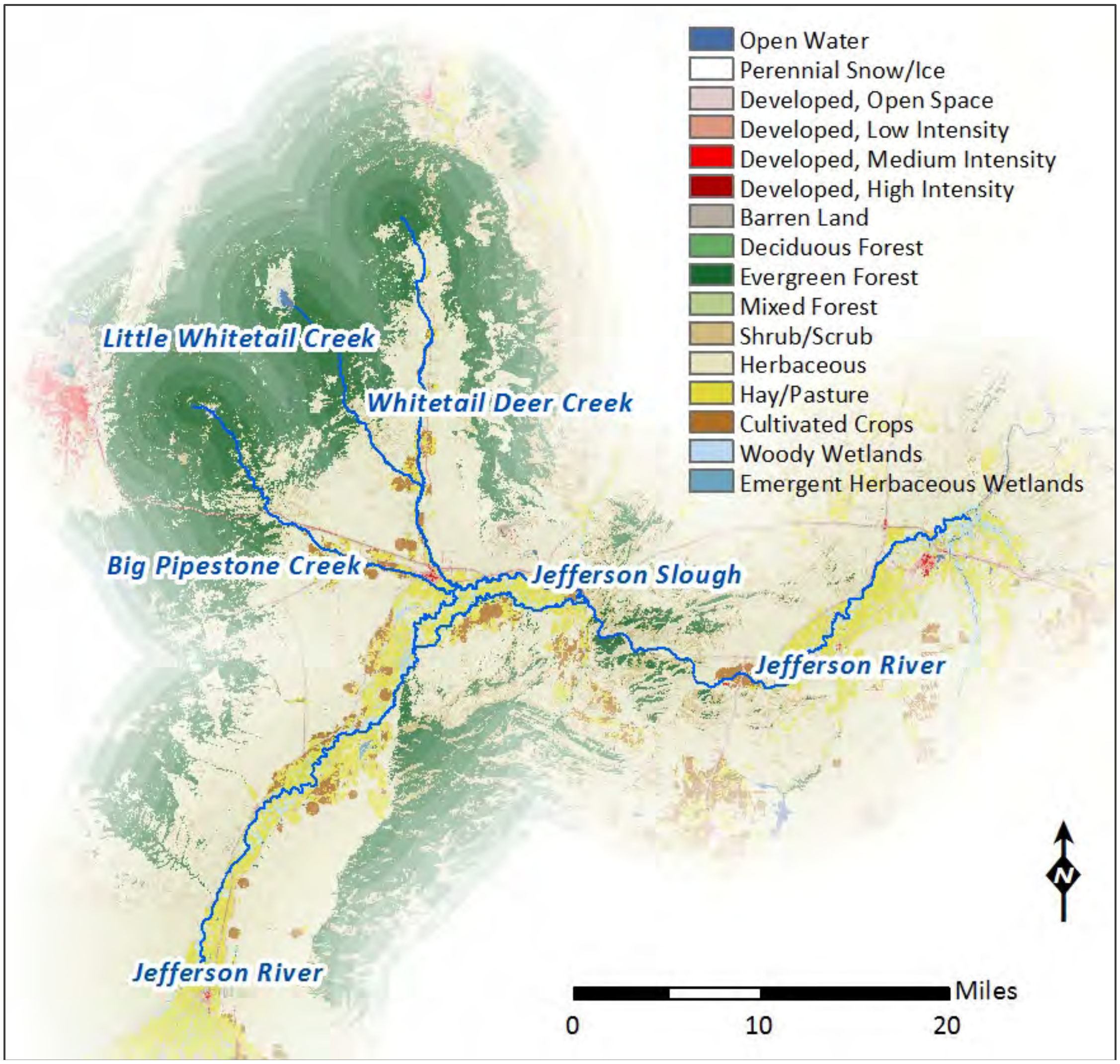

Figure 2-6. Land Use and Land Cover from the 2006 NLCD

2.2.3 Aquatic Life

Fish distribution is mapped by FWP and reported on the Internet via the MFISH site (Montana Department of Fish, Wildlife and Parks, 2014).

The Jefferson River hosts fish species common to this part of Montana, including: rainbow trout, brown trout, brook trout, mountain whitefish, burbot, carp, longnose dace, longnose sucker, Rocky Mountain sculpin, and white sucker. Westslope cutthroat trout are mapped in isolated tributaries. Westslope cutthroat trout are a Montana Species of Concern. Westslope cutthroat trout are mapped only in tributary streams. Arctic grayling, another Montana Species of Concern, are not found in the project area, although they are present in two tributary streams: the Beaverhead and Big Hole rivers. Distribution of selected species is mapped in **Figure 2-7**.

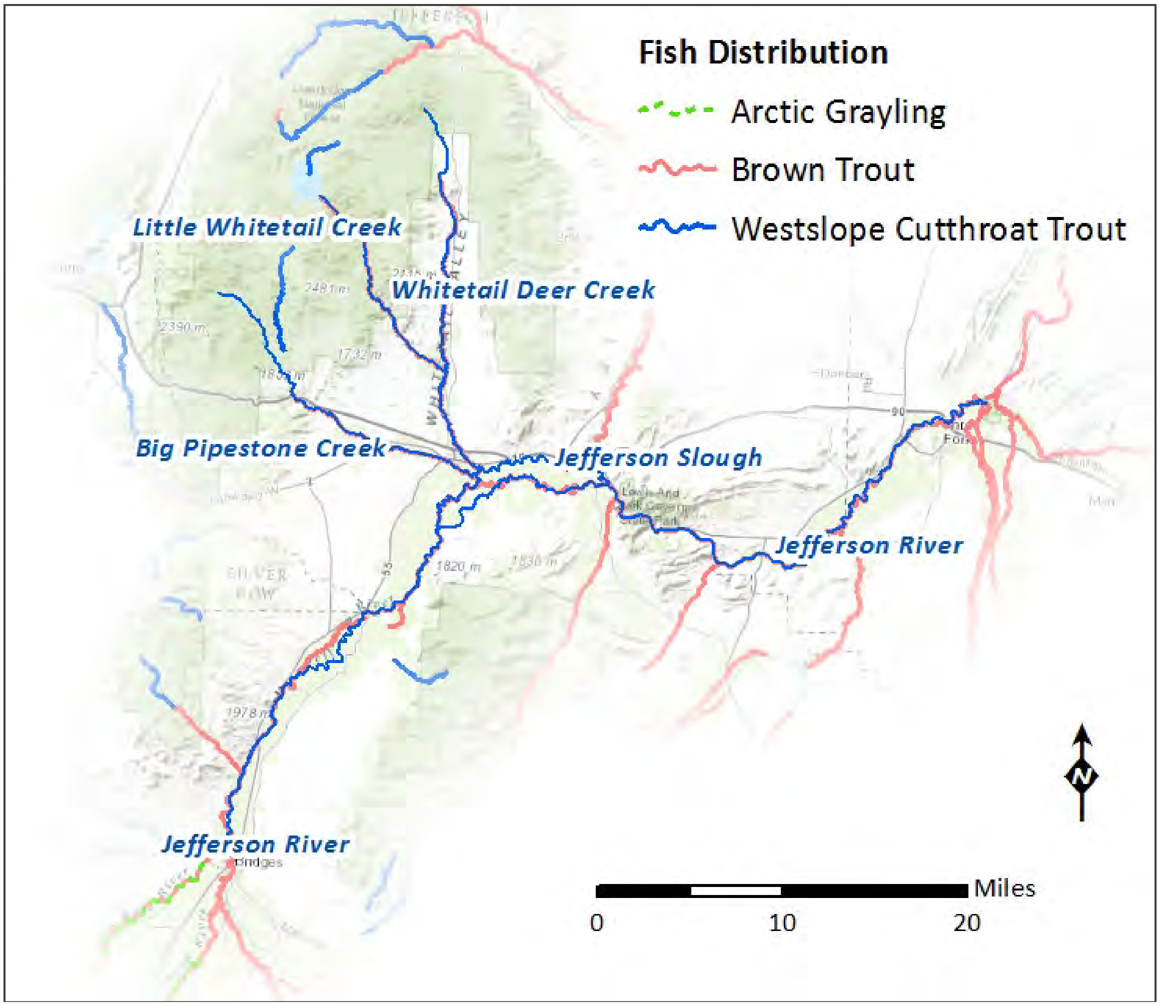

Figure 2-7. Distribution of Selected Fish Species

2.3 Cultural Profile

The following information describes the social profile of the Jefferson River corridor.

2.3.1 Population

Populations of communities located in the Jefferson valley are reported in the 2010 Census as:

- Twin Bridges: 375
- Silver Star: 141
- Whitehall: 1,038
- Cardwell: 50

2.3.2 Land Ownership

The majority of the land that the river and project streams flow past is privately owned, except for the headwaters of Big Pipestone and Little Whitetail creeks, where there are large expanses of U.S. Forest Service (USFS) and U.S. Bureau of Land Management (BLM) lands. Public lands lower in the watersheds include county and state rights-of-way for bridge crossings, FWP fishing access sites, and isolated State Trust and BLM lands. Public land ownership is illustrated on **Figure 2-8**.

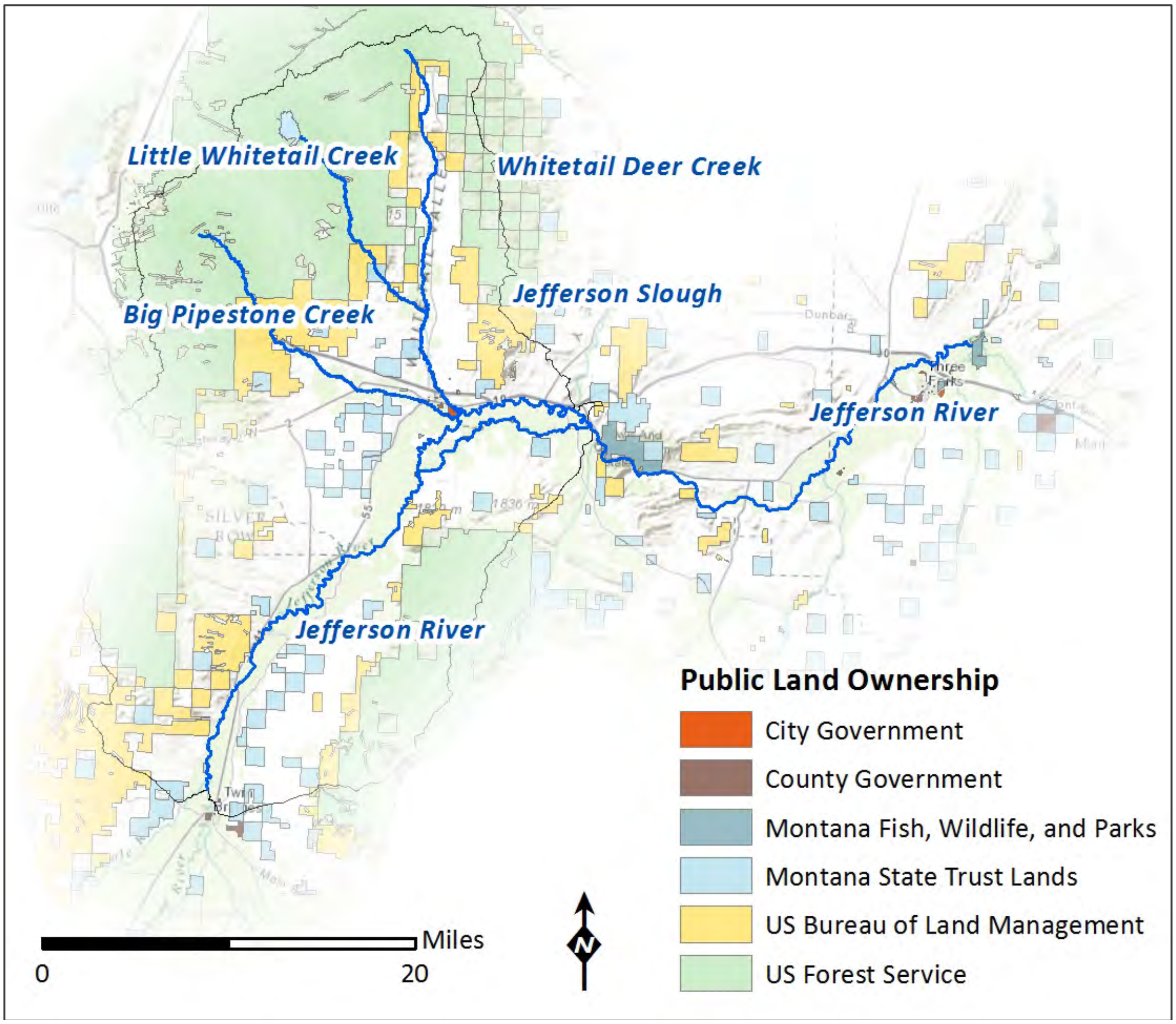

Figure 2-8. Public Land Ownership

2.3.3 Transportation Networks

The Jefferson River corridor hosts a number of major transportation routes, including Interstate I-90, state highway 41, and old highway 2. These routes parallel and cross the waterbodies in many locations. In some areas, the transportation networks restrict the stream channel. Conversely, there are also reaches along which roads are set back from the river.

2.3.4. Permitted Point Sources

Two wastewater treatment plants (WWTPs), three suction dredge operations and one stormwater discharge associated with industrial activity discharge to the stream segments included in this project. They are summarized below in **Table 2-3** and discussed in more detail in **Section 5.7.1.1**.

Table 2-3. Permitted Point Source in the Lower Beaverhead and Upper Jefferson Rivers

Facility Name	NPDES ID	Permit Type	Waterbody Name
Twin Bridges Wastewater Treatment Facility	MT0028797	Sewerage System	Upper Jefferson River
Whitehall Wastewater Treatment Facility	MT0020133	Sewerage System	Big Pipestone Creek
Golden Sunlight Mine	MTR000498	Stormwater	Jefferson Slough

Table 2-3. Permitted Point Source in the Lower Beaverhead and Upper Jefferson Rivers

Facility Name	NPDES ID	Permit Type	Waterbody Name
Steve Stoner	MTG370303	Suction Dredge	Big Pipestone Creek
William Duncan	MTG370328	Suction Dredge	Big Pipestone Creek
Sherwood Swanson	MTG370316	Suction Dredge	Lower Jefferson River

2.3.5 Mining History

The project area has a long history of metals mining. The Silver Star mining district was one of the first lode mining districts in Montana, with a major mine opening in 1867 (Montana Department of Environmental Quality, 2009). The Silver Star district produced early and faded early, declining by 1910. The Whitehall district, however, got a later start (Golden Sunlight Mine (GSM) was located in 1890) and is still a major producer in Montana.

Although not in the project area, the South Boulder or Mammoth district influences water quality in the Jefferson River. The district is located high in the South Boulder River Valley. The South Boulder River is a tributary to the Jefferson River. The Mammoth Mine was a major producer, with the largest production between 1924 and 1935 (Montana Department of Environmental Quality, 2009). As of 2012, Mammoth Mining, LLC continued to mine the 1930s-era tailings pile, sending the material to Golden Sunlight for processing (Montana Bureau of Mines and Geology, 2014) (http://www.mbmg.mtech.edu/gmr/gmr-mines_exploration.asp).

DEQ's inventory of abandoned mines, as well as the Priority Abandoned Mines, is mapped below on **Figure 2-9**.

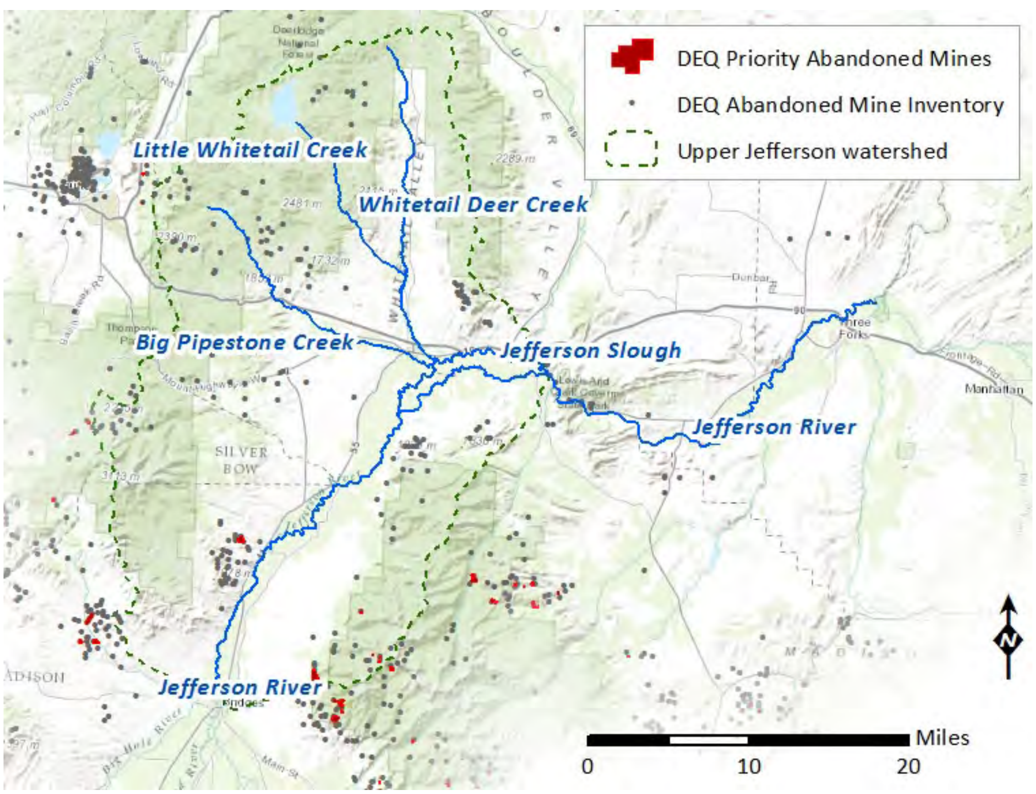

Figure 2-9. Abandoned Mines

3.0 MONTANA WATER QUALITY STANDARDS

The federal CWA 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)), 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, 2012c).

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 Jefferson River watershed are classified as B-1, which specifies that the water must be maintained suitable for all of the following uses (ARM (17.30.623(1), State of Montana, 2014[1]):

- 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. DEQ's water quality assessment methods are designed to evaluate the most sensitive uses for each pollutant group, thus ensuring protection of all designated uses (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2011). For streams in Western Montana, the most sensitive use assessed for metals are drinking water and/or aquatic life. DEQ determined that six waterbody segments in this project area do not meet the metals water quality standards (**Table 3-1**).

[1] State of Montana, Administrative Rules of Montana, 8/8/2014. http://mtrules.org/gateway/RuleNo.asp?RN=17%2E30%2E623

Table 3-1. Metals Impaired Waterbodies and Their Impaired Designated Uses in the Jefferson River TMDL Project Area Addressed Within this Document

Waterbody and Location Description	Waterbody ID	Impairment Cause[1]	Impaired Uses(s)
Big Pipestone Creek, Headwaters to mouth (Jefferson Slough), T1N R4W S11	MT41G002_010	Arsenic	Drinking Water
Jefferson River, Headwaters to confluence of Jefferson Slough	MT41G001_011	Iron	Aquatic Life
		Lead	Aquatic Life
Jefferson River, Confluence of Jefferson Slough to mouth (Missouri River)	MT41G001_012	Copper	Aquatic Life
		Lead	Aquatic Life
Jefferson Slough, Jefferson River to the mouth (Jefferson River)	MT41G002_170	Arsenic	Drinking Water
		Cadmium	Aquatic Life
		Copper	Aquatic Life
		Zinc	Aquatic Life
Little Whitetail Creek, Whitetail Reservoir to mouth (Whitetail Deer Creek)	MT41G002_140[2]	Aluminum	Aquatic Life
		Copper	Aquatic Life
		Lead	Aquatic Life
Whitetail Deer Creek, Headwaters to mouth (Jefferson Slough)	MT41G002_141[2]	Aluminum	Aquatic Life
		Lead	Aquatic Life

[1] Only includes those pollutant impairments addressed by TMDLs in this document.
[2] The assessment units (waterbody IDs) for Little Whitetail Creek and Whitetail Deer Creek are incorrectly defined in the 2012 Water Quality Integrated Report (see **Table A-1** and **Figure A-1** in **Appendix A**). The 2014 Integrated Report and this document reflect the corrected and redefined assessment units.

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 (HHSs) 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 (CAL) standards prevent long-term, low level exposure to pollutants. Acute Aquatic Life (AAL) 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.

For the Jefferson River TMDL Project Area, numeric standards are applied as the primary targets for metals impairment determinations and subsequent TMDL development. These targets address allowable water column chemistry concentrations. Narrative standards are also used to develop supplemental targets to address metals concentrations in stream sediment. **Section 5.4** defines the water quality criteria for the Jefferson River TMDL Project Area.

4.0 Defining TMDLs and Their Components

A 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: $TMDL = \Sigma WLA + \Sigma LA$, 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.

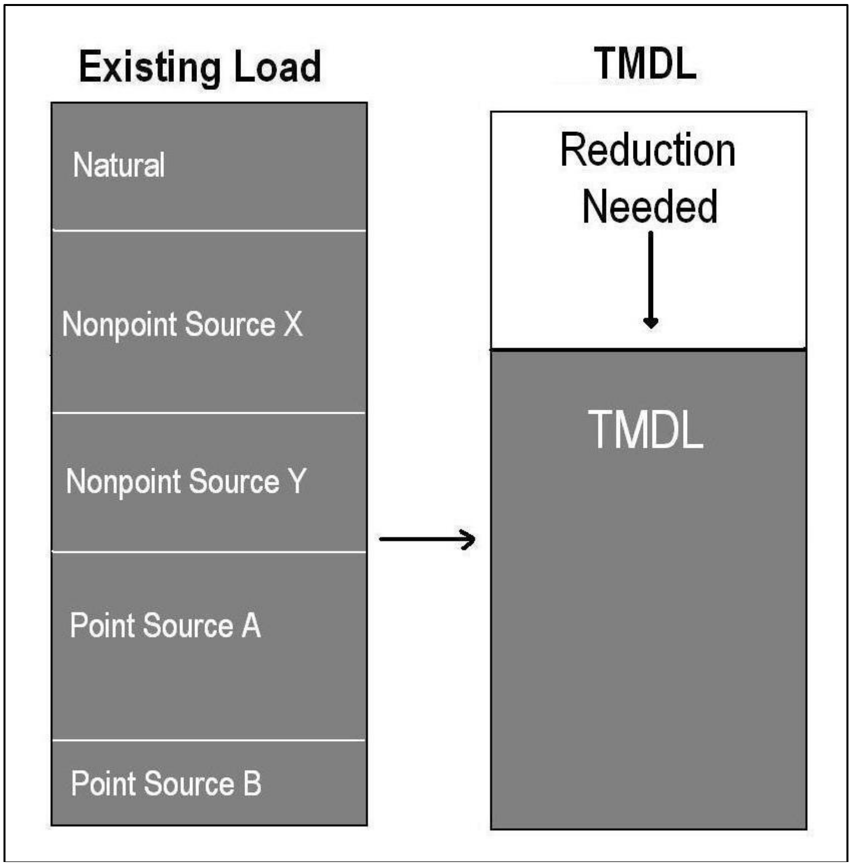

Figure 4-1. Schematic Example of TMDL Development

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., mining sources) and/or by land uses (e.g., forestry). 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 CWA. 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 (BMPs) 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 TMDL for all segments of the waterbody. **Figure 4-2** shows multiple point and nonpoint source allocations; however, composite allocations may be used in some cases where data is limited. Composite wasteload or load allocations provide stakeholders with flexibility in addressing sources, allowing them to choose where to focus remediation or restoration efforts.

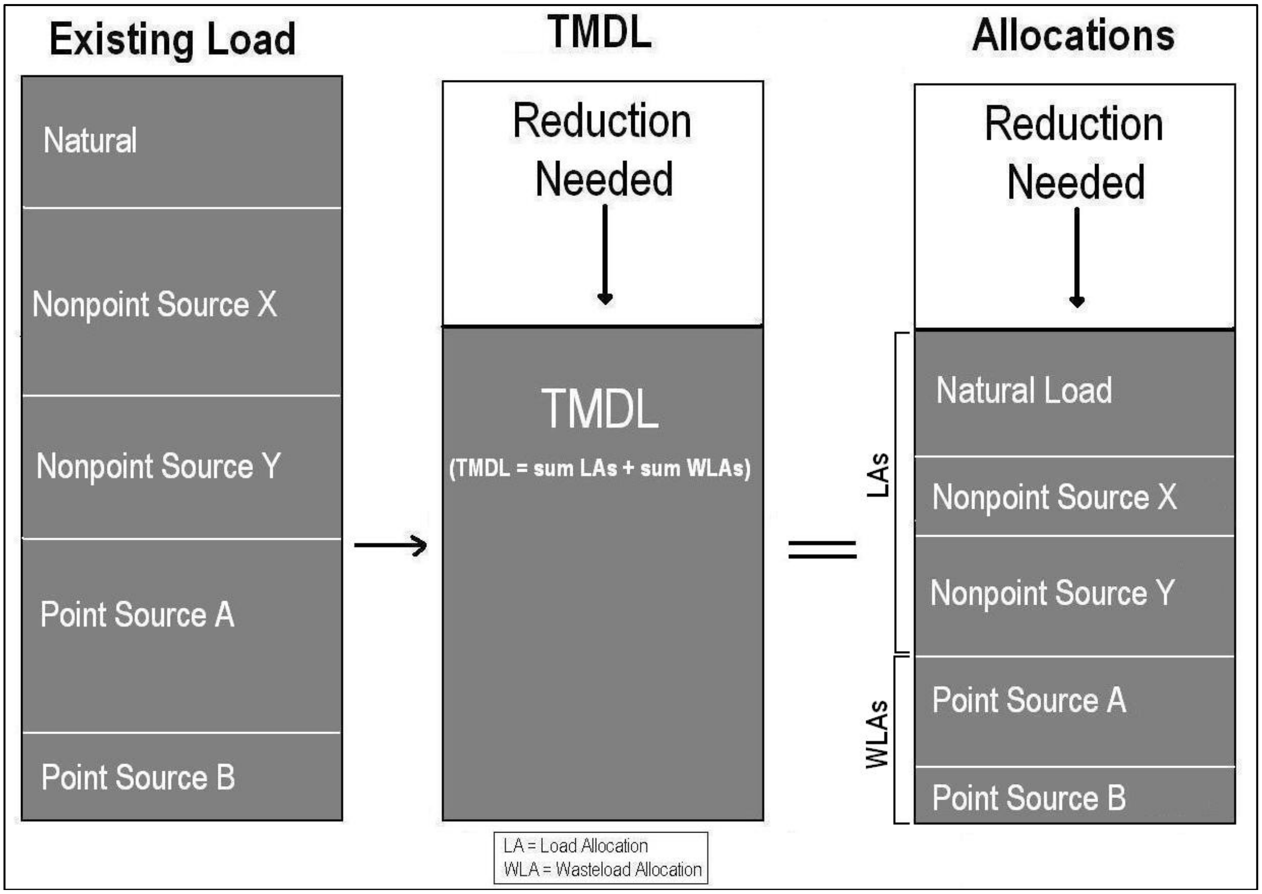

Figure 4-2. Schematic Diagram of a TMDL and Its Allocations

TMDLs must also incorporate an MOS. The MOS accounts for the uncertainty, or any lack of knowledge, about the relationship between the pollutant loads and the quality of the receiving waterbody. 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 (i.e., a TMDL = WLA + LA + MOS) (U.S. Environmental Protection Agency, 1999). The MOS 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 unless the loading from an individual point source is negligible based on no measureable impacts to water quality.

4.5 Implementing TMDL Allocations

The CWA and Montana state law (Section 75-5-703 of the Montana Water Quality Act) require WLAs to be incorporated into appropriate discharge permits, thereby providing a regulatory mechanism to achieve load reductions from point sources. Because of the limited regulatory requirements at the state and federal level, nonpoint source reductions linked to LAs are implemented primarily through voluntary measures, although there are some important nonpoint source regulatory requirements, such as Montana streamside management zone law and applicable septic system requirements. This document contains several key components to assist stakeholders in implementing nonpoint source controls. **Section 7.0** provides a water quality improvement plan that discusses restoration strategies and provides recommended BMPs per source category (e.g., grazing, mining). **Section 7.10** 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://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 7.0**). This includes a monitoring strategy and an implementation review that is required by Montana statute (Section 75-5-703 of the Montana Water Quality Act). TMDLs may be refined as new data become available, land uses change, or as new sources are identified.

5.0 METALS TMDL COMPONENTS

This portion of the document addresses metals water quality impairments in the Jefferson River TMDL Project Area. It includes:

- Effects on metals on designated beneficial uses
- Stream segments of concern
- Water quality data and information sources
- Water quality targets and comparison to existing conditions
- Metals TMDLs
- Metals source assessments
- Metals TMDL allocations

5.1 EFFECTS OF METALS ON DESIGNATED BENEFICIAL USES

Elevated concentrations of metals can impair the support of numerous beneficial uses including: aquatic life, primary contact recreation, 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. Because elevated metals concentrations can be toxic to plants and animals, high metals concentrations in irrigation or stock water may also affect agricultural uses. Although arsenic is technically a metalloid, it is treated as a metal for TMDL development due to the similarity in sources, environmental effects, and restoration strategies.

5.2 STREAM SEGMENTS OF CONCERN

Typically TMDL documents cover impairment causes identified on the most current 303(d) list. The most current 303(d) list was approved on September 30, 2014. Given that the majority of this TMDL document was developed prior to the approval of the 2014 303(d) List, DEQ has chosen use the 2012 303(d) List as the baseline for this document and will reference it as such.

Four waterbody segments in the Jefferson River TMDL Project Area are listed as impaired due to metals on the 2012 303(d) List and associated 2012 Water Quality Integrated Report (IR). These waterbodies include Whitetail Deer Creek, Cherry Creek the upper Jefferson River and the lower Jefferson River. While not listed on the 2012 303(d) List, Big Pipestone Creek, Little Whitetail Creek, and the Jefferson Slough were found to be impaired for metals; therefore TMDLs were developed for these waterbodies. There are several waterbody-pollutant combinations that are identified as impaired in the 2012 303(d) List that are not covered in this document. These include the South Boulder River, which is impaired for copper and lead; North Willow Creek, which is impaired for lead and mercury; South Willow Creek that is impaired for zinc; Willow Creek that is impaired for zinc; and Norwegian Creek that is impaired for arsenic (**Table A-1** in **Appendix A**) (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012). These waterbody-pollutant combinations will be re-assessed for metals impairment in the future and if they are determined to be impaired for a metal(s), they will undergo TMDL development. Additional information regarding the specific metals impairments identified on the 2012 303(d) List is contained within **Table A-1** in **Appendix A.**

The stream names and the assessment unit identifications (IDs) for Little Whitetail Creek and Whitetail Deer Creek were incorrectly defined in the 2012 Water Quality IR. **Table A-1** and **Figure A-1** in **Appendix A** shows the original name structure given to these streams. The 2014 IR was updated with the correct and current names for each of these streams. This document reflects the corrected and redefined stream names and assessment unit IDs. **Tables DS-1, 1-1, 3-1** and all subsequent tables and text reference the correct stream names for Little Whitetail and Whitetail Deer creeks. To help the reader understand the name changes to these streams and the effects the names changes have on TMDL development, the following explanation is provided:

Whitetail Deer Creek was changed as follows:

- Changed assessment unit identification number from MT41G002_140 to MT41G002_141
- Changed name from Whitetail Creek to Whitetail Deer Creek
- Changed location description from WHITETAIL CREEK, Whitetail Reservoir to mouth (Jefferson Slough) to WHITETAIL DEER CREEK, headwaters to mouth (Jefferson Slough)
- Changed upstream endpoint from 46.072899/-112.21807 to 46.143562/-112.147616 (downstream endpoint remained the same)
- Changed stream length from 23.4 mi to 27.13 mi

Little Whitetail Creek was changed as follows:

- Changed the assessment unit identification number from MT41G002_141 to MT41G002_140
- Changed the location description from LITTLE WHITETAIL CREEK, headwater to mouth (Whitetail Creek) to LITTLE WHITETAIL CREEK, Whitetail Reservoir to mouth (Whitetail Deer Creek)

DEQ performed updated assessments on seven waterbody segments (Little Whitetail, Whitetail Deer, Big Pipestone, and Cherry Creeks as well as the Jefferson Slough and the upper and lower segments of the Jefferson River), using the data sources defined below in **Section 5.3**. The updated assessments were performed in 2013 after concerted data collection efforts as part of the TMDL process (see **Section 5.4.3**). As a result of the updated assessment, six impairments on the 2012 303(d) List were confirmed, and eight new impairments were identified. The new assessment determinations are recorded in the 2014 303(d) List. All 14 of these updated metals impairments have TMDLs established in the document.

The updated assessments confirmed metals impairment conditions for Whitetail Deer Creek and the upper and the lower segments of the Jefferson River (**Figure 5-1**). Little Whitetail Creek, Big Pipestone Creek and the Jefferson Slough were found to have new impairments as a result of the updated assessment. The metals with confirmed impairment conditions include aluminum (Al), arsenic (As), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), and zinc (Zn). The metals assessment results for these six waterbody segments are included within **Section 5.4.3**. For each stream, results are provided for those metals causing impairment. Results are also provided for those metals that are not causing impairment but were previously identified as a cause of impairment on the 2012 303(d) List.

Cherry Creek, which was originally listed on the 2012 303(d) List as being impaired for zinc, was determined to not be impaired and is not discussed in **Section 5.4.3**. Recent water quality data (2003-2013) from Cherry Creek was used in the re-assessment process, and the 10% exceedance rate used for impairment determination was not exceeded (**Section 5.4.2.1**).

Figure 5-1. Metals Impaired Waterbodies in the Jefferson River TMDL Project Area

5.3 Water Quality Data and Information Sources

The data and information used in this report was obtained from the U.S. Geological Survey and DEQ water and sediment quality sampling conducted from 2004-2013. In accordance with DEQ's data quality objectives (DQOs) guidance (discussed further in **Section 5.8**) 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.

DEQ data is the most recent, and provides the basis for the existing condition analyses, TMDLs, and allocations in this document. In most cases, water quality was analyzed for a standard suite of metals. The standard suite of metals includes aluminum, arsenic, cadmium, chromium, copper, iron, lead, selenium, silver and zinc. Those metals that were historically listed on the 303(d) list, or identified as causing impairment, are discussed in the following sections. The water and sediment metals data used for analysis in this report is attached in **Appendix B**. Data summaries of relevant water quality and sediment quality parameters for each metals-impaired waterbody segment are provided in **Section 5.4**.

5.4 Water Quality Targets and Comparison to Existing Conditions

DEQ compiled the water quality data described in **Section 5.4.2** 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 5.4.1** presents the evaluation framework, the metals water quality targets used in the evaluation, and the results of these evaluations for each impaired waterbody.

5.4.1 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 5.4.2**).

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 5.4.2**.

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, the waterbody-pollutant combination remains unlisted, or if it was historically listed, it is removed from the subsequent 303(d) list.

5.4.2 Metals Water Quality Targets

Water quality targets for metals-related impairments in the Jefferson River TMDL Project Area include both water chemistry targets and sediment chemistry targets. The water chemistry targets are based on numeric human health standards (HHSs) and both Chronic Aquatic Life (CAL) and Acute Aquatic Life (AAL) standards, as defined in DEQ Circular DEQ-7 (Montana Department of Environmental Quality, 2012c). Sediment chemistry targets are adopted from numeric screening values for metals in freshwater sediment established by the National Oceanographic and Atmospheric Administration (NOAA).

5.4.2.1 Water Chemistry Targets

Most metals pollutants have numeric water quality criteria defined in Circular DEQ-7 (Montana Department of Environmental Quality, 2012c). 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 (**Section 3.0**). 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 in order to protect all beneficial uses. 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 (AAL and CAL, 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 5-1**. These criteria translate into the applicable water quality targets and are expressed in micrograms per liter (µg/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 aluminum and arsenic do not have variable criteria. The acute and chronic criteria are fixed and do not fluctuate with changes in hardness. The CAL and AAL 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 AAL or CAL target, then the waterbody is considered impaired for that pollutant.
- If both the AAL and CAL 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 AAL 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 5-1. Metals Numeric Water Chemistry Targets Applicable to the Jefferson River 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 (µg/L)
	Acute	Chronic	Acute	Chronic	
Aluminum, D*	750	87	750	87	NA
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
Iron, TR	NA	1,000	NA	1,000	NA
Lead, TR	14.0	0.54	477	18.5	15
Zinc, TR	37.0	37.0	388	388	2,000

* D = dissolved, ** TR = total recoverable, NA = not applicable

5.4.2.2 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 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 (PELs). 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, 1999). 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 5-2 contains the PEL values (in parts per million) for metals of concern in the Jefferson River TMDL Project Area.

Table 5-2. Screening Level Criteria for Sediment Metals Concentrations

Metal of Concern	PEL (mg/kg or parts per million)
Aluminum	Not Applicable
Arsenic	17.0
Cadmium	3.53
Copper	197
Iron	Not Applicable
Lead	91.3
Zinc	315

5.4.3 Existing Conditions and Comparison with Water Quality Targets

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 Jefferson River TMDL Project Area for the purpose of reassessing the metals impairment determinations. This data provides the basis for the metals target evaluations below.

Metals data is assessed seasonally; this is because metals loading pathways and water hardness change from high to low flow conditions. Hardness tends to be lower during higher flow conditions, which leads to lower water quality standards for hardness-dependent metals during the runoff season. As such, seasonally high flow (April1- through May 31) and low flow (June 1 through March 31) data are presented for each of the stream segments in the following sections.

5.4.3.1. Little Whitetail Creek MT41G002_140

Little Whitetail Creek, from Whitetail Reservoir to the mouth (Whitetail Deer Creek), is not listed in the 2012 IR as being impaired for any metals. Data compilation, collection and analysis identify the need for aluminum, copper and lead.

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 2004-2013 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 5-3** and **5-4**.

Table 5-3. Little Whitetail Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Aluminum	Copper	Lead
# Samples	10	12	12
Minimum values (µg/L)	29	1	<0.5
Maximum Values (µg/L)	290	9	6
# Acute Exceedances	0	4	0
Acute Exceedance Rate	0.0%	33.3%	0.0%
# Chronic Exceedances	7	7	8
Chronic Exceedance Rate	70.0%	58.3%	66.7%
# Samples >2X the Acute Standard	0	2	0
# Human Health Exceedances	0	0	0
HHS Exceedance Rate	0.0%	0.0%	0.0%

*All units, with the exception of aluminum, reported in µg/L are total recoverable fraction. Aluminum is reported in the total dissolved fraction.

Table 5-4. Little Whitetail Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Aluminum **	Copper	Lead
# Samples	0	1	1
Minimum (mg/kg)	NA	33.3	44.1
Maximum (mg/kg)	NA	33.3	44.1
PEL Value (mg/kg)	NA	197	91.3
# Samples> 2X PEL	NA	0	0
>2X PEL Exceedance Rate	NA	0.0%	0.0%

*All units in mg/kg are dry weight
** No PEL exists for aluminum (NA = Not Applicable)

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination
Each pollutant is discussed individually. The discussions are summarized below in **Table 5-5**.

<u>Aluminum</u>
Little Whitetail Creek was not listed as impaired by aluminum in the 2012 IR. Data collected from 2010-2013 indicated that seven of 10 samples (70.00%) exceeded chronic targets. Because metals concentrations were found to be above the CAL target in more than 10% of the samples, aluminum will be listed as a cause of impairment to Little Whitetail Creek and a TMDL will be developed. No sediment data was collected for aluminum, as no PEL exists for aluminum.

<u>Copper</u>
Little Whitetail Creek was not listed as impaired by copper in the 2012 IR. Data collected from 2004-2013 indicated that seven of 12 samples (58.3%) exceeded chronic targets. This same data indicated that two samples were greater than 2X the AAL target. Because copper concentrations were greater than the chronic exceedance target and greater than twice the aquatic life target copper will be listed as a cause of impairment to Little Whitetail Creek and a TMDL will be developed. Sediment data collected during the same time period showed metals concentrations did not exceed 2X the PEL.

<u>Lead</u>
Little Whitetail Creek was not listed as impaired by lead in the 2012 IR. Data collected from 2004-2013 indicated that eight of 12 samples (66.7%) exceeded chronic targets. Because lead concentrations were found to be above the CAL in more than 10% of the samples, lead will be listed as a cause of impairment to Little Whitetail Creek and a TMDL will be developed. Sediment data collected during the same time period showed metals concentrations did not exceed 2X the PEL.

Little Whitetail Creek TMDL Development Summary
As discussed above and summarized in **Table 5-5**, aluminum, copper and lead TMDLs are developed for Little Whitetail Creek. These impairment conditions are summarized in **Table 5-5**, and are documented within DEQ's assessment files and are included in the 2014 IR.

Table 5-5. Little Whitetail Creek Metals TMDL Decision Factors

Parameter	Aluminum	Copper	Lead
Number of Samples	10	12	12
CAL exceedance rate >10%?	Yes	Yes	Yes
Greater than 2X AAL target exceeded?	No	Yes	No
Human Health target exceeded?	No	No	No
2X NOAA PEL exceeded?	NA	No	No
Human-caused sources present?	Yes	Yes	Yes
2012 303(d) listed?	No	No	No
TMDL developed?	**Yes**	**Yes**	**Yes**

NA = Not Applicable

Figure 5-2 plots those metals for which TMDL development will take place. This is provided to help illustrate the magnitude and seasonality of target exceedances. All metals impairments for Little Whitetail Creek will require greater reductions during high flow than during low flow, as shown in **Figure 5-2**. Aluminum, copper and lead exceed the target by the greatest degree when flows were high, and require reductions of up to 62.2, 65.1 and 83.9%, respectively during high flow (**Table 5-22**). The targets for aluminum, copper and lead are generally met during low flow conditions.

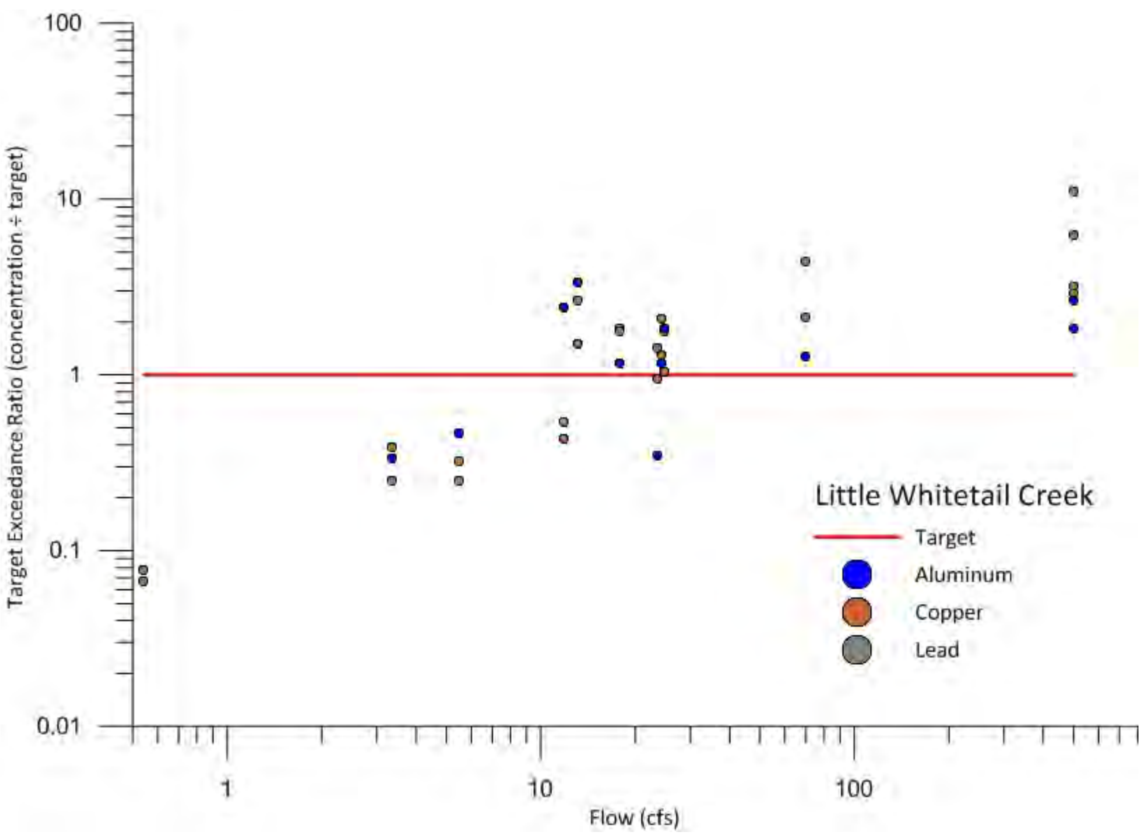

Figure 5-2. Metals Concentrations Relative to Targets in Little Whitetail Creek

5.4.3.2. Whitetail Deer Creek MT41G002_141

Whitetail Deer Creek, from the headwaters to the mouth (Jefferson Slough), is listed in the 2012 IR as being impaired for aluminum, copper, lead and silver. Data compilation, collection and analysis confirm the need for aluminum and lead, and alleviate the need for copper and silver TMDL's.

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 2004, 2006, 2009-2013 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 5-6** and **5-7**.

Table 5-6. Whitetail Deer Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Aluminum	Copper	Lead	Silver
# Samples	19	23	23	20
Minimum values (µg/L)	<100	1	<0.5	<0.2
Maximum Values (µg/L)	520	6	4	0.3
# Acute Exceedances	0	0	0	0
Acute Exceedance Rate	0.0%	0.0%	0.0%	0.0%
# Chronic Exceedances	8	1	5	0
Chronic Exceedance Rate	42.11%	4.35%	21.7%	0.0%
# Samples >2X the Acute Standard	0	0	0	0
# Human Health Exceedances	0	0	0	0
HHS Exceedance Rate	0.0%	0.0%	0.0%	0.0%

*All units with the exception of aluminum, reported in µg/L are total recoverable fraction. Aluminum is reported in the dissolved fraction.

Table 5-7. Whitetail Deer Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Aluminum**	Copper	Lead	Silver**
# Samples	0	1	1	0
Minimum (mg/kg)	NA	18.8	20.6	NA
Maximum (mg/kg)	NA	18.8	20.6	NA
PEL Value (mg/kg)	NA	197	91.3	NA
# Samples> 2X PEL	NA	0	0	NA
>2X PEL Exceedance Rate	NA	0.0%	0.0%	NA

*All units in mg/kg are dry weight
**There is no aluminum or silver PEL (NA = Not Applicable)

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

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

<u>Aluminum</u>

Whitetail Deer Creek was listed as impaired by aluminum in the 2012 IR. Data collected from 2004-2013 indicated that eight of 19 samples were above the CAL target. Because metals concentrations were found to be above the CAL target in 10% of the samples, aluminum will be listed as a cause of impairment to Whitetail Deer Creek and a TMDL will be developed. No sediment data was collected during the same time period, as no aluminum PEL is exists.

<u>Copper</u>

Whitetail Deer Creek was listed as impaired by copper in the 2012 IR. Data collected from 2004-2013 indicated that one of 23 samples (4.35%) exceeded chronic targets. Because copper concentrations were below the chronic exceedance rate and sediment concentrations were less than 2X the PEL, copper will not be listed as a cause of impairment to Whitetail Deer Creek and a TMDL will not be developed.

Lead

Whitetail Deer Creek was listed as impaired by lead in the 2012 IR. Data collected from 2004-2013 indicated that five of 23 sample exceeded (21.7%) exceeded the CAL target. Because of this exceedance rate, lead will be listed as a cause of impairment to Whitetail Deer Creek and a TMDL will be developed. Sediment data collected during the same time period did not exceed 2X the PEL.

Silver

Whitetail Deer Creek was listed as impaired by silver in the 2012 IR. Data collected from 2004-2013 indicated that no samples exceeded CAL or AAL targets. Because silver concentrations were below the targets, silver will not be listed as a cause of impairment to Whitetail Deer Creek and a TMDL will not be developed. There is no sediment PEL for silver to assess the effects of metals pollution.

Whitetail Deer Creek TMDL Development Summary

As discussed above and summarized in **Table 5-8**, aluminum and lead TMDLs are developed for Whitetail Deer Creek. These impairment conditions are summarized in **Table 5-8**, and are documented within DEQ's assessment files and are included in the 2014 IR.

Table 5-8. Whitetail Deer Creek Metals TMDL Decision Factors

Parameter	Aluminum	Copper	Lead	Silver
Number of Samples	19	23	23	20
CAL exceedance rate >10%?	Yes	No	Yes	No
Greater than 2X AAL target exceeded?	No	No	No	No
Human Health target exceeded?	No	No	No	No
2X NOAA PEL exceeded?	NA	No	No	NA
Human-caused sources present?	Yes	Yes	Yes	Yes
2012 303(d) listed?	Yes	Yes	Yes	Yes
TMDL developed?	**Yes**	**No**	**Yes**	**No**

NA = Not Applicable

Figure 5-3 plots those metals for which TMDL development will take place in Whitetail Deer Creek. This is provided to help illustrate the magnitude and seasonality of target exceedances. All metals impairments for Whitetail Deer Creek will require greater reductions during high flow than during low flow, as shown in **Figure 5-3**. Aluminum and lead exceed the target by the greatest degree when flows were high, and require reductions of up to 42 and 49.3%, respectively, during high flow (**Table 5-22**). The targets for aluminum, lead are generally met during low flow conditions.

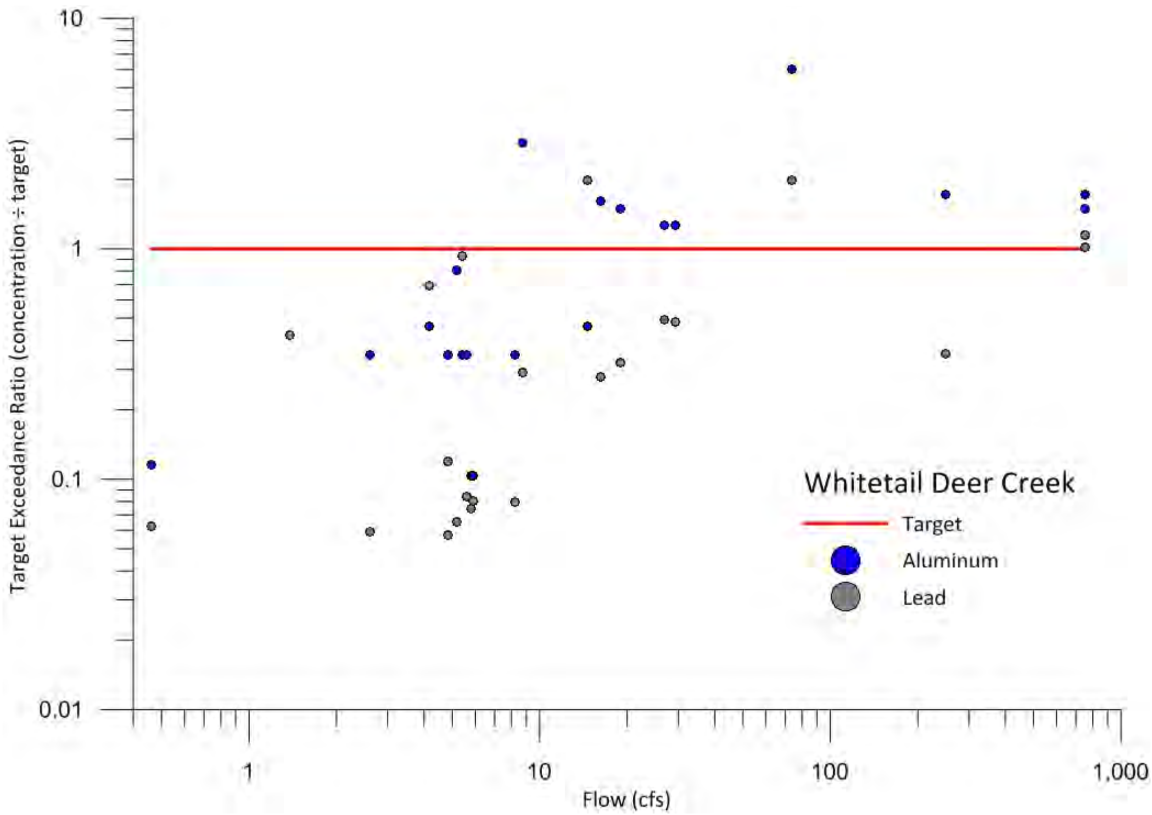

Figure 5-3. Metals Concentrations Relative to Targets in Whitetail Deer Creek

5.4.3.3. Big Pipestone Creek MT41G002_010

Big Pipestone Creek, from the headwaters to the mouth (Jefferson Slough), was not listed in the 2012 IR as being impaired for any metals. Recent data compilation, collection and analysis confirm the need for an arsenic TMDL.

Available Water Quality Data

DEQ used recent metals water quality data to evaluate current conditions relative to water quality targets. Data used were recent 2012-2013 synoptic high and low flow sampling data collected by DEQ for subsequent TMDL development support. The water sample results for those metals exhibiting impairment are compared to water chemistry in **Tables 5-9**. Limited water quality and no sediment data were collected for Big Pipestone Creek. This was a result of sampling on Big Pipestone being part of the Jefferson Slough source assessment purposes. While only three water quality samples were collected on Big Pipestone Creek, numerous flow measurements have been recorded. Flow data exist for 2004, 2006, 2009, 2010, 2012 and 2013. The average high and low flow data from this data set is 30.45 cfs and 6.48 cfs, respectively. Flow recorded when the three water quality samples were collected were reported as 1.89 cfs (October 2012), 1.02 cfs (May 2012) and 0.41 cfs (May 2012). Typically water quality samples collected in May would be considered high flow samples, however the two flow measurement from May are well below the average low flow value. As a result, these two specific flow data and associated water quality data will be considered low flow values for the purpose of this document and TMDL development.

Table 5-9. Big Pipestone Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Arsenic
# Samples	3
Minimum values (µg/L)	4
Maximum Values (µg/L)	11
# Acute Exceedances	0
Acute Exceedance Rate	0.0%
# Chronic Exceedances	0
Chronic Exceedance Rate	0.0%
# Samples >2X the Acute Standard	0
# Human Health Exceedances	1
HHS Exceedance Rate	33.3%

*All units in µg/L are total recoverable fraction

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination
Arsenic is discussed specifically below. The discussion is summarized below in **Table 5-10**.

Arsenic
Big Pipestone Creek was not listed as impaired by arsenic in the 2012 IR. Data collected from 2012-2013 indicated that one sample was above the human health target. Because metals concentrations were found to be above the human health target, arsenic will be listed as a cause of impairment to Big Pipestone Creek and a TMDL will be developed. No sediment data were collected during the same time period.

Big Pipestone Creek TMDL Development Summary
As discussed above and summarized in **Table 5-10**, an arsenic TMDL is developed for Big Pipestone Creek. These impairment conditions are summarized in **Table 5-10**, and are documented within DEQ's assessment files and will be included in the 2014 IR.

Table 5-10. Big Pipestone Creek Metals TMDL Decision Factors

Parameter	Arsenic
Number of Samples	3
CAL exceedance rate >10%?	No
Greater than 2X AAL target exceeded?	No
Human Health target exceeded?	Yes
2X NOAA PEL exceeded?	No
Human-caused sources present?	Yes
2012 303(d) listed?	No
TMDL developed?	**Yes**

Arsenic impairment for Big Pipestone Creek will require reductions during low flow. Arsenic exceed the target by the greatest degree when flows were low, and may require reductions of up to 9.1% during low flow (**Table 5-22**). There was limited high flow data for arsenic, as such it is unknown if the targets for arsenic are being met during high flow conditions.

5.4.3.4. Jefferson Slough MT41G002_170

The Jefferson Slough, from the Jefferson River to the mouth (Jefferson River), is not listed in the 2012 IR as being impaired for any metals. Data compilation, collection and analysis identify the need for arsenic, cadmium, copper and zinc 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 2010-2013 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 5-11** and **5-12**.

Table 5-11. Jefferson Slough Metals Water Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Zinc
# Samples	10	10	14	10
Minimum values (µg/L)	5	<.03	1	<8
Maximum Values (µg/L)	13	0.48	31	100
# Acute Exceedances	0	0	1	1
Acute Exceedance Rate	0.0%	0.0%	7.14%	10.0%
# Chronic Exceedances	0	1	1	1
Chronic Exceedance Rate	0.0%	10.0%	7.14%	10.0%
# Samples >2X the Acute Standard	0	1	0	0
# Human Health Exceedances	2	0	0	0
HHS Exceedance Rate	20.0%	0.0	0.0%	0.0%

*All units in µg/L are total recoverable fraction

Table 5-12. Jefferson Slough Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Zinc
# Samples	1	1	1	1
Minimum (mg/kg)	54	8.3	294	1440
Maximum (mg/kg)	54	8.3	294	1440
PEL Value (mg/kg)	17.0	3.53	197	315
# Samples> 2X PEL	1	1	0	1
>2X PEL Exceedance Rate	100%	100%	0.0%	100%

*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 5-13**.

Arsenic

The Jefferson Slough was not listed as impaired by arsenic in the 2012 IR. Data collected from 2010-2013 indicated that two samples were above the human health target. Sediment data collected during the same time period showed metals concentrations exceeded 2X the PEL. Because metals concentrations were found to be above the human health targets, arsenic will be listed as a cause of impairment to the Jefferson Slough and a TMDL will be developed.

Cadmium

The Jefferson Slough was not listed as impaired by cadmium in the 2012 IR. Data collected from 2010-2013 indicated that one of 10 samples (10.00%) exceeded chronic targets. Sediment data collected during the same time period showed metals concentrations exceeded 2X the PEL. A data set needs to exceed the greater than 10 % exceedance rate to be considered not attaining water quality standards and to be listed as impaired and undergo TMDL development. Because cadmium concentrations were exactly at the chronic exceedance (10%) and the sediment concentrations exceeded 2X the PEL, DEQ has chosen to list cadmium as a cause of impairment based on magnitude of the sediment exceedance even though water quality data met target concentrations. As such, a TMDL will be developed for cadmium in the Jefferson Slough. For additional information on the use of sediment data in the impairment determination process see **Section 5.4.2.2**.

Copper

The Jefferson Slough was not listed as impaired by copper in the 2012 IR. Data collected from 2010-2013 indicated that one sample exceeded 2X the acute target. Because of this exceedance copper will be listed as a cause of impairment to the Jefferson Slough and a TMDL will be developed.

Zinc

The Jefferson Slough was not listed as impaired by zinc in the 2012 IR. Data collected from 2010-2013 indicated that one of 10 samples (10.00%) exceeded chronic targets. Sediment data collected during the same time period showed metals concentrations exceeded 2X the PEL. A data set needs to exceed the greater than 10 % exceedance rate to be considered not attaining water quality standards and to be listed as impaired and undergo TMDL development. Because zinc concentrations were exactly at the chronic (10%) exceedance and the sediment concentrations exceeded 2X the PEL, DEQ has chosen to list zinc as a cause of impairment based on magnitude of the sediment exceedance even though water quality data met target concentrations. As such, a TMDL will be developed for zinc in the Jefferson Slough. For additional information on the use of sediment data in the impairment determination process see **Section 5.4.2.2**.

Jefferson Slough TMDL Development Summary

As discussed above and summarized in **Table 5-13**, Arsenic, cadmium, copper and zinc TMDLs are developed for the Jefferson Slough. These impairment conditions are summarized in **Table 5-13**, and are documented within DEQ's assessment files and are included in the 2014 IR.

Table 5-13. Jefferson Slough Metals TMDL Decision Factors

Parameter	Arsenic	Cadmium	Copper	Zinc
Number of Samples	10	10	14	10
CAL exceedance rate >10%?	No	No*	No	No*
Greater than 2X AAL target exceeded?	No	No	Yes	No
Human Health target exceeded?	Yes	No	No	No
2X NOAA PEL exceeded?	Yes	Yes	No	Yes
Human-caused sources present?	Yes	Yes	Yes	Yes
2012 303(d) listed?	No	No	No	No
TMDL developed?	**Yes**	**Yes**	**Yes**	**Yes**

*Cadmium and Copper exceedance rates were at exactly 10%, not exceeding. However, this in combination with sediment concentrations exceeding 2X the PEL requires TMDL development.

Figure 5-4 plots those metals for which TMDL development will take place in Jefferson Slough. This is provided to help illustrate the magnitude and seasonality of target exceedances. All metals impairments for the Jefferson Slough will require greater reductions during high flow than during low flow, as shown in **Figure 5-4**. Arsenic, cadmium, copper and zinc exceed the targets by the greatest degree when flows were high, and may require reductions of up to 23.1, 55.4, 77 and 8.2%, respectively, during high flows (**Table 5-22**). The targets for arsenic, cadmium, copper and zinc are generally met during low flow conditions.

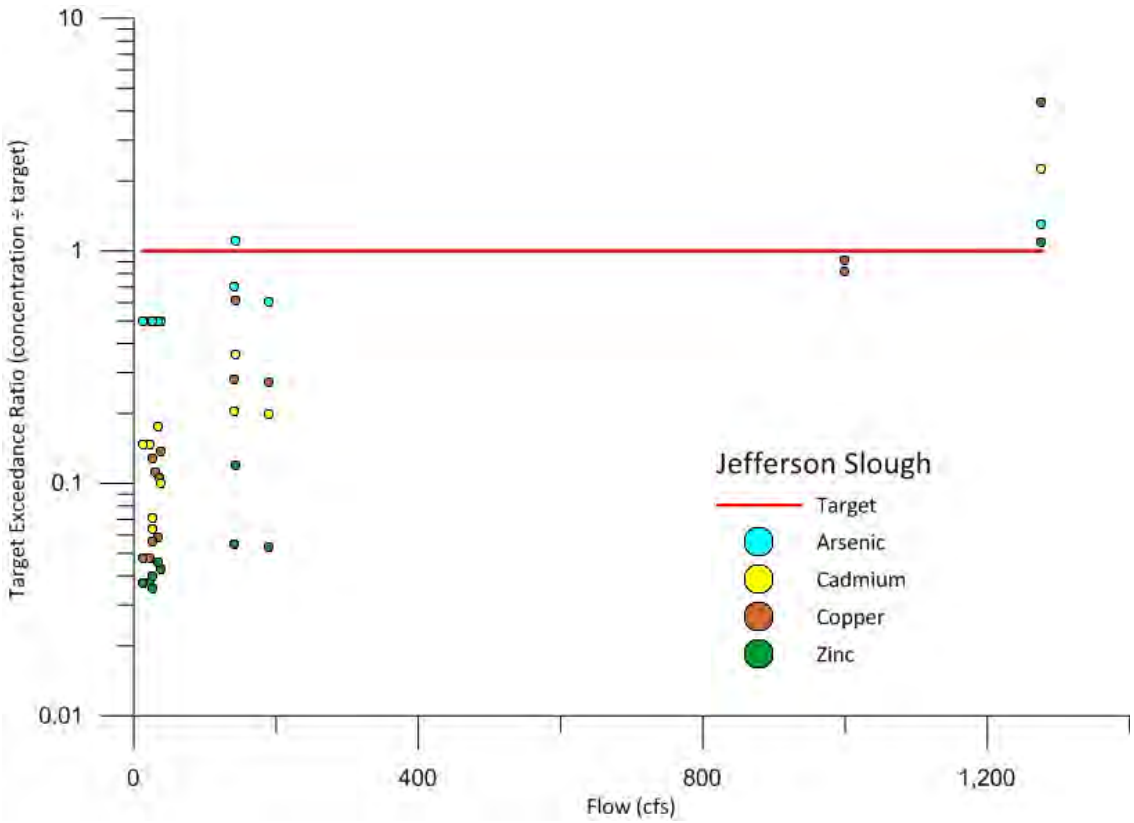

Figure 5-4. Metals Concentrations Relative to Targets in the Jefferson Slough

5.4.3.5 Jefferson River MT41G001_011

The Jefferson River from the headwaters to the confluence with the Jefferson Slough is listed in the 2012 IR as being impaired for copper and lead. Data compilation, collection and analysis confirm the need for a lead TMDL, demonstrate the need for an iron TMDL, and alleviate the need for a copper TMDL. For the purposes of this document this section of the river will be called the upper Jefferson River.

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 2004 and 2010-2013 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 5-14** and **5-15**.

Table 5-14. Upper Jefferson River Metals Water Quality Data Summary and Target Exceedances

Parameter*	Copper	Iron	Lead
# Samples	24	8	24
Minimum values (µg/L)	<1	170	<0.02
Maximum Values (µg/L)	5	1050	3.1
# Acute Exceedances	0.0%	NA	0.0%
Acute Exceedance Rate	0	NA	0
# Chronic Exceedances	0	1	3
Chronic Exceedance Rate	0.0%	12.5%	12.5%

Table 5-14. Upper Jefferson River Metals Water Quality Data Summary and Target Exceedances

Parameter*	Copper	Iron	Lead
# Samples >2X the Acute Standard	0	NA	0
# Human Health Exceedances	0	NA	0
HHS Exceedance Rate	0.0%	NA	0.0%

*All units in µg/L are total recoverable fraction
NA = Not Applicable

Table 5-15. Upper Jefferson River Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Copper	Iron**	Lead
# Samples	2	0	2
Minimum (mg/kg)	18.7	NA	17.3
Maximum (mg/kg)	25	NA	20.3
PEL Value (mg/kg)	197	NA	91.3
# Samples> 2X PEL	0	NA	0
>2X PEL Exceedance Rate	0.0%	NA	0.0%

*All units in mg/kg are dry weight
**No iron PEL exists (NA = Not Applicable)

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination
Each pollutant is discussed individually. The discussions are summarized below in **Table 5-16**.

Copper
The upper Jefferson River was listed as impaired by copper in the 2012 IR. This impairment was originally based upon older sampling from the 1980s and 1990s. Copper concentrations in samples recently collected (2004-2013) from upper Jefferson River did not exceeded the human health life, AAL, or CAL targets. Copper concentrations in sediment samples were not above PELs. Therefore, DEQ determined that copper is not a cause of impairment to upper Jefferson River, and a TMDL will not be developed for copper. Copper as a cause of impairment was removed from the 2014 IR.

Iron
The upper Jefferson River was not listed as impaired by iron in the 2012 IR. Data collected from 2010-2013 indicated that one of 8 samples (12.5%) exceeded the chronic targets. Because iron targets were exceeded in more than 10% of the samples iron will be listed as a cause of impairment to the upper Jefferson River and a TMDL will be developed.

Lead
The upper Jefferson River was listed as impaired by lead in the 2012 IR. Recent data collected from 2004-2013 indicated that three of 24 water quality samples exceeded the chronic target. The chronic exceedance rate for lead was 12.5%. As a result of the CAL exceedance rate DEQ will add lead as a cause of impairment and develop a TMDL for it.

Upper Jefferson River TMDL Development Summary
As discussed above and summarized in **Table 5-16**, iron and lead TMDLs are developed for the upper Jefferson River. These impairment conditions are summarized in **Table 5-16**, and are documented within DEQ's assessment files and are included in the 2014 IR.

Table 5-16. Upper Jefferson River Metals TMDL Decision Factors

Parameter	Copper	Iron	Lead
Number of Samples	24	8	24
CAL exceedance rate >10%?	No	12.5	12.5
Greater than 2X AAL target exceeded?	No	NA	No
Human Health target exceeded?	No	NA	No
2X NOAA PEL exceeded?	No	No	No
Human-caused sources present?	Yes	Yes	Yes
2012 303(d) listed?	Yes	No	Yes
TMDL developed?	**No**	**Yes**	**Yes**

Figure 5-5 plots those metals for which TMDL development will take place in upper Jefferson River. This is provided to help illustrate the magnitude and seasonality of target exceedances. All metals impairments for the upper Jefferson River will require greater reductions during high flow than during low flow, as shown in **Figure 5-5**. Iron and lead exceed the target by the greatest degree when flows were high, and require reductions of up to 4.8 and 11.5%, respectively, during high flow (**Table 5-22**). The targets for iron and lead are generally met during low flow conditions.

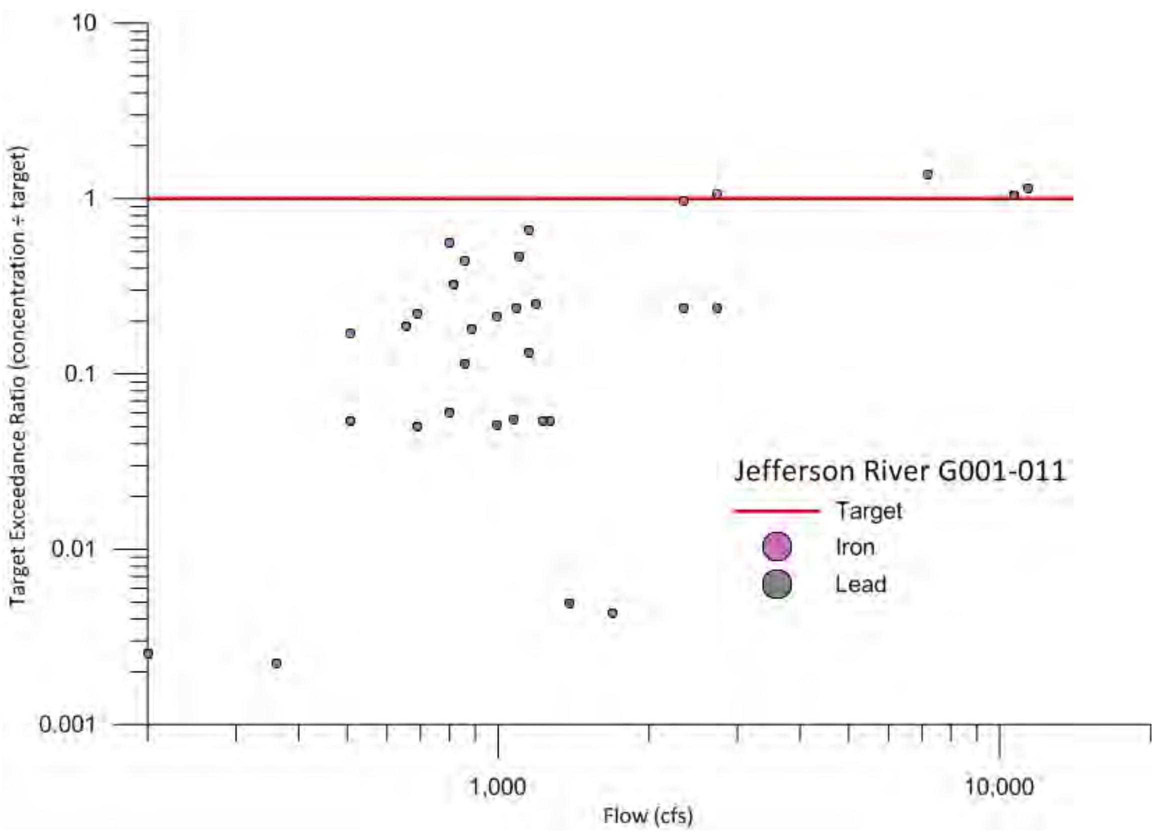

Figure 5-5. Metals Concentrations Relative to Targets in the Upper Jefferson River

5.4.3.6 Jefferson River MT41G001_012

The Jefferson River from the confluence of the Jefferson Slough to the mouth (Missouri River) is listed in the 2012 IR as being impaired for copper and lead. Data compilation, collection and analysis confirm the need for copper and lead TMDL development. For the purposes of this document this section of the river will be called the lower Jefferson River.

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 2003-2013 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 5-17** and **5-18**.

Table 5-17. Lower Jefferson River Metals Water Quality Data Summary and Target Exceedances

Parameter*	Copper	Lead
# Samples	38	38
Minimum values (µg/L)	< 1	0.08
Maximum Values (µg/L)	25	11.6
# Acute Exceedances	4	0
Acute Exceedance Rate	10.53%	0.0%
# Chronic Exceedances	4	5
Chronic Exceedance Rate	10.53%	13.16%
# Samples >2X the Acute Standard	2	0
# Human Health Exceedances	0	0
HHS Exceedance Rate	0.0%	0.0%

*All units in µg/L are total recoverable fraction

Table 5-18. Lower Jefferson River Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Copper	Lead
# Samples	3	3
Minimum (mg/kg)	32	19
Maximum (mg/kg)	56.3	29.6
PEL Value (mg/kg)	197	91.3
# Samples> 2X PEL	0	0
>2X PEL Exceedance Rate	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 5-19**.

<u>Copper</u>

The Lower Jefferson River was listed as impaired by copper in the 2012 IR. Data collected from 2003-2013 indicated that four of 38 samples (10.53%) exceeded chronic targets. This data also indicates that two of 38 samples exceeded twice the acute standard. Because multiple copper targets were exceeded copper will remain listed as a cause of impairment to the lower Jefferson River and a TMDL will be developed.

<u>Lead</u>

The lower Jefferson River was listed as impaired by lead in the 2012 IR. Recent data collected from 2003-2013 indicated that five of 38 water quality samples exceeded the chronic target. The chronic exceedance rate for lead was 13.16%. As a result of the CAL exceedance rate being greater than 10% lead will remain as a cause of impairment and DEQ will develop a TMDL for it.

Lower Jefferson River TMDL Development Summary

As discussed above and summarized in **Table 5-19**, copper and lead TMDLs are developed for the lower Jefferson River. These impairment conditions are summarized in **Table 5-19**, and are documented within DEQ's assessment files and are included in the 2014 IR.

Table 5-19. Lower Jefferson River Metals TMDL Decision Factors

Parameter	Copper	Lead
Number of Samples	38	38
CAL exceedance rate >10%?	Yes	Yes
Greater than 2X AAL target exceeded?	Yes	No
Human Health target exceeded?	No	No
2X NOAA PEL exceeded?	No	No
Human-caused sources present?	Yes	Yes
2012 303(d) listed?	Yes	Yes
TMDL developed?	**Yes**	**Yes**

Figure 5-6 plots those metals for which TMDL development will take place in the lower Jefferson River. This is provided to help illustrate the magnitude and seasonality of target exceedances. All metals impairments for the lower Jefferson River will require greater reductions during high flow than during low flow, as shown in **Figure 5-6**. Copper and lead exceed the target by the greatest degree when flows were high, and require reductions of up to 65.4 and 78.4%, respectively, during high flow (**Table 5-22**). The targets for copper and lead are generally met during low flow conditions.

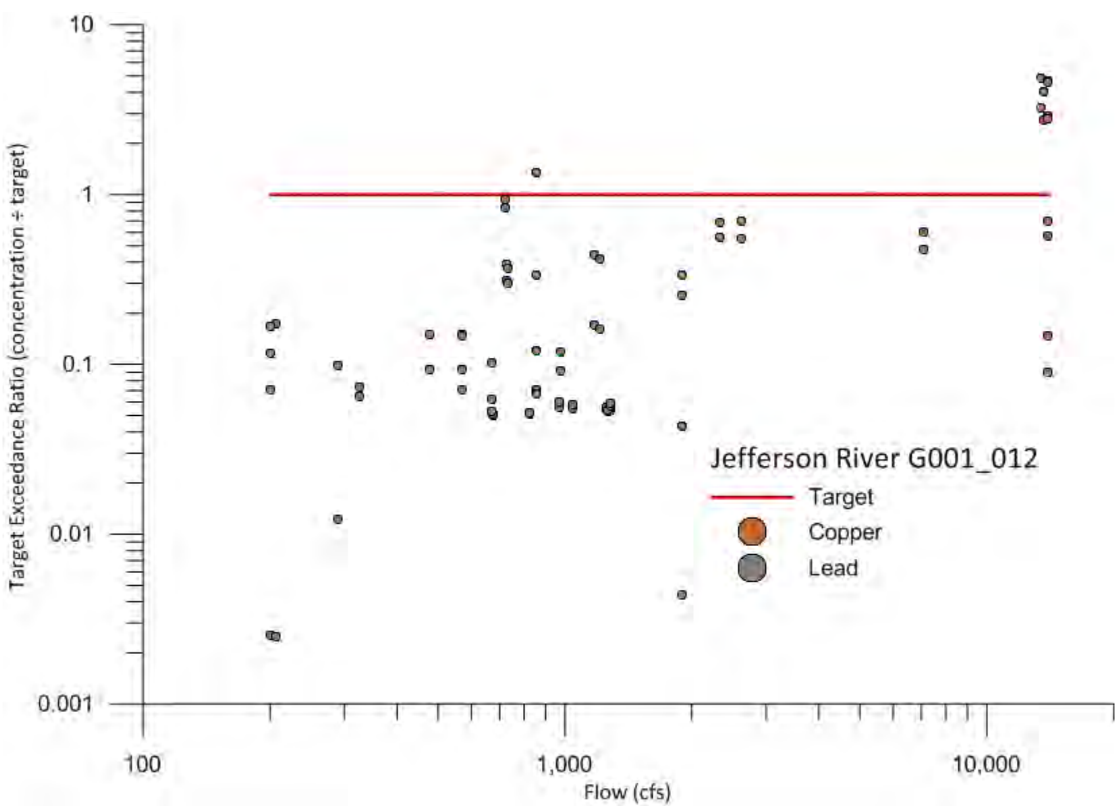

Figure 5-6. Metals Concentrations Relative to Targets in the Lower Jefferson River

5.4.4 Metals Target Comparison and TMDL Development Summary

Based on the updated metals assessment and target comparison results summarized above, 14 metals TMDLs will be developed for six waterbody segments in the Jefferson River TMDL Project Area. These are identified in **Table 5-20**. **Table 5-20** 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. All updated assessment results captured within **Table 5-20** are incorporated within the 2014 303(d) List and associated 2014 IR.

Reassessment of metals impairment causes in the upper and lower Jefferson River and Whitetail Deer Creek confirmed the majority of the metals impairments on the 2012 IR. Exceptions to this include the removal of copper and the addition of iron as impairment causes from the upper Jefferson River, and the removal of copper and silver as an impairment cause from Whitetail Deer Creek.

Assessment of metals impairment causes in the Jefferson Slough, Big Pipestone Creek and Little Whitetail Creek found that concentrations are not within target values for a number of metals impairment causes. These impairment causes were not identified in the 2012 IR. The impairment causes include the addition of arsenic, cadmium, copper and zinc in the Jefferson Slough, the addition of arsenic for Big Pipestone Creek and the addition of aluminum, copper and lead for Little Whitetail Creek.

Table 5-20. Updated Metals Assessment Results and TMDLs Developed for the Jefferson River TMDL Project Area

Waterbody and Location Description	Waterbody ID	Metal Pollutant	Listed as Impaired on 2012 303(d) List	Updated Impairment Determination	TMDL Developed
LITTLE WHITETAIL CREEK, Whitetail Reservoir to mouth (Whitetail Deer Creek)	MT41G002_140[1]	Aluminum	No	Impaired	Yes
		Copper	No	Impaired	Yes
		Lead	No	Impaired	Yes
WHITETAIL DEER CREEK, Headwater to mouth (Jefferson Slough)	MT41G002_141[1]	Aluminum	Yes	Impaired	Yes
		Copper	Yes	Not Impaired	No
		Lead	Yes	Impaired	Yes
		Silver	Yes	Not Impaired	No
BIG PIPESTONE CREEK, Headwaters to mouth (Jefferson Slough)	MT41G002_010	Arsenic	No	Impaired	Yes
JEFFERSON SLOUGH, Jefferson River to the mouth (Jefferson River)	MT41G002_170	Arsenic	No	Impaired	Yes
		Cadmium	No	Impaired	Yes
		Copper	No	Impaired	Yes
		Zinc	No	Impaired	Yes
JEFFERSON RIVER, Headwaters to confluence of Jefferson Slough	MT41G001_011	Copper	Yes	Not Impaired	No
		Iron	No	Impaired	Yes
		Lead	Yes	Impaired	Yes
JEFFERSON RIVER, confluence of Jefferson Slough to mouth (Missouri River)	MT41G001_012	Copper	Yes	Impaired	Yes
		Lead	Yes	Impaired	Yes

[1] The assessment units (waterbody IDs) for Little Whitetail Creek and Whitetail Deer Creek are incorrectly defined in the 2012 Water Quality Integrated Report (see **Table A-1** and **Figure A-1** in **Appendix A**). This table and this document reflect the corrected and redefined assessment units as they will be identified in the 2014 Integrated Report.

5.5 METALS TMDLS

This section presents metals TMDLs for impaired waterbodies in the Jefferson River 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 5.4.2.1**.

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 and a conversion factor. These equations are illustrated below in **Figures 5-7** through **5-13**. 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 (Cu, Pb, Cd and Zn) in the Jefferson River TMDL 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, 2012c). 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 applied. This target normally equates to the CAL standard using the measured hardness corresponding to that sample. In the case of aluminum and iron, the water CAL is not hardness specific. In those cases where the HHS is the lowest target, those values are used to calculate the TMDL. This is the case with arsenic in Big Pipestone Creek. At very high hardness values, the HHS for lead can be lower than the hardness specific CAL standard, although this condition was not encountered within any of the streams in the Jefferson River TMDL Project Area.

Figures 5-7, **5-8**, and **5-9** are plots showing TMDLs versus flow for impairment causes that are not influenced by hardness. **Figures 5-10**, **5-11**, **5-12**, and **5-13** show TMDLs versus flow for the hardness-dependent impairment causes at hardness conditions of 25mg/L and 400/mg/L $CaCO_3$. These values represent the complete range of variability of hardness influence on water quality standards per DEQ-7, as well as the naturally occurring conditions in the Jefferson River Project Area (**Appendix B**). 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 an MOS by focusing remediation and restoration efforts toward 100% compliance to the extent practical. Note that both the CAL and human health TMDLs are displayed for lead in **Figure 5-12**, and that at high hardness the TMDL is defined by the human health criteria.

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 Jefferson River TMDL Project Area since there are no permitted discharges with metals-specific mixing zones.

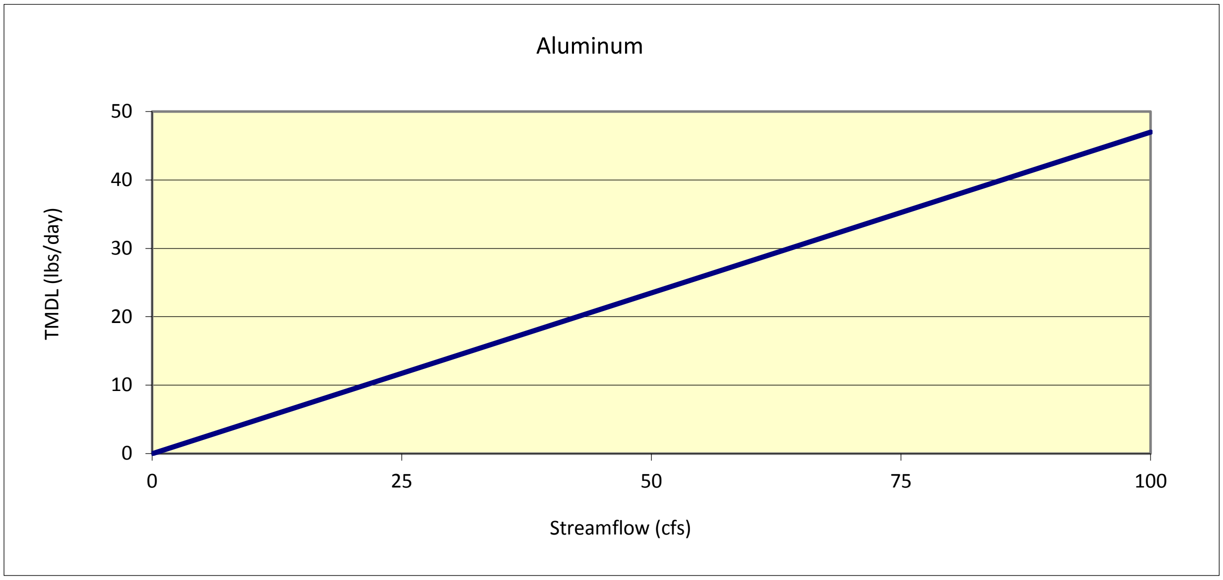

Figure 5-7. Hardness-Independent Aluminum TMDL as a Function of Flow

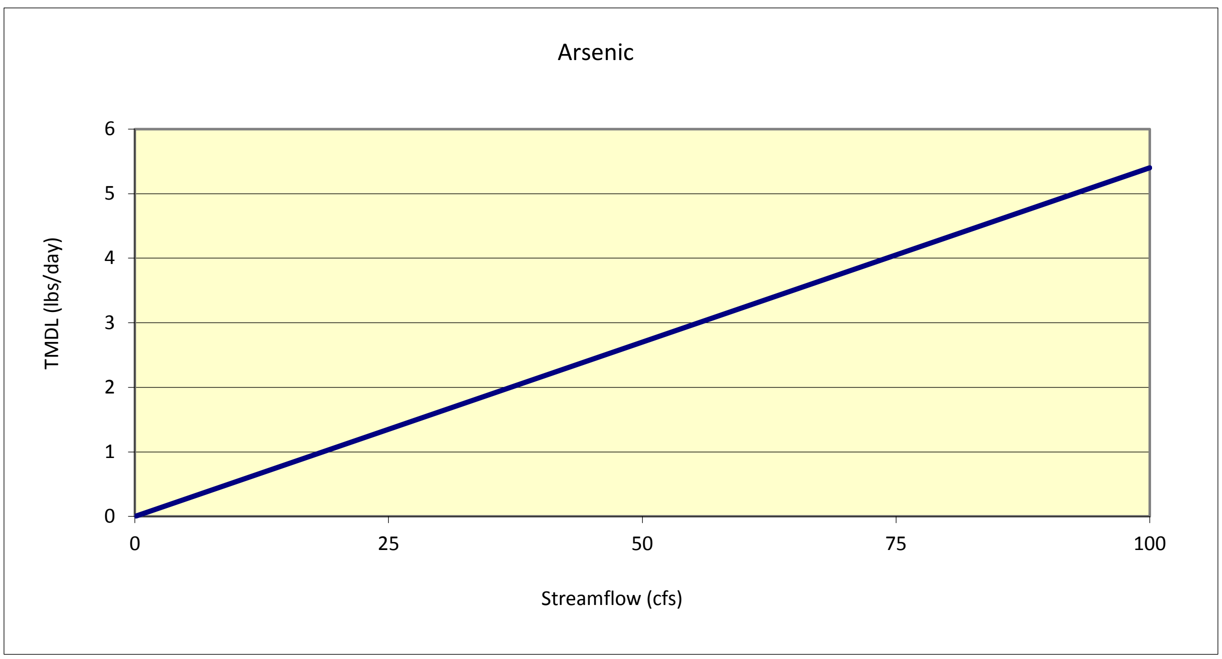

Figure 5-8. Hardness-Independent Arsenic TMDL as a Function of Flow

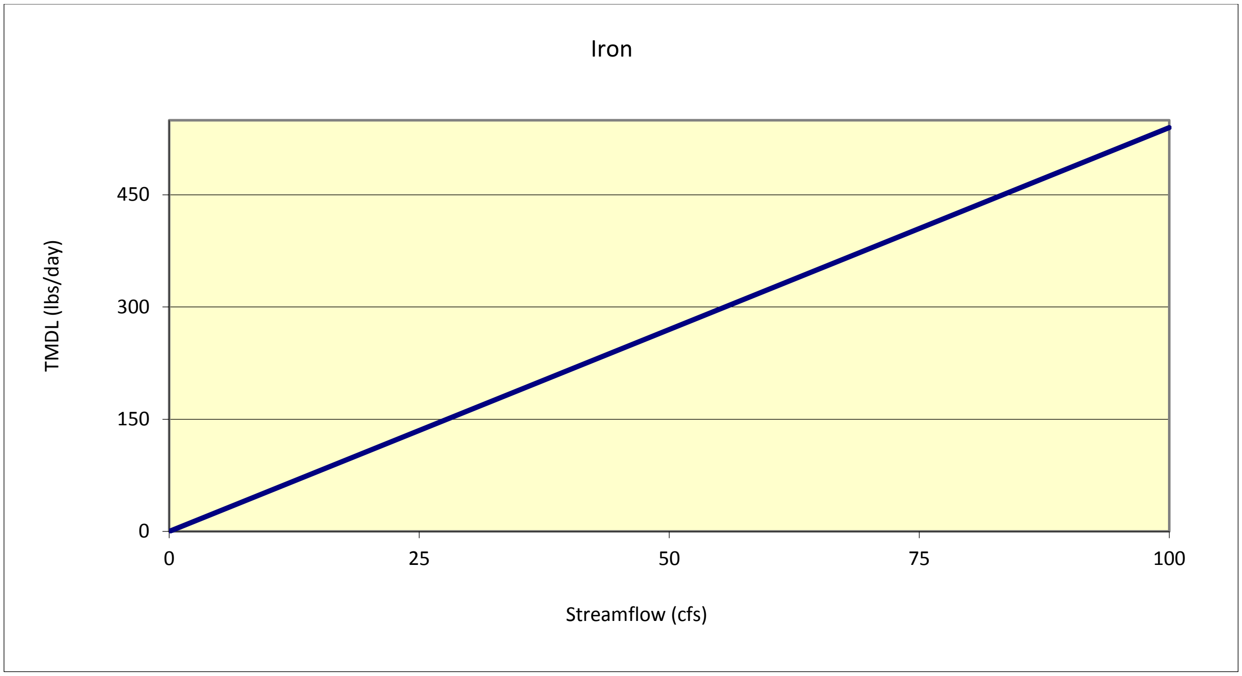

Figure 5-9. Hardness-Independent Iron TMDL as a Function of Flow

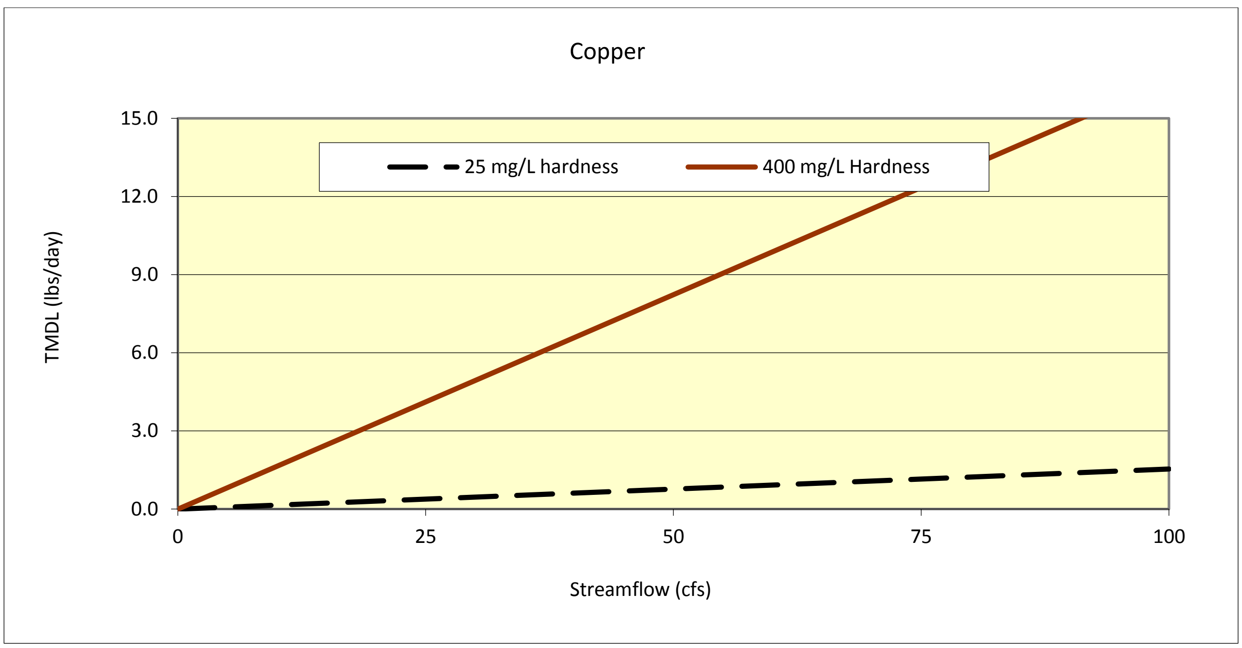

Figure 5-10. Copper TMDL as a Function of Flow

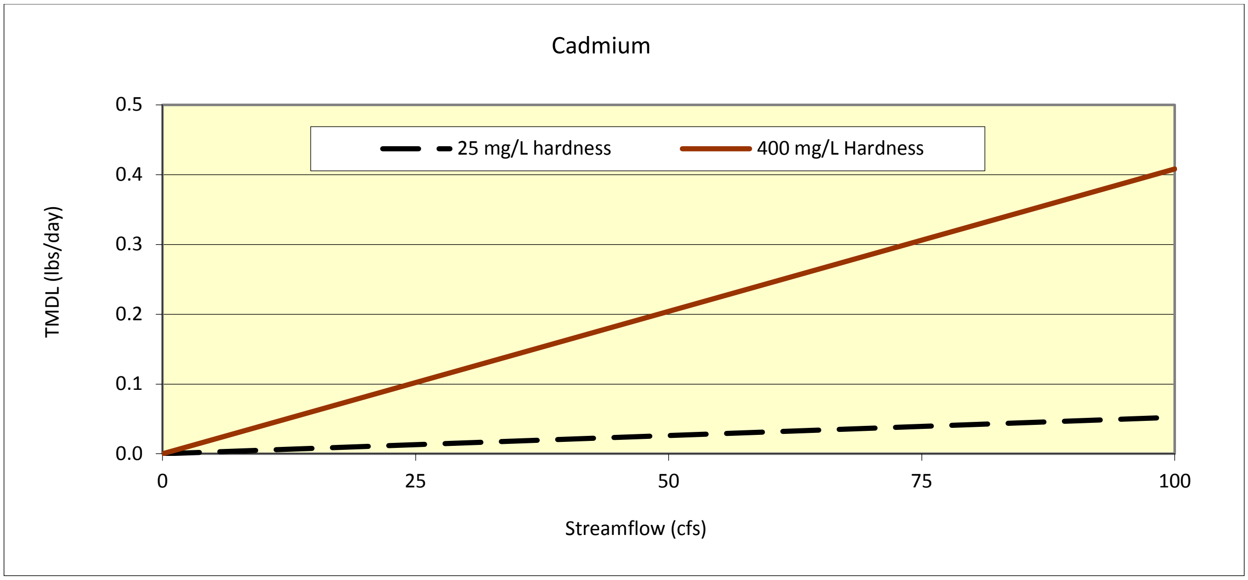

Figure 5-11. Cadmium TMDL as a Function of Flow

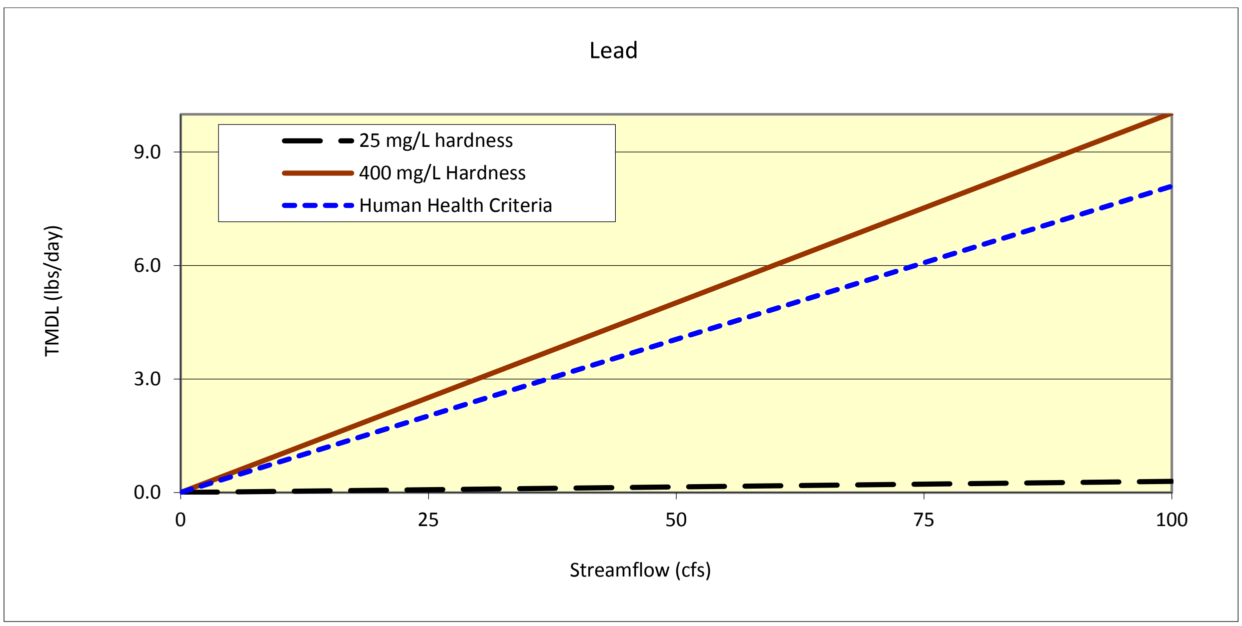

Figure 5-12. Lead TMDL as a Function of Flow

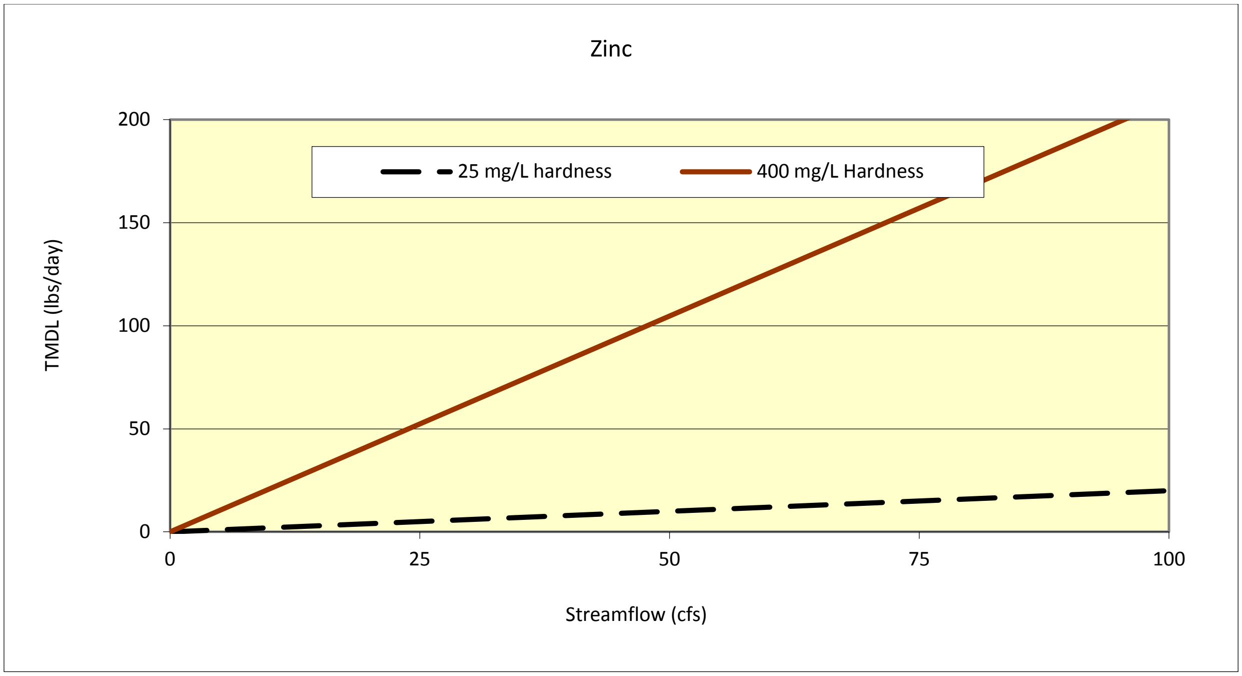

Figure 5-13. Zinc TMDL as a Function of Flow

Table 5-21 provides example TMDLs for each of the waterbody – impairment cause combinations in the Jefferson River TMDL Project Area. The TMDLs are calculated according to the TMDL equation provided above using the highest and lowest measured flows provided within **Appendix B** and the lowest hardness-dependent target concentrations, with the exception of high flow for the Jefferson Slough which was estimated by summing measured flows of the Jefferson Slough above the Boulder River (1,000 cfs on 6/10/11) and the Boulder River flow measured at a USGS gage station (2,700 cfs on 6/9/11). Using data in this manner accounts for seasonal variability by providing a representative range of streamflow and water hardness for each waterbody – impairment cause combination (**Appendix B**).

Table 5-22 provides the percent reductions required to meet each TMDL during high and low flow conditions. Existing loads are calculated using the highest observed metal concentration, associated flow, and unit conversion factor using the same equation as used for calculating the TMDL (with the exception that the highest observed concentration was substituted for the target concentration). The required percent reduction in total loading is then calculated by subtracting the TMDL from the existing load, dividing the difference by the existing load, and multiplying the result by 100. In cases where streams appear to be meeting the TMDL based on the current dataset (primarily during low flows), the percent reduction is reported as 0%.

Table 5-21. Detailed Inputs and Example TMDLs in the Jefferson River TMDL Project Area

Stream	Flow Volume (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
LITTLE WHITETAIL CREEK, Whitetail Reservoir to mouth (Whitetail Deer Creek)	500	0.54	28	175	Aluminum	87	87	234.9	0.25
					Copper	3.14	15.05	8.49	0.04
					Lead	0.63	6.49	1.70	0.02
WHITETAIL DEER CREEK, Headwater to mouth (Jefferson Slough)	750	0.46	72	215	Aluminum	87	87	352.4	0.21
					Lead	2.09	8.43	8.46	0.021
BIG PIPESTONE CREEK, Headwaters to mouth (Jefferson Slough)	30.5*	0.41	NA	NA	Arsenic	10	10	1.65	0.022
JEFFERSON SLOUGH, Jefferson River to the mouth (Jefferson River)	3,700**	11.82	73	258	Arsenic	10	10	199.8	0.638
					Cadmium	0.21	0.55	4.19	0.0351
					Copper	7.13	20.97	142.457	1.338
					Zinc	91.77	267.47	1,833.56	17.072
UPPER JEFFERSON RIVER, Headwaters to confluence of Jefferson Slough	11,400	200	89	204	Iron	1,000	1,000	61,560.0	1,080.0
					Lead	2.74	7.89	168.67	8.5
LOWER JEFFERSON RIVER, confluence of Jefferson Slough to mouth (Missouri River)	14,000	200	83	164	Copper	7.96	14.24	601.78	15.4
					Lead	2.51	5.97	189.7	6.45

*No water quality samples were collected at high flows. As such, high flow values are from an average of data from a dataset that does not include metals sampling.

** Flow near mouth estimated by summing the measured flows of the Jefferson Slough above the Boulder River (1,000 cfs on 6/10/2011) and the Boulder River (2,700 cfs on 6/9/2011)

Table 5-22. Percent Reductions Needed in the Jefferson River TMDL Project Area

Stream	Parameter	% Load Reduction To Meet TMDL	
		High Flow	Low Flow
LITTLE WHITETAIL CREEK, Whitetail Reservoir to mouth (Whitetail Deer Creek)	Aluminum	62.2	0.0
	Copper	65.1	0.0
	Lead	83.9	0.0
WHITETAIL DEER CREEK, Headwater to mouth (Jefferson Slough)	Aluminum	42.0	0.0
	Lead	49.3	0.0
BIG PIPESTONE CREEK, Headwaters to mouth (Jefferson Slough)	Arsenic	No Arsenic Data*	9.1
JEFFERSON SLOUGH, Jefferson River to the mouth (Jefferson River)	Arsenic	23.1	0.0
	Cadmium	55.4	0.0
	Copper	77.0	0.0
	Zinc	8.2	0.0
JEFFERSON RIVER, Headwaters to confluence of Jefferson Slough	Iron	4.8	0.0
	Lead	11.5	0.0
JEFFERSON RIVER, confluence of Jefferson Slough to mouth (Missouri River)	Copper	65.4	0.0
	Lead	78.4	0.0

* As noted in **Section 5.4.3,** all flow data for Big Pipestone Creek is considered low flow data

5.6 Metals Source Assessments

Identified metals sources linked to human activity are primarily related to Montana's mining legacy and include sources such as abandoned and inactive hard rock mines and placer operations. These metals sources typically include features such as adits and seeps, metals-laden floodplain deposits, waste rock and tailings, and other features associated with abandoned and inactive mining operations.

As part of the TMDL development process, MPDES permitted surface water discharges are evaluated for potential metals load contributions. There are several MPDES permitted dischargers in the Jefferson River TMDL Project Area. These include discharges of domestic wastewater, stormwater and discharges associated with suction dredging operations. MPDES permitted discharges of domestic wastewater include the WWTPs for the town of Whitehall, and the town of Twin Bridges. The Golden Sunlight Mine (GSM) discharges stormwater to the Jefferson Slough, and there are several suction dredge discharges in Big Pipestone Creek and the lower Jefferson River.

The town of Twin Bridges and Whitehall domestic wastewater discharge permits do not have effluent limits or sampling requirements for metals. In those cases, the effluent could not be characterized using discharge-specific monitoring data. To estimate the copper and lead loads contributed from these sources, DEQ used a well-studied domestic wastewater facility: East Helena. The East Helena WWTP uses similar treatment technology and serves a community with residences of similar construction and age. As such it is expected to have a similar effluent quality as the town of Twin Bridges and Whitehall WWTPs. DEQ's Technical and Financial Assistance Bureau engineering staff provided guidance on this approach (Lavigne, Paul personal communication 2014)[2]. Average copper concentrations of 16.9 µg/L

[2] Personal Communication between Paul Lavigne, DEQ and Lou Volpe, DEQ. 2014.

and lead concentrations of 1.36 µg/L (Robert Peccia & Associates, 2011) could be used to represent the discharge concentrations for these systems.

5.6.1 Little Whitetail Creek MT41G002_140 Source Assessment

The major metals source identified in the Little Whitetail Creek watershed are those associated with historical mining activities that have taken place over the years.

DEQ stream sampling data from 2010-2013 were used for an updated assessment and to support subsequent TMDL development (**Appendix B**). Aluminum concentrations were regularly (70%) above the CAL target in water samples collected in Little Whitetail Creek. Copper data collected during the same time frame indicated that 7 of 12 samples (58.3%) exceeded the CAL. These same data indicated that two copper samples were greater than twice the AAL target. Lead data collected from 2004-2013 indicated that 8 of 12 samples (66.7%) exceeded the CAL. The monitoring locations used to assess water quality are included in **Figure 5-14**. Sediment data collected during the assessment process were inconclusive, as only one sample was collected, and all sample results were below NOAA PEL's.

The highest observed water quality metals concentrations for aluminum and lead were associated with higher flow samples (**Figure 5-2**), suggesting that one mechanism of elevated metals loading is via metals bound in the sediment that become mobile when there is a significant disturbance, such as high flow events. A review of the flow, total suspended solids (TSS), and metals concentrations in **Appendix B** shows that other loading pathways, such as via groundwater, may also be significant since there are target exceedances for all three metals during relatively moderate flow events with relatively low TSS values (see analytical data for 9/8/2011).

It is also evident that the highest metals concentrations occurred in the upstream sampling locations, although concentrations exceeding water quality targets also occur at the lower sampling sites for all three metals. This indicates that the major sources of metals loading to Little Whitetail Creek are in the upper most portions of the watershed.

5.6.1.1 Mining Sources in Little Whitetail Creek Watershed

In comparison to the rest of Jefferson River TMDL Project Area, limited mining has taken place in Little Whitetail Deer Creek watershed. The only recorded production from the Whitetail district occurred in 1948 when 12 tons of ore were shipped. This ore yielded 42 ounces of silver, 100 pounds of copper, 2,300 pounds of lead, and 1,100 pounds of zinc. The district has produced little additional ore (Roby et al., 1960; Steere, 1979).

There are several abandoned or inactive mines in the Little Whitetail Creek watershed. They include the Two HY lode mine, the St. Anthony lode mine, and the Whitetail Park Vein load mine. Also included on this list are the Silver Bell lode mine, which was a lead producer, the Bi-Metallic load mine which was a gold, silver, lead, and copper as well as an unnamed gold and silver lode mine that produces gold, silver, lead, and zinc.

5.6.1.2 Sediment Sources in Little Whitetail Creek Watershed

There are several USFS and BLM grazing allotments that exist in the Little Whitetail Creek watershed. USFS allotments include the North Pony allotment, the South Pony allotment, Little Boulder allotment, and a portion of the Big Foot allotment. Approximately 24,197 acres, 4,176 acres, 660 acres, and 1,007 acres, respectively, of these allotments exist in the Little Whitetail watershed. Portions of BLM allotments that exist in the Little Whitetail watershed include the Spring allotment for 3,710 acres, the Riding Rocks allotment for 816 acres, the Dry Mountain allotment for 384 acres, and the Big Foot allotment for 412 acres.

While cattle grazing is not a direct source of metals loading, trampling of riparian and upland soils can increase erosion. The resulting sediment has the potential to increase metals loading to Little Whitetail Creek if the sediment is from an area with elevated metals concentrations. **Figure 5-14** shows the spatial extent of historic mining activity and grazing allotment acreage in the Little Whitetail Creek watershed.

It is important to note that the BLM and the Jefferson River Watershed Committee have both been working on watershed scale planning projects in this watershed that evaluate uplands, stream and riparian function. Continued efforts of this nature should insure mitigation of effects of cattle operations in this area.

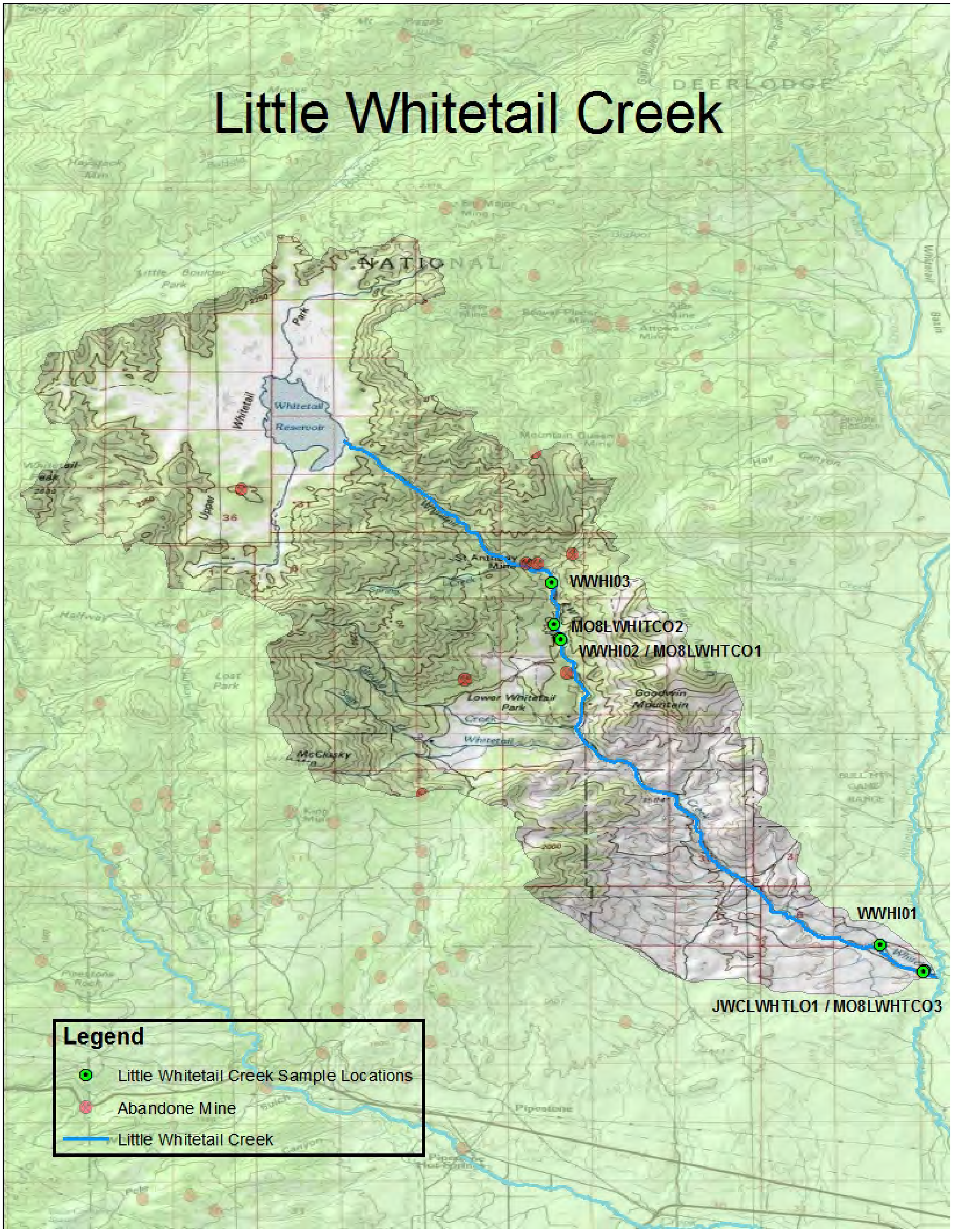

Figure 5-14. Metals Sources and Sample Locations in the Little Whitetail Creek Watershed

5.6.1.3 Upstream to Downstream Samples Results Comparisons

The **Appendix B, Table B-2** data show that there are several upstream and downstream samples taken on the same or similar dates, with sample locations WWHI03, MO8LWHITCO2, WWHI02, and MO8LWHTCO1 representing upstream sites and sample locations WWHIO1, JWCLWHTLO1, and MO8LWHTCO3 representing downstream sites. Results from 9/7/2010 and 9/8/2010 show aluminum concentrations decreasing from 290 µg/L to 210 µg/L in the downstream direction. Both copper and lead also had higher upstream concentrations with lower downstream concentrations for these same sample dates (concentrations decreased from 5.0 µg/L to 3.0 µg/L for copper and 1.8 µg/L to 1.1 µg/L for lead). A similar pattern of lower concentrations from upstream to downstream for all three metals was observed on 9/8/2011 and 5/7/2013. During the extremely high flow sampling event on 6/10/2011 (**Section 2.1.2**), aluminum increased in concentration from upstream to downstream (160 µg/L to 230 µg/L), the copper concentration remained essentially the same at 9.0 µg/L, and the lead concentration decreased from 6.0 µg/L to 3.9 µg/L. All of the results suggest that the elevated metals loads are predominately from upstream of the upper sample sites (**Figure 5-14**). A possible exception is for aluminum during very high flow conditions where the data suggest additional significant elevated aluminum loading between the upstream and downstream sampling locations

5.6.2 Whitetail Deer Creek MT41G002_141 Source Assessment

The major metals sources identified in Whitetail Deer Creek watershed are most likely associated with historical mining activities.

DEQ stream sampling data from 2004, 2006, and 2009-2013 was used for updated assessment and to support subsequent TMDL development (**Appendix B**). Aluminum concentrations in Whitetail Deer Creek were routinely (42%) above the CAL target in water samples collected. Lead data collected during the same time frame indicated that three of 23 samples (13%) exceeded the CAL. The monitoring locations used to assess water quality are depicted in **Figure 5-15**.

Many of the higher observed water quality metals concentrations for both aluminum and lead were associated with higher flow samples (**Figure 5-3**), suggesting that one mechanism of elevated metals loading is via metals bound in sediment, which becomes mobile when there is a significant disturbance, such as high flow events. Nevertheless, a review, TSS, and metals concentrations in **Appendix B** do not indicate a strong correlation between TSS and aluminum or lead, suggesting the potential for localized sediment bound metals loading. Elevated metals concentrations at lower flows suggest the potential for groundwater metals loading when groundwater is contributing a larger volume of water (and subsequent metals load) to the creek.

5.6.2.1 Mining Sources in Whitetail Deer Creek Watershed

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 Whitetail Deer Creek. **Figure 5-15** shows the spatial extent of historic mining activity in the Whitetail Deer Creek watershed. The majority of mining that took place occurred in the Big Foot and Whitehall mining districts.

The Big Foot district encompasses the northwestern most portion of the watershed. Several creeks flow out of this mining district, they include Big Foot, Beaver, and State creeks. These creeks contribute flow directly to Whitetail Deer Creek and have the potential to contribute metals loading. Abandoned or inactive mines in this area include the Big Four and the State mines. The Big Four was most productive in the late 1920s up to 1930, but had some production as late as 1940. The mine is credited with almost 1,600 tons of ore. The State mine was also active in the 1920s. It is credited with 544 tons of ore that yielded 384 ounces of gold. The gold veins on the State claim were said to be the source of the district's placer gold (Roby et al., 1960). Several other abandoned or inactive claims occur in the Big Foot district, they include Hoosier Boy, Terror, Nickel Plate, Searchlight, and Ajax. There was also the Beaver Creek placer operation.

The Whitehall district is located in the south eastern portion of the watershed. There were several abandoned or inactive mines in this district that were of considerable size, however the majority of the load mining in this district occurred on the opposite side of the hydrologic divide from Whitetail Deer Creek in St. Paul Gulch. Those mining claims that are within both the Whitehall mining district and drain into Whitetail Deer Creek are discussed below.

The largest of these mines was the Carbonate Mine. This mine was in production for 26 years between 1909 and 1957. Total production was reported at 6,098 tons, which yielded 325 ounces of gold, 16,215 ounces of silver, 8,622 pounds of copper, 1,649,315 pounds of lead and 147, 387 pounds of zinc (Roby et al., 1960; Walsh and Orem, 1906). There were also several smaller operations that reported production. These include the Surprise Mine that produced gold, silver, lead, and zinc in 1911, and between 1930 and 1940 and the Midnight Mine that produced gold, silver, lead and copper between 1926-and 1940. There were also several small operations that did not have reported production that occurred in this area as well. They include the Parrot, Examiner, Whitehall and the Gem mines. They produced gold, silver, lead, zinc and copper in various combinations.

5.6.2.2 Sediment Sources in Whitetail Deer Creek Watershed

A considerable portion of the Whitetail Deer Creek watershed is grazed. A significant portion of this grazing takes place on USFS and BLM allotments. Portions of USFS allotments that exist in this watershed include the Hadley Park allotment, consisting of approximately 2,786 acres, the Big Foot allotment consisting of approximately 2,256 acres, the North Pony consisting of approximately 4,178 acres, the North Bull Mountain allotment of which approximately 1,387 acres and the South Bull mountain allotment of which 7,347 acres are in the Whitetail Deer Creek watershed. The BLM has several allotments in the watershed as well. These include the Dry Mountain, Three East Pastures (11,953), Fitz Creek (1,903), Spring (2,320), Big Foot (24,504), and Whitetail Basin (11,158) allotments that encompass approximately acres, respectively.

While cattle grazing is not a direct source of metals loading, trampling of riparian and upland soils can increase erosion. The resulting sediment has the potential to increase metals loading to Whitetail Deer Creek if the sediment is from an area with elevated metals concentrations. **Figure 5-15** shows the spatial extent of historic mining activity and grazing allotment acreage in the Whitetail Deer Creek watershed.

It is important to note that the BLM and the Jefferson River Watershed Committee have both been working on watershed scale planning projects in this watershed that evaluate uplands, stream and riparian function. Continued efforts of this nature should insure mitigation of effects of cattle operations in this area.

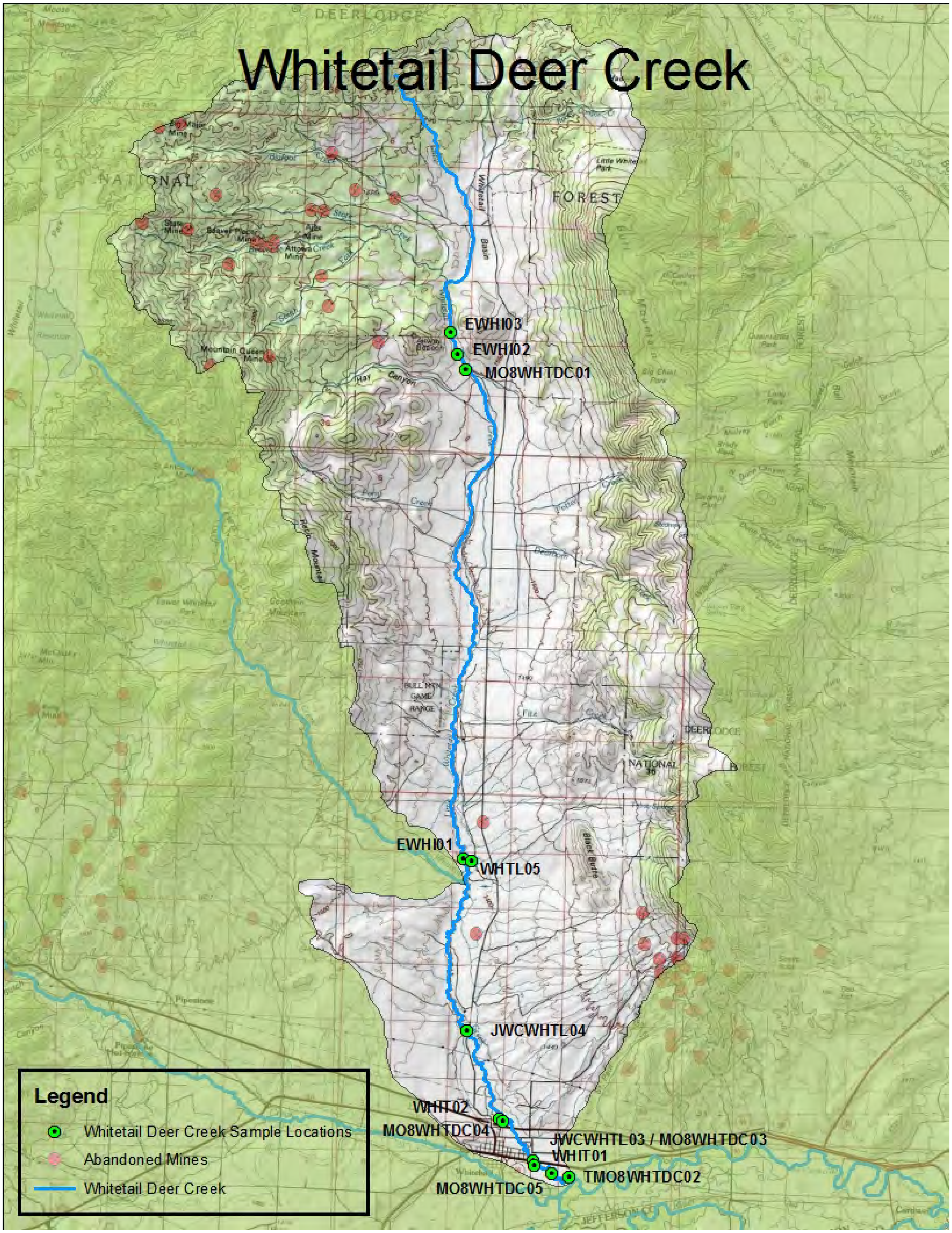

Figure 5-15. Metals Sources and Sampling Locations in the Whitetail Deer Creek Watershed

5.6.2.3 Upstream to Downstream Sample Results Comparison

The **Appendix B**, **Table B-3** shows that there are several upstream to downstream samples taken on the same or similar dates. For the purpose of this analysis, the upper sites refer to the three uppermost sample locations (**Figure 5-15**), the middle sites are above the confluence with Little Whitetail Creek, and all lower sites are below the confluence with Little Whitetail Creek. Sampling on 5/24/2010 and 5/25/2010 shows low aluminum concentration (40 µg/L) at EWHI-03 (an upper sampling site), increasing to 250 µg/L at EWHI-01 (the middle site), and then decreasing to 110 µg/L at WHIT-02 (a lower site). Data reported on 5/25/2010, at WWHI-01 (lower sample site from Little Whitetail Creek) showed a concentration of 160 µg/L for aluminum (**Appendix B**, **Table B-2**). These results suggest a significant aluminum source area contributing loads at above target concentrations between the upper and middle sites, in addition to elevated aluminum loading from Little Whitetail Creek between the middle and lower sites.

Lead sample results from 5/24/2010 show that lead exceeded the target concentration of 4 µg/L at an upper site and then decreased to a below-target concentration of 1.4 µg/L at a middle site. This suggests a significant lead source in the upper part of Whitetail Deer Creek. Little Whitetail Creek also contributes elevated lead loading to Whitetail Deer Creek based on the increased concentrations between the middle and lower sites observed on 6/10/2011. These results are consistent with elevated lead concentrations observed within Little Whitetail Creek on the same date

During the very high flow conditions of 6/10/2011 (**Section 2.1.2**), the upstream to downstream trends for aluminum and lead were similar to those observed from May, 2010 with one notable exception: EWHI-03 (upper site) aluminum concentration was extremely high at 520 µg/L. This suggests a significant aluminum source in the upper watershed only during very high flow conditions since the aluminum target concentration was not exceeded at the upper sites during two lower flow events.

5.6.3 Big Pipestone Creek MT41G002_010 Sources Assessment

Potential metals sources identified in Big Pipestone Creek watershed include those associated with historical mining activities, the Whitehall wastewater treatment facility, and naturally occurring high levels of arsenic from groundwater contributions. An important issue to remember is that dewatering of Big Pipestone Creek could be contributing to the arsenic impairment. The portion of water removed from the stream from dewatering would likely add dilution of arsenic-polluted waters further downstream. The effects of dewatering on Big Pipestone Creek are not fully understood and dewatering is not identified as a source of metals pollution in this section. Also not fully understood are the potential effects of Big Pipestone Hot Springs. Given the limited amount of metals data collected, DEQ was not able to fully determine if Big Pipestone Hot Springs is a contributing source.

DEQ stream sampling data from 2012-2013 were used for an updated assessment and to support subsequent TMDL development (**Appendix B**). Metals sampling was limited to a few locations near the mouth with only three available arsenic results. Although the goal was to capture a high flow event, actual arsenic sampling appears to have occurred during relatively low flows that occurred between peaks of the spring 2013 hydrograph. One of three arsenic concentrations (33%) was above the Human Health target. As such, this waterbody was determined to be impaired and listed as needing TMDL development. The monitoring locations used to assess water quality are depicted in **Figure 5-16.**

5.6.3.1 Mining Sources in Big Pipestone Creek Watershed
The Big Pipestone watershed includes three mining districts. These include the Homestake, Pipestone, and Little Pipestone districts. Minor portions of the Highland, Whitetail, and Elk Park districts are in the Big Pipestone watershed as well. About 20 abandoned mines exist in the Homestake district. Some of the larger claims in the Homestake district include the Blackwell, Big Chief, Gold Bug, Nellie, Flag, Leslie, and the Sixteen to One (Steere, 1979).

The Pipestone mining district is bordered on the west by the Homestake mining district and to the north and east by the hydrologic divide between Little Whitetail Creek and Big Pipestone Creek. There are about 35 abandoned mine properties within the mining district, most of which reported little or no production. However, the Columbia mine appeared briefly in the mining literature in 1898, and lode mining peaked around 1935. Most of the claims were made in Dry Creek four to five miles north of Pipestone Hot Springs.There was also placer activity in the district. Big Pipestone Creek appears to have been worked historically, the only recorded production occurred after the increase in gold prices in the Great Depression. From 1932 to 1941 a few properties were intermittently active. The district's placer boom peaked in 1935 when three claims produced 4.8 ounces of gold.

The Little Pipestone district is southeast of Butte and west of Whitehall, essentially it is located within the bounds of the Little Pipestone Creek drainage. There are approximately 16 abandoned mining operations in this mining district. The more notable mines include the Jupiter and Slim Cedar mines.

5.6.3.2 Sediment Sources in Big Pipestone Creek Watershed
A considerable portion of the Big Pipestone Creek watershed is grazed. A significant portion of this grazing takes place on USFS and BLM allotments. Some of the larger allotments occur on USFS land. These allotments include the Toll Mountain (11,964 acres), Fish Creek (18,928 acres), Homestake (33,068 acres), North Pony (26,391 acres), and South Pony (71,277 acres) allotments. Additional USFS allotments include the Nez Perce allotments. Portions of BLM allotments that exist in the Big Pipestone watershed range in size from approximately 287 acres (Pipestone) to 5,353 acres (Ringing Rocks). Additional BLM allotments include the Yellow Shack, Delmoe, South Pony, Homestake, Big Pipestone Creek, Toll Mountain, Pole Canyon, and Broken Barrier. Grazing is an unlikely source of elevated arsenic in this watershed based on the sampling locations and flow conditions.

It is important to note that the BLM and the Jefferson River Watershed Committee have both been working on watershed scale planning projects in this watershed that evaluate uplands, stream and riparian function. Continued efforts of this nature should insure mitigation of any effects of cattle operations in this area.

5.6.3.3 MPDES Point Sources in Big Pipestone Creek Watershed
The Whitehall WWTP (MPDES Permit No. MT0020133) is a domestic WWTP located in the town of Whitehall. The facility has a permit to discharge to Big Pipestone Creek and a mixing zone that extended 46 feet from the point of discharge (Outfall 001). The permit does not provide effluent limits for metals, as such no metals data exist for the discharge from this facility. The facility does not currently discharge wastewater to Big Pipestone Creek. The wastewater treatment facility uses the existing lagoons and storage cells to retain its wastewater during the winter months and land applies the wastewater during the growing season.

As discussed above, the arsenic target concentration in Big Pipestone Creek was only exceeded once, based on a total of three samples all collected near the mouth. This exceedance occurred at sampling location MT41G002_010 (Big Pipestone Creek 70 yards downstream of WWTP). The exceedance occurred on May 13, 2013, with recorded a concentration of 11 µg/L at a flow of 0.41 cubic feet per second (cfs). A sample collected on this same date just upstream at M08BGPSC04 (Big pipestone Creek at Division Street Crossing) had a higher flow (1.02 cfs) but significantly lower arsenic concentration of 4 µg/L. At the time of exceedance, there were no WWTP discharges to Big Pipestone Creek.

To determine the potential arsenic contribution of this point source, DEQ compared the WWTP load to the TMDL. The WWTP discharge load is estimated using the HHS of 10.0 µg/L and the design flow of the WWTP (0.251 million gallons a day or 0.388 cfs (Montana Department of Environmental Quality, 2008b). The HHS was used, as it is a conservatively high estimate as it is unlikely that the WWTP is concentrating arsenic from the supply wells enough to have a significant impact on water quality. The calculated arsenic load equals approximately 0.021 lbs/day.

Review of public water supply (PWS) well data for arsenic revealed that out of 7 samples 1 was over the HHS of 10 µg/L. The PWS sample collected on September 8, 2004 was reported as 11 µg/L. The PWS exceedance does not coincide with the May 13, 2013 exceedance in Big Pipestone Creek. Review of the PWS data indicates the highest arsenic values all originating from the same supply well (Well1). All PWS wells are within the city limits of the town of Whitehall. Well 1 is located at 1974 Division St. and well 2 is located at 1952 Fire Hall. All public supply well analysis were conducted under EPA method 200.8 and reported as total direct metals, which is equivalent to total recoverable metals analysis used for impairment assessment purposes.

The average low flow for Big Pipestone Creek is 6.48 cfs. The flow conditions near the mouth when the arsenic standard was exceeded was less than 1 cfs, possibly reduced due to upstream irrigation diversions. The TMDL or allowable load at 1 cfs equates to 0.054 lbs/day based on the target concentration of 10.0 µg/L (**Section 5.4.2.1**). Comparing the Whitehall WWTP load of approximately 0.021 lbs/day of arsenic to the river's allowable load (TMDL) of 0.054 lbs/day under very low flow conditions, shows that there is potential for a contribution from the WWTP discharge.

Overall, the data are inconclusive regarding the elevated arsenic loading. The fact that one of the PWS wells had an arsenic detection above 10 µg/L suggests that there may be a potential groundwater source of arsenic in the Whitehall area. An exceedance of the standard in Big Pipestone Creek during low flows supports the possibility that arsenic is being added to the system via groundwater recharge. That being said, it is unlikely that the PWS wells providing source water for the WWTP are the cause of the elevated arsenic concentrations in Big pipestone Creek given that only one PWS well was above the standard and was only above the standard by 1.0 µg/L.

There is also potential leakage from the Whitehall wastewater lagoons; although the above analysis suggests that any leakage to groundwater would be at concentrations less than 10 µg/L. While lagoon cells were lined in 2012, at the time this document was written there was still a significant amount of lagoon sludge that was being stored in abandoned lagoon cells onsite. It is unlikely that the WWTP is concentrating arsenic from the groundwater (domestic water supply wells). The limited data do not provide strong evidence linking arsenic to historical mining or the existing suction dredge operations.

While the WWTP currently employs land application as a method of disposing of wastewater, making its contributing load to Big Pipestone Creek effectively zero at this time, the MPDES permit allows for a discharge to Big Pipestone Creek. Therefore a wasteload allocation is developed for the Whitehall WWTP to ensure that the TMDL is met whenever the WWTP discharges to Big Pipestone Creek. Because it is in the interest of the community to ensure that water used for domestic purposes does not exceed the arsenic drinking water standard, and because at low flows elevated arsenic values in the WWTP discharge could be a significant source of loading to Big Pipestone Creek, the HHS (TMDL target) will serve as the basis for the WWTP's WLA (**Section 5.7.2.3**).

As of July 2014, there were two active MPDES general permits in the Big Pipestone watershed for suction dredge operations (MTG370303 and MTG370328).The general permit requires the operators to minimize harm caused by elevated suspended sediment concentrations and can only be active from July 1st through August 31st and May 1st through September 15th (for MTG370303 and MTG370328, respectively) to protect fish life stages during other times of the year. The general permit does not include loading limits for metals. Suction dredge permitees are not required to collect sediment metals data. As no sediment metals data was collected by DEQ, there is no data to compare to the PEL. The suction dredging operations are not expected to contribute to arsenic water quality exceedances in the Big Pipestone Creek watershed based on the type of activity and requirements contained in the permit that limit suspended sediment. As such, the composite WLA for suction dredge operations in Big pipestone Creek will be set to zero.

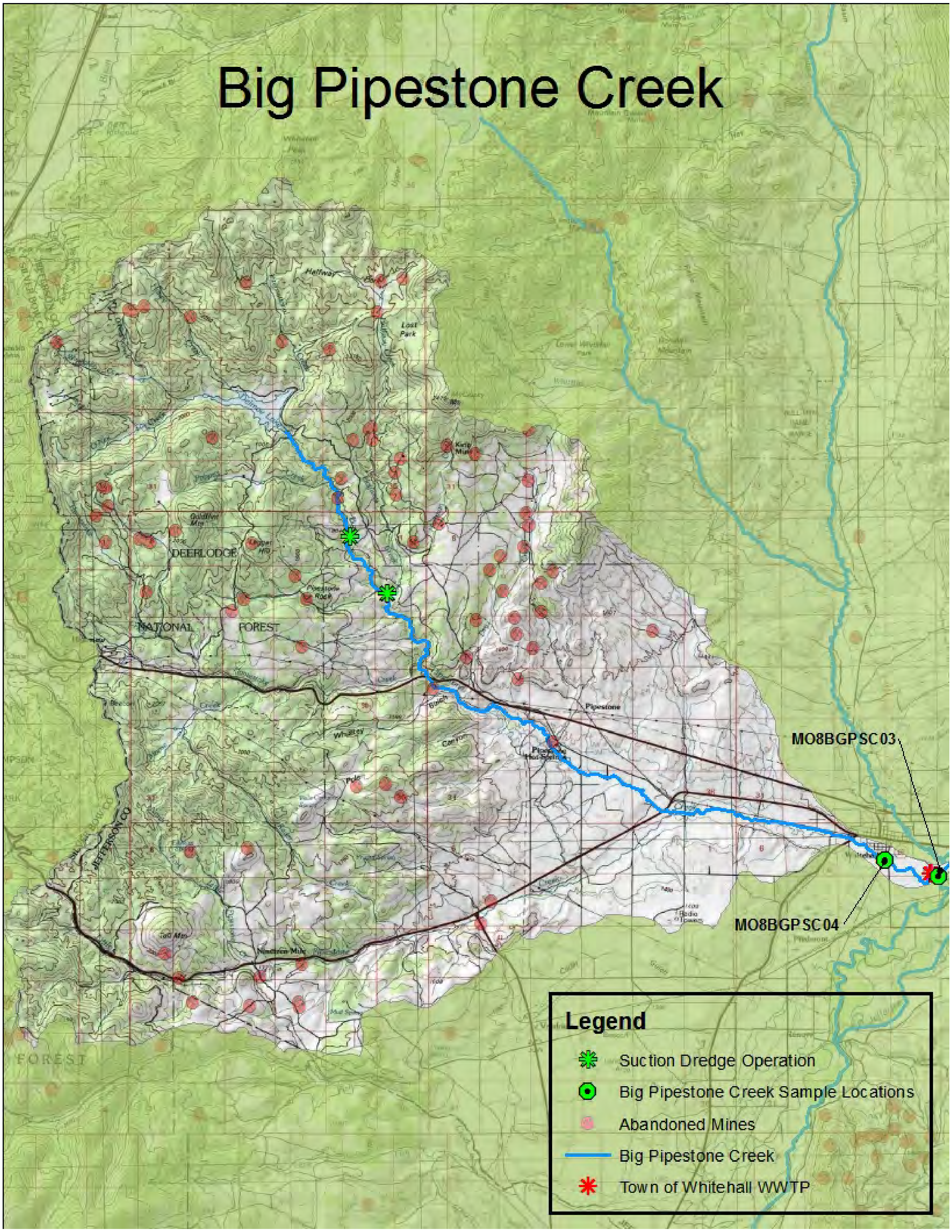

Figure 5-16. Metals Sources and Sampling Locations in Big Pipestone Creek Watershed

5.6.4 Jefferson Slough MT41G002_170 Source Assessment

The Jefferson Slough receives the majority of its flow contributions from Big Pipestone Creek, Whitetail Deer Creek (which receives flow contributions from Little Whitetail Deer Creek) and the Boulder River. While there is likely some connectivity between the Upper Jefferson River and the Jefferson Slough, the extent of this connectivity is not well defined. If the Upper Jefferson River was impacting the Jefferson Slough impairment causes from the Upper Jefferson River (iron and lead) should be present in the Jefferson Slough. This is not the case. The upper Jefferson River does not appear to be contributing to the impairment causes in the Jefferson Slough, as none of the same metals for which the slough is impaired (arsenic, cadmium, copper, zinc) are found in the upper Jefferson River.

The highest observed water quality metals concentrations for arsenic, cadmium, copper, and zinc were recorded at the furthest downstream monitoring location on Jefferson Slough (**Figure 5-17**). Most of the highest observed metals concentrations were associated with higher flow samples suggesting that one mechanism of elevated metals loading is via metals bound in the sediment that become mobile when there is a significant disturbance, such as a high flow event. Arsenic is the one exception, with an elevated value above the target concentration during a low flow condition with relatively low corresponding TSS concentration. Review of the concentration data for metals indicates that concentrations increase dramatically during both high and moderate flows downstream of the confluence of the Boulder River and the Jefferson Slough. The Jefferson Slough is meeting the water quality standard from its origin to the confluence with the Boulder River. This concept is discussed further in **Section 5.6.4.3.** Metals contributions to the Boulder River are a result of historical mining operations (Montana Department of Environmental Quality, 2012b). DEQ stream sampling data from 2012-2013 was used in the assessment process and to support subsequent TMDL development (**Appendix B, Table B-5**).

5.6.4.1 Mining Sources in the Jefferson Slough Watershed

The Jefferson Slough sits squarely in the Whitehall mining district and there are a few historical mining operations with the potential to contribute metals pollution directly to it. However, there is one active mine that exist within the hydrologic bounds of the slough.

The Golden Sunlight-Ohio Group property is located in sections 19, 20 and 30 T2N, R3W about four miles northeast of Whitehall and is comprised of multiple mine locations that have seen extensive development. The mine is a gold and silver property that is working both oxidized and sulphide ores. From 1890 to 1910 the mine was reported to have produced 75,000 tons of ore worth $1.5 million. The output between 1910 and 1917 was listed at 5,000 tons worth $200,000 in gold and silver. From 1917 to 1935 the mine produced 10,000 tons of ore worth $226,000. In the 26 years of production between 1902 and 1956 the mine produced 154,308 tons of ore. This yielded 57,117 ounces of gold, 78,089 ounces of silver, and 55,503 pounds of copper (Roby et al., 1960).

The GSM is up gradient of the Jefferson Slough. There are no direct perennial contributions from surface waters from the mine area to the Jefferson Slough. Groundwater flows in the area of the South Bull Mountains tend to be perpendicular to topographic contour lines. This means that groundwater to the west of the mine tends to flow toward Whitetail Deer Creek (west). Groundwater to the south of the mine tends to flow toward the Jefferson Slough (south), and groundwater to the east of the mine tends to flow toward the Boulder River. Groundwater is likely to be contributing to the Jefferson Slough, however there is limited information regarding the volume of contributing groundwater and concentrations of metals in this groundwater. It is important to note that those sampling sites in the slough, immediately down gradient of the mine site did not show any exceedance of the water quality standards. Sample results from these sites were not the driver in impairment determination. Impairment was determined by sample results from those sites downstream of the confluence with the Boulder River.

The Lucky Hit abandoned mine is located in the northwest corner of section 19, T2N, R3W. The mine is credited with 6,147 tons of ore with continuous production between 1932 and 1953. The ore yielded 2,995 ounces of gold, 13,850 ounces of silver, 22,529 pounds of copper, 333,699 pounds of lead and 78,195 pounds of zinc (Roby et al., 1960).

Other abandoned mines in the Whitehall mining district with recorded production include the Sunny Corner mine. Roby et al. (1960) and Gilbert (1935) mention the Blue Moose and Sunnyside, the Inspiration and South View. Other mines in the area include the Gold Star, Northern Sunlight, Mary Lucile, Perhaps, Payday Group and the Florence Group.

5.6.4.2 MPDES Point Sources in the Jefferson Slough Watershed

There is one active MPDES stormwater permit in the Jefferson Slough watershed. Permit number MTR300199 issued to GSM. GSM is an active surface gold mining operation north of Whitehall. The total area of the mine is approximately 6,125 acres with various active and abandoned mine areas within this acreage. GSM is permitted to discharge at eleven outfalls, all of which ultimately terminate in the Jefferson Slough. GSM monitors stormwater quality on three outfalls (001, 002 and 003). GSM reports the stormwater runoff data to DEQ in the form of a discharge monitoring report (DMR). DMR data indicated outfall 002 is the most consistent outfall with regards to recent (2009-2013) storm event water quality data and corresponding flow data. Maximum flow values were used in conjunction with corresponding concentration data to reveal arsenic, copper, cadmium and zinc storm event loads of 0.01 lbs/day, 0.06lbs/day, 0.007lbs/day and 0.6 lbs/day, respectively. When compared to the Jefferson Slough example TMDL values (**Table 5-21**) these loads represent 0.85% of the low flow arsenic TMDL and 0.014% of the high flow arsenic TMDL, 2.3% of the low flow copper TMDL and 0.12% of the high flow copper TMDL, 11.6% of the low flow cadmium TMDL and 0.48% of the high flow cadmium TMDL, and 1.9% of the low flow zinc TMDL and 0.094% of the high flow zinc TMDL.

It is important to note that the loads from the GSM are not constant. Storm event loading is periodic, based on the frequency of runoff events that cause runoff from GSM. It is also important to note that not all of the stormwater flow and associated metals loading reaches the Jefferson Slough during a given storm event (Buus, Charles personal communication 2014[3]). DEQ intends to use a conservative approach and portray loading from stormwater runoff as constant in WLAs to the Jefferson Slough (**Section 5.7.2.4**).

Under the stipulations of the permit, GSM is required to maintain an approved stormwater pollution prevention plan (SWPPP). The SWPPP sets forth the procedures, methods, and equipment used to prevent the pollution of stormwater discharges. In addition, the SWPPP describes general practices used to reduce pollutants in stormwater discharges. According to the SWPPP, the facility's primary BMP is to use conveyances that minimize contact between runoff and sediment and other pollutants.

[3] Personal communication by phone with Charles Buus, GSM representative and Lou Volpe, DEQ 8/15/2014

5.6.4.3 Tributary and Other Loading Sources to the Jefferson Slough

Of the 14 copper samples collected on the Slough, 11 were upstream and 3 were downstream of the Boulder River. Of the 10 arsenic, cadmium, and zinc samples, 7 were upstream and 3 were downstream of the Boulder River. Only samples below the confluence with the Boulder River, during high and, for arsenic, low flow conditions, were above the metals targets. All data from Jefferson Slough sampling locations above the confluence with the Boulder River met the metals targets, although there is somewhat limited high flow data above the confluence for most of the metals. Note that the sediment sample site, which played a role in making impairment determinations, was near the mouth of the Jefferson Slough below the confluence with the Boulder River. This information shows that impairment conditions and associated elevated metals loading within the Boulder River are causing the identified metals impairment conditions within the Jefferson Slough.

A loading evaluation was performed for the streams and rivers that contribute to the slough. These streams and rivers include Whitetail Deer, Big Pipestone Creek, and the Boulder River. Metals loads were calculated from recent (2004, 2010-2013) water quality data using the highest measured concentrations for a given impairment cause for each flow regime for Whitetail Deer Creek and Big Pipestone Creek. Loading values for the Boulder River were taken from the example existing high and low flow loads provided within **Table 5-40** of the Boulder-Elkhorn Metals TMDLs and Framework Water Quality Improvement Plan (Montana Department of Environmental Quality, 2012b). Where values were less than the detection limit, one-half the detection limit was used for calculating these loads. Unfortunately high and low flow sampling dates varied for each stream, with results from Whitetail Deer Creek based on a very high flow event not represented within the data for the other two streams. Nevertheless, a review of the **Table 5-23** data shows that the Boulder River loading tends to dominate the overall loading to the Jefferson Slough.

Table 5-23. Metals Loading Examples to the Jefferson Slough from Contributing Waterbodies

Contributing Waterbody	Flow Regime	As Load (lbs/day)	Cd Load (lbs/day)	Cu Load (lbs/day)	Zn Load (lbs/day)
Whitetail Deer Creek	High Flow	0.191	0.0013	24.3	0.128
	Low Flow	0.0373	0.0003	0.0226	0.0373
Big Pipestone Creek	High Flow	1.65*	0.006*	0.32*	0.81*
	Low Flow	0.024	0.0004	0.004	0.008
Boulder River**	High Flow	202	7.1	465	1,480
	Low Flow	6.57	0.13	4.1	28.7

* Due to lack of high flow metals data, high flow values were calculated using the highest metals concentration and a flow of 30.5 cfs as noted in **Table 5-21**

Boulder River loads are the existing loads from representative high and low flows calculated in the Boulder-Elkhorn Metals TMDL and Framework Water Quality improvement Plan (Table 5-40** (Montana Department of Environmental Quality, 2012b))

Another method to evaluate loading to the Jefferson Slough is to calculate the amount of the load from each tributary that is above the target concentration for each stream, and then evaluate how much reduction would be required to meet the target concentration in the Jefferson Slough. In other words, if each tributary stream were to meet the same TMDL targets that apply to the Jefferson Slough, how much resulting reduction in loading would occur. These values are determined by subtracting the target concentration from the existing concentration and then translating this to a load by multiplying by the flow and the 0.0054 conversion factor; or in the case of the Boulder River the load above target can be readily determined by subtracting the TMDL from the existing loads provided in the Boulder River TMDL document (Montana Department of Environmental Quality, 2012b). Where a stream is not impaired or there are no sampling results above the target concentration, then the amount of load above target concentration equates to zero. If the tributary had any target exceedances, even if the stream was not impaired because it was within the allowable exceedance rate, the target exceedance concentrations were used to determine the load reduction that would occur if the target were achieved at the time of the sample event. These results are shown in **Table 5-24,** and are compared to the calculated load reductions needed in the Jefferson Slough (**Table 5-25**) based on the high and low flow conditions when targets were exceeded by the greatest extent within the slough. As discussed above, these results are from sampling locations below the confluence with the Boulder River and are all from one high flow event (6/1/2010) with one exception of a low flow arsenic target exceedance (8/1/2010). Note that the above target loads within the Jefferson Slough are significantly less than those within the Boulder River, strongly indicating that meeting target concentrations (and associated TMDLs) within the Boulder River will result in meeting all target and TMDL conditions within the Jefferson Slough. For example, at low flow the Jefferson Slough would require a 0.76 lbs/day reduction in arsenic loading to meet the target concentration. Meeting the target concentration in Big Pipestone Creek would only provide 0.054 lbs/day (7%) of the load reduction needed in the Jefferson Slough, whereas meeting the Boulder River TMDL would provide as much as 2.5 lbs/day of arsenic load reduction to the slough, significantly exceeding the required load reduction for the slough.

Table 5-24. Above Target Loads from Jefferson Slough Tributaries

Contributing Waterbody	Flow Regime	As Above Target Load (lbs/day)	Cd Above Target Load (lbs/day)	Cu Above Target Load (lbs/day)	Zn Above Target Load (lbs/day)
Whitetail Deer Creek	High Flow	0	0	0.043	0
	Low Flow	0	0	0	0
Big Pipestone Creek	High Flow	No Data	No Data	No Data	No Data
	Low Flow	0.054	0	0	0
Boulder River*	High Flow	140	6.34	440	1,200
	Low Flow	2.5	0.06	1.9	0.01

* Based on Boulder River TMDL values provided in **Table 5-24** and sample concentrations provided in **Appendix D** of the Boulder – Elkhorn TMDL document (Montana Department of Environmental Quality, 2012b)

Table 5-25. Measured Above Target Loads within the Jefferson Slough

Waterbody	Flow Regime	As Above Target Load (lbs/day)	Cd Above Target Load (lbs/day)	Cu Above Target Load (lbs/day)	Zn Above Target Load (lbs/day)
Jefferson Slough*	High Flow	21	1.9	170	58
	Low Flow	0.76	0	0	0

* Values are calculated using measured flows and concentrations compared against example target concentrations from **Table 5-21** of this document.

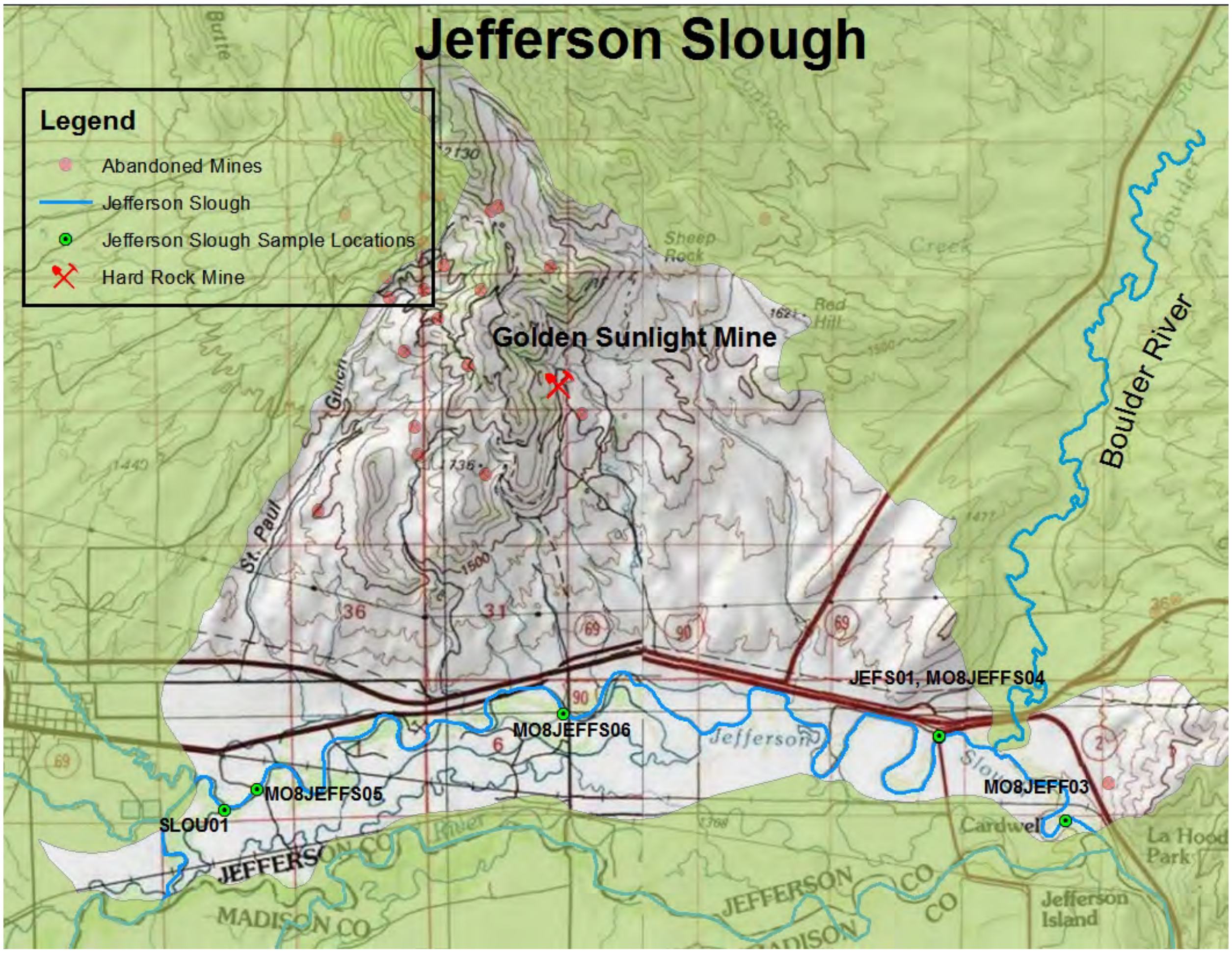

Figure 5-17. Metals Sources and Sampling Locations in the Jefferson Slough Watershed

5.6.5 Upper Jefferson River MT41G001_011 Source Assessment

Metals loading sources to the upper Jefferson River segment include the Ruby, Beaverhead, and Big Hole Rivers. There are other metals sources identified in smaller tributaries and drainage areas along the upper Jefferson that include active, priority abandoned and inactive mines sites. These occur primarily in the Silver Star, Tidal Wave, Highland and Renova mining districts. For the purposes of this document, the area that will be referred to as the upper Jefferson segment is the area of the Jefferson River from the town of Twin Bridges, to the confluence with the Jefferson Slough, and the tributaries that contribute to it (**Figure 5-18**). This does not include the Jefferson Slough and its tributaries since this slough drains into the lower Jefferson River segment.

DEQ stream sampling data from 2004 and 2010-2013 was used for an updated assessment and to support subsequent TMDL development (**Appendix B**, **Table B-6**). One of 8 iron concentrations (12.5%) and 3 of 24 lead concentrations (12.5%) were above the CAL target in water samples collected in the upper Jefferson segment. As such, this waterbody was determined to be impaired and listed as needing iron and lead TMDL development. High iron and lead concentrations tend to occur during the higher flow conditions and appear to strongly correlate to high levels of TSS. The monitoring locations used to assess water quality are depicted in **Figure 5-18.**

5.6.5.1 Mining Sources in the Upper Jefferson Watershed

The Silver Star mining district is on the southeast slope of the Highland Mountains, west of Silver Star, Montana. This area was heavily mined from the mid 1860's to the early 1900's. One significant mine in the area is the Broadway/Victoria mine. This mine is located in Tom Benton Gulch, an ephemeral drainage to Cherry Creek, a perennial tributary to the Jefferson River. The volume of waste rock associated with this site was estimated at approximately 34,575 cubic yards, the volume of tailings associated with the mine site was estimated to be approximately 132,000 cubic yards. Concentrations of numerous metals including iron and lead were elevated at least three times background. There are several open adits and one mine shaft onsite (http://deq.mt.gov/AbandonedMines/priority.mcpx). The Broadway Victoria mine has recently become active, and is no longer on the DEQ Priority Abandoned Mines list (Koerth, John personal communication 2014[4]).

An additional active mining operation in the Silver Star mining district is the Madison Mine. Coronado Resources USA, LLC maintains a groundwater discharge permit (MTX000205) to discharge wastewater associated with mining operations at the Madison Mine to groundwater. The Mine discharges wastewater to the shallow alluvial aquifer via two percolation pond. The percolation ponds are adjacent to Tom Benton Gulch, an ephemeral drainage to Cherry Creek, a perennial tributary to the Jefferson River. While not an active point source, the Madison Mine does have potential to contribute metals to adjacent waterbodies that contribute to the upper Jefferson River.

Other potential contributing sources in the Silver Start mining district include abandoned and inactive mines identified by DEQ and the Montana Bureau of Mines and Geology (MBMG). Some of the large load mines in the district included the Aurora, Edgerton Eagle, Golden Rod or Iron Rod, Green Campbell, Hudson, King Fisher, Moonlight, Silver Star, Strawn Julian and Son, Wheal Clifford and others.

The Tidal Wave mining district is located on the northwestern slopes of the Tobacco Root range, east of Twin Bridges, Montana. The priority mines in the area are located primarily on Dry Gulch (Dry Gulch Mine) and Bear Gulch (Pete and Joe/ B&H Mine). This area was first prospected in the mid 1860's, with mining beginning in earnest several years later. Mining continued in this area until closure of several gold mines during World War II. Site investigations made onsite at the B&H mine indicated a volume of waste rock estimated to be approximately 42,000 cubic yards. Sampling of waste rock revealed a number of metals to be three times background. These included iron and lead. Two discharging adits were identified at the site during the investigation. One of the discharges was documented as entering Bear Gulch. Bear Gulch is a tributary to the Upper Jefferson River. Another priority mine in the Tidal Wave Mining district is the Dry Gulch mine site. This site is reported as having approximately 16, 930 cubic yards of waste rock onsite. This site also has a number of metals including lead that were reported to be three times background concentration. There are several open adit/mine shafts onsite (http://deq.mt.gov/AbandonedMines/priority.mcpx).

Other inactive mines of the Tidal Wave mining district are the Bielenger and Higgins (Inspiration), Smelter Mountain Group, Giant, Copper King, Little Bear, Grouse, Crystal Lake, Eleanora, Sunbeam, Sunflower, High Ridge, Empire State, Deutschland, Corncracker and Strawn. Other mines in the district include the Eureka, Moffat, and Ohio Lode

[4] Personal communication by e-mail between John Koerth, DEQ and Lou Volpe, DEQ 8/6/14.

The Highland mining district boundaries follow the Continental Divide on the north and west. The east boundaries are the section lines dividing sections 26 /27 and 34/35. The southern boundary is the township boundary separating Townships 1N from 1S in Range 7W. Other inactive mines in the Highland district include the Ballarat, Blue Bird, Gold Hill, Highland Chief, Highland, Highland Placer, J.B Thompson, Murphy Mine, Nevin, and Only Chance mines.

The Renova mining district is approximately six miles south of Whitehall. All of the mines in the district are located on the foothills of the west slope of the Tobacco Root Mountains. Historic mines of note in this district include the Colorado, Bonanza Fraction, Florence, Gold Hill, Iron King, Mary Ingbar, Mayflower, and West Mayflower.

5.6.5.2 Sediment Sources in the Upper Jefferson Watershed

A considerable portion of the upper Jefferson watershed is grazed. A portion of this grazing takes place on USFS and BLM allotments.

The majority of the allotments occur on BLM land. Some portions of the larger allotments that are within the upper Jefferson watershed include the Hells Canyon (37,126 acres), Dry Boulder (18,517 acres), Iron Rod (9,764 acres) and the Lower Rochester (5,195 acres). Other BLM allotments worth mentioning include the Two Hart, Kountz, Delmoe, Third Creek and Shakey Springs. The USFS also has a number of allotments in the upper Jefferson watershed. Portions of these allotments within the upper Jefferson watershed include the Hells Canyon (18,968 acres), Fish Creek (14,404 acres), Waterloo (12,710 acres), and Silver Star (10,317 acres). Other USFS allotments worth noting include the Perry Canyon, Goodrich Gulch, South Boulder, Blacktail and Moose Camp allotments.

While cattle grazing is not a direct source of metals loading, trampling of riparian and upland soils can increase erosion. The resulting sediment has the potential to increase metals loading to the upper Jefferson River if the sediment is from an area with elevated metals concentrations. What is uncertain is whether all elevated sediment loading results in elevated metals concentrations, or if the elevated metals loading only results from elevated sediment loading in specific locations throughout the Jefferson River watershed including the major river tributaries. DEQ has previously completed sediment TMDLs for all three major rivers and several of the tributaries in the upper Jefferson watershed. These TMDL documents include the Beaverhead, Ruby, Upper and North Fork of the Big Hole, Middle and Lower Big Hole and Upper Jefferson Tributaries (Montana Department of Environmental Quality, 2012a; Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2006; 2009a; 2009b; Kron et al., 2009).

5.6.5.3 MPDES Point Sources in the Upper Jefferson Watershed

The only significant MPDES surface water permit in the Upper Jefferson River assessment unit is issued to the town of Twin Bridges for their WWTP. The Twin Bridges WWTP is a point source authorized by DEQ under MPDES (permit # MT0028797). The Twin Bridges WWTP discharges to Bayer’s Ditch. While Bayer Ditch is not directly connected to the Jefferson River, during the high flow conditions it does have the potential to discharge to the Jefferson River. Discharge to the Jefferson River likely only occurs during extremely high flow events (Novich, Sam personal communication 2014[5]). DEQ has chosen to evaluate potential metals loading and develop a WLA for this discharge as the potential for the effluent to reach the Jefferson River exists.

[5] Personal phone communication between Sam Novich, Maintenance Operator, Twin Bridges and Lou Volpe, DEQ June 3, 2014

To determine the potential lead contribution of this point source, DEQ compared the WWTP load to the TMDL. The WWTP discharge lead load is estimated using the existing high flow Jefferson River target concentration of 2.74 µg/L as the WWTP discharge concentration. This value was used as it is a conservatively high estimate, given that mean lead concentrations from a similar facility discharge (East Helena WWTP) is 1.36 µg/L. Samples collected from another similar WWTP (Lolo WWTP) average 0.7 µg/L. Lead data from like facilities are referenced here as there was no lead data collected at the Twin Bridges WWTP. Therefore, there is no way of knowing the lead concentrations entering the receiving water at this time. The seasonally high design flow of the WWTP is 0.0713 million gallons a day (0.11 cfs) (Montana Department of Environmental Quality, 2008a). This value is then used to calculate a lead load of approximately 0.0016 lbs/day.

The flow on the upper Jefferson River when the only lead target exceedance occurred was 7,190 cfs; the TMDL or allowable load at this flow equates to 106.3 lbs/day based on the target concentration of 2.74 µg/L (**Section 5.4.2.1**). Comparing the Twin Bridges WWTP load of approximately 0.0016 lbs/day of lead to the river's allowable load (TMDL) of 106.3 lbs/day, the WWTP lead load represents 0.0015% of the TMDL.

Iron discharged from the WWTP will have a similarly insignificant impact to the upper Jefferson River. There were no wastewater quality data available for iron from the WWTP. The Jefferson River target iron concentration of 1,000 µg/L and the WWTP design flow of 0.11 cfs are used to calculate a load of approximately 0.59 lbs/day from the WWTP to the upper Jefferson River. The one iron target exceedance occurred at a flow of 2,740 cfs; the TMDL or allowable load at this flow equates to 14,796 lbs/day based on the target concentration of 1000 µg/L (**Section 5.4.2.1**). Comparing the Twin Bridges WWTP load of approximately 0.59 lbs/day of iron to the river's allowable load (TMDL) of 14,796 lbs/day, the iron load represents 0.004% of the TMDL.

These results show that lead and iron loading from the WWTP, even under conservatively high discharge concentrations, are negligible and would not measurably increase the concentration in the upper Jefferson River under elevated flow conditions where lead and iron target exceedances have occurred.

5.6.5.4 Evaluation of Tributary and Other Loading Sources

Significant sources of metals loading in the upper Jefferson River are the three major rivers that combine to form the Jefferson River. These include the Beaverhead, Big Hole, and Ruby rivers. It is important to note that the Ruby River and the Beaverhead River converge prior to joining with the Big Hole River to form the Jefferson River. For evaluating the contributing load from the Beaverhead River, only data from above the Ruby River confluence was used. This data was used to ensure that the load contribution from the Ruby River was not accounted for twice. Metals loading from these sources was calculated from recent (2003-2006, 2008-13) water quality data.

Table 5-26 outlines the high flow loads from each upstream river for those metals that are contributing to the impairment of the upper Jefferson River. As there was limited data available for these streams, lead loads were calculated with data from the same high runoff event on 6/9/2011. No iron data were collected on this 6/9/2011; as such iron loads were calculated from the highest measured iron concentration and corresponding flow from another date. For the Big Hole and Ruby rivers, recent sample data were available from locations near the mouth of each river. For the Beaverhead River, data included several locations within the lower segment of the river. High flow data for the Beaverhead, Big

Hole, and Ruby rivers are available in **Appendix D**, **Table D-1**. Note that the Big Hole River tends to dominate the loading followed by the Ruby River.

Table 5-26. Metals Loading to the Upper Jefferson River from Major River Tributaries

Contributing Waterbody	Flow Regime	Fe Load (lbs/day) (based on highest measured concentration)	Pb Load (lbs/day) (based on flow and corresponding concentrations on 6/9/2011)
Beaverhead River	High Flow	1,409.40	12.83
Big Hole river	High Flow	11,274.13	261.42
Ruby River	High Flow	6,694.38	14.26

Another method to evaluate loading information is to calculate the portion of the load from each major tributary river (Beaverhead, Big Hole, and Ruby Rivers) that is above the Jefferson River target concentrations, and then estimate how much reduction would be necessary to meet the target concentration in the upper segment of the Jefferson River. In other words, if each tributary river were to meet the same TMDL targets that apply to the upper segment of the Jefferson River, how much resulting reduction in loading would occur?

These values are determined by subtracting the target concentration from the existing concentration and then translating this to a load by multiplying by the flow and the 0.0054 conversion factor. If the tributary river is not impaired or there are no sampling results above the target concentration in the contributing tributary, then the amount of load above target concentration equates to zero. If the tributary river had any target exceedances, even if the stream was not impaired because it was within the allowable exceedance rate, the results were used to determine the load reduction that would occur if the target were achieved at the time of the sample event. These results are shown in **Table 5-27**.

Table 5-27. Above Target Loads from the Upper Jefferson River Tributaries

Tributary River	Flow Regime	Fe Above Target Load (lbs/day)	Pb Above Target Load (lbs/day)
Beaverhead River	High Flow	0	3.88 (at 660 cfs on 6/9/11)
	Low Flow	0	0
Big Hole River	High Flow	0	115 (at 9880 cfs on 6/9/11)
	Low Flow	0	0
Ruby River	High Flow	4,960 (at 322 cfs on 6/1/10)	1.8 (at 322 cfs on 6/1/10)
	Low Flow	0	0

Table 5-27 values can be compared to the calculated load reductions needed in the upper Jefferson River (**Table 5-28**) where targets were exceeded within the this segment of the Jefferson River. For iron, the Big Hole River is the largest loading source based on **Table 5-27**. Nevertheless, the Ruby River contributes the largest above-target concentration load, with the elevated iron load occurring on the same date (6/1/2010) as the iron target exceedance on the upper Jefferson River segment. For lead, the Big Hole River is the largest loading source based on **Table 5-26** and also has the most significant above target load per **Table 5-27**. Note that the above target lead loading of 115 lbs/day in the Big Hole River greatly exceeds the above target lead load of 29 lbs/day within the upper segment of the Jefferson River.

Table 5-28. Measured Above Target Concentration Loads within the Upper Jefferson River Segment

Waterbody	Flow Regime	Fe Above Target Load (lbs/day)	Pb Above Target Load (lbs/day)
Jefferson River (upper segment)	High Flow	740 (at 2740 cfs on 6/1/10)	29* (at 11,400 cfs on 6/9/11)
	Low Flow	0	0

*All lead target exceedances were from three samples taken on the same date (6/9/11), with above target loads ranging from 5.2 to 29 lbs/day

To further evaluate iron loading sources, data from the upper sample sites were compared to data from lower (downstream) sample sites on the upper segment of the Jefferson River. On 6/1/2010, the 970 µg/L below target iron concentration at an upstream sample site (JEFF-07) increased to an above target concentration of 1050 µg/L at a downstream sample site (JEFF-06) located toward the middle of the segment (**Figure 5-18**). This represents a change from no above target loading to the 740 lbs/day of above target loading identified within **Table 5-28**, suggesting elevated sources of iron loading within the upper Jefferson River segment watershed area during high flow conditions. DEQ sampled several tributaries in the upper Jefferson area, including Fish and Cherry creeks. All iron values were below target concentrations, although there are limited sample data and they are focused on low flow conditions. Addressing elevated iron loading within the major river tributaries, particularly within the Ruby River watershed, can readily reduce loading to the point where there will no longer be an iron impairment within the upper segment of the Jefferson River. Alternatively, addressing elevated sources of iron loading within the upper Jefferson watershed also has the potential to reduce loading enough to eliminate the iron impairment cause.

To further evaluate lead loading sources, data from an upstream sample sites were compared to data from downstream sample sites on the upper segment of the Jefferson River. On 6/9/2011, the 2.6 µg/L concentration at mid-segment site JEFF-06 increased to 3.1 µg/L at a sample site further downstream (JEFF-05); resulting in an increase of 16.8 lbs/day of above target loading. This suggests elevated sources of lead loading within the upper Jefferson River segment watershed area during high flow conditions. DEQ sampled several tributaries in the upper Jefferson watershed area, including Fish and Cherry creeks. All lead values were below target concentrations, although there is limited sample data and it is focused on low flow conditions. Nevertheless, the largest above target load of 29 lbs/day occurs in the uppermost sample location on the Jefferson River (resulting from a low hardness-dependent target at this location), meaning that high flow lead reductions in the major tributary rivers would be necessary to consistently meet the lead target within the upper segment of the Jefferson River. This is further supported by the fact that the elevated lead loads within the upper segment of the Jefferson River occurred on the same date (6/9/2011) when the highest lead concentrations were also noted in the two of the three tributary rivers.

In summary, meeting concentrations of iron in the Ruby River consistent with water quality standards during high flows would more than likely resolve the iron impairment for the upper Jefferson River segment, and meeting concentrations of lead in the Big Hole River consistent with water quality standards during high flows would more than likely resolve the lead impairment for the upper Jefferson River segment. Reductions can also be achieved in other source areas, but these two rivers control the elevated (above target) metals loading when the sampling results show iron and lead impairment for the upper Jefferson River segment. DEQ previously developed TMDLs for the Ruby River watershed (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2006), but the metals TMDLs only focused on a few tributaries and iron was not included. In fact, there are currently no iron impairments identified within the Ruby watershed. Further metals TMDL work is planned in the Ruby watershed, and it is anticipated that this work will include additional iron and other metals sampling throughout the watershed. DEQ also developed TMDLs within the Big Hole watershed (Kron et al., 2009). These include several lead TMDLs where mining sources within the Wise River drainage were identified as a source of elevated lead loading to both the Wise River and the Big Hole River.

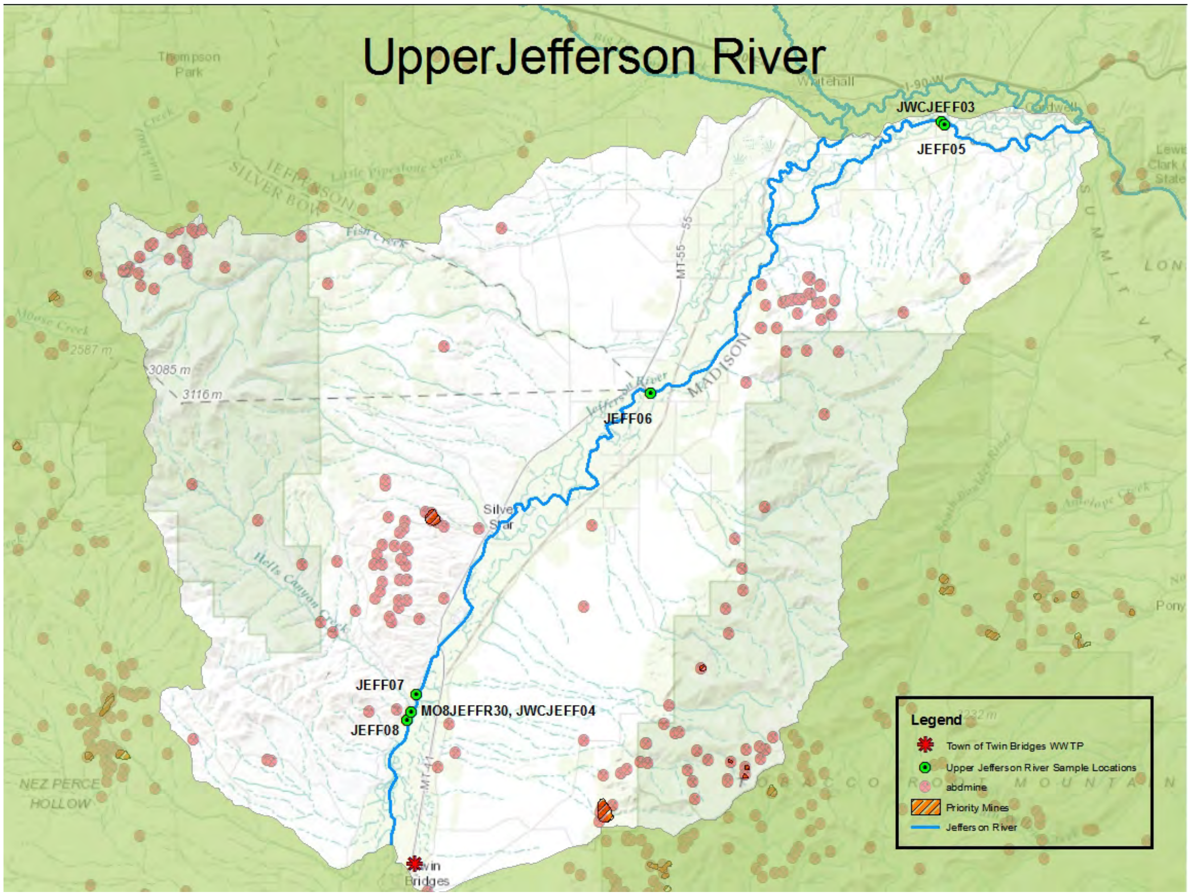

Figure 5-18. Metals Sources and Sampling Locations in the Upper Jefferson Watershed

5.6.6 Lower Jefferson River MT41G001_012 Sources Assessment

Some of the metals sources identified in the lower Jefferson River watershed include active, priority abandoned mines and inactive mines sites in the South Boulder, Bismark, Potosi, Norwegian Creek, Sand Creek, Three Forks, Whitehall, and Boulder mining districts. These are in addition to the sources already identified within the upper Jefferson watershed and the three major river tributaries to the upper Jefferson River segment. For the purposes of this document, the area that drains directly to the lower Jefferson River segment and the tributaries within this portion of the Jefferson River TMDL Project Area will be referred to as the lower Jefferson watershed as shown by **Figure 5-19**. This does not include the Jefferson Slough and its tributaries (including the Boulder River) since the slough is instead a separate major tributary to the lower Jefferson River segment. This lower Jefferson watershed essentially equates to the Lower Jefferson TPA boundaries (http://deq.mt.gov/wqinfo/CWAIC/default.mcpx).

DEQ stream sampling data from 2003-2006 and 2010-2013 were used for an updated assessment and to support subsequent TMDL development (**Appendix B, Table B-7**). Four of 38 copper samples (10.5%) and 5 of 38 lead samples (13.16%) were above the CAL target in water samples collected in the lower Jefferson River watershed. Two of the 38 copper samples were greater than twice the AAL standard. As such, this waterbody was determined to be impaired and listed as needing TMDL development for copper and lead. The highest copper and lead concentrations occurred during the highest flow condition with the highest concentrations of suspended solids. In fact, eight of the nine copper and lead target exceedances occurred on the same high flow sampling date of June 9, 2011 (**Section 2.1.2**).

The monitoring locations used to assess water quality are included in **Figure 5-19.**

5.6.6.1 Mining Sources in the Lower Jefferson Watershed

The South Boulder mining district is located on South Boulder River, about 15 miles west of Harrison, Montana. This mining district has a number of historic mines that are worth noting. These include the Bismark, Gold Bug, Highland Mary Lode, and Surprise mines. The Mammoth Tailing site was originally listed as a priority mine site in the South Boulder district. However, it has recently been removed from the list of priority mine sites (Well, Kim personal communication 2014[6]).The Mammoth mine site was removed from the list of priority mine sites as it has recently gone active and is under regulation through the Small Mines Exclusion program (SME). Site visits conducted by the Abandoned Mine Reclamation Bureau of the Montana Department of Health and Environmental Sciences in 1993 indicated tailings (47,950 cubic yards) and waste rock (29,350 cubic yards) were present on site. Both copper and lead concentrations were found to be at least three times background in samples taken from the tailing and waste rock. One discharging adit was noted, water samples collected from this adit indicated acute and chronic targets for copper were exceeded.

The Bismark mining district has one priority mine, the Atlantic/Pacific mine. The Atlantic/Pacific mine was noted to have a volume of tailings (64,500 cubic yards) and waste rock present, (19,000 cubic yards). Sampling of soils onsite indicted high concentrations of copper and lead in the waste rock. One adit found onsite was discharging water. Water samples collected from the adit water showed copper concentrations above the CAL target.

The Pony mining district has several mines worth noting. These include the Ben Harrison, Bozeman, Garnet, Keystone, Lone Wolf, Cliff Mountain, Ned, Old Joe, Willow Creek, and White Pine mines.
The Pony mining district has a number of priority mine sites as well. These include the Boss Tweed, Strawberry, Garnet Gold, and the Chicago Mining Corporation (CMC) Pony Mill site. Site visits conducted by DEQ in September of 1993 at the Boss Tweed Mine revealed tailings (65,900 cubic yards) and waste rock (26,520 cubic yards) present onsite. Copper and lead concentrations were above three times background in both the tailings and waste rock samples. Four discharging adits were also documented onsite. The Strawberry Mine site visit yielded tailings (13,475 cubic yards) and waste rock (12,820 cubic yards) present onsite. Copper and lead concentrations were above three times background in both the tailings and waste rock samples. One discharging adit was identified. Water quality samples from the adit water indicated CAL targets were exceeded for copper (http://deq.mt.gov/AbandonedMines/priority.mcpx). The site visit at the Garnet Gold Mine revealed tailings (23,450 cubic yards) and waste rock (21,640 cubic yards) present onsite. Copper and lead concentrations were above three times background in both the tailings and waste rock samples. One discharging adit was observed onsite. Water quality samples from the adit water indicated AAL and CAL targets were exceeded for copper and lead. The CMC Pony Mill site was reported to have a tailings pond onsite, the volume of the tailings was not reported.

[6] Personal communication via e-mail between Kim Wells, DEQ Abandoned Mine Land and Lou Volpe, DEQ 8/7/14

The Norwegian mining district is located about seven miles northwest of Norris, in the Norwegian Creek drainage. There are several mines worth noting in this mining district. These include the Gold Hill, Norwegian, and the Norwegian placer operation. The Norwegian Creek mining district has one priority mine site, the Norwegian mine.

5.6.6.2 Sediment Sources in the Lower Jefferson Watershed

There are several USFS and BLM grazing allotments in the Lower Jefferson watershed. The USFS has two rather large allotments. Portions of these allotments are within the lower Jefferson watershed. These include Willow Creek (31,368 acres) and the South Boulder (32,483 acres). The BLM has one large allotment within the watershed, the Copper City (7,272 acres). Other BLM allotments include the Strawberry Ridge (5,158 acres), Dry Hollow (4,511 acres), Huller Springs (3,367 acres), and the Milligan Canyon (2,073 acres). Other BLM allotments worth mentioning include the Armstrong, Windy Pass AMP, Bill Grant Kyle, Preacher Creek, Sappington Spring, Cottonwood Spring, and Shoddy Spring. While cattle grazing is not a direct source of metals loading, trampling of riparian and upland soils can increase erosion. The resulting sediment has the potential to increase metals loading to the lower Jefferson River if the sediment is from an area with elevated metals concentrations. It is uncertain whether all elevated sediment loading results in elevated metals concentrations. It is also uncertain whether elevated sediment loading results from a precipitation event and high runoff/ overland flow or if the elevated metals loading results from elevated sediment loading in specific locations within each major tributary.

5.6.6.3 MPDES Point Sources in the lower Jefferson Watershed

As of July 2014, there was one active MPDES permit in lower Jefferson River watershed for suction dredge operations (MTG370316). The general permit requires the operators to minimize harm caused by elevated suspended sediment concentrations and can only be active from January 1st through September 15th, to protect fish life stages during other times of the year. The general permit does not include loading limits for metals. DEQ sampled streambed sediments in the lower Jefferson River in 2001 and 2004 and found all metal concentrations to be below targets (see data tables in **Appendix C**). The suction dredging operation is not expected to contribute to water quality exceedances of lead and copper in the lower Jefferson River watershed based on the type of activity and requirements contained in the permit that limit suspended sediment.

5.6.6.4 Evaluation of Tributary and Other Loading Sources

A significant source of metals loading to the lower Jefferson River segment includes loading from the upper Jefferson River segment (impaired for lead) and the Jefferson Slough (impaired for copper). Other potential sources include the major tributaries that enter directly into the lower Jefferson River, including the South Boulder River, which is impaired for copper and lead; North Willow Creek, which is impaired for lead and mercury; South Willow Creek that is impaired for zinc; Willow Creek that is impaired for zinc; and Norwegian Creek that is impaired for arsenic (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012).

High flow loading examples are provided in **Table 5-29** for the upper Jefferson River, the Jefferson Slough and the South Boulder River using the highest recent concentrations and associated flows (from 2010 to 2013 data, **Appendix B**, **Table B-7**) that occurred during high flow events (**Section 2.1.2**). High Flow event data was used because this was when exceedances were observed in the lower Jefferson River. Note that for both copper and lead, significant loads come from both the upper Jefferson River segment and the Jefferson Slough. Loading from the South Boulder River is relatively small primarily due to the small relative flow from this river (**Appendix E**). There is a lack of data from Willow Creek to evaluate copper and lead loading at high flow conditions, and therefore Willow Creek is not included in **Table 5-29**. During low flow, Willow Creek copper and lead values all appear to be at values below the Jefferson River targets.

Table 5-29. Metals Loading to the Lower Jefferson River Segment from Contributing Waterbodies

Contributing Waterbody	Flow Regime	Cu Load (lbs/day)	Pb Load (lbs/day)
Upper Jefferson River Segment	High Flow (11,400 cfs)	307	190
Jefferson Slough	High Flow (1,276 cfs)	214	68.9
South Boulder River	High Flow (200 cfs)	6.48	0.756

Another method to evaluate loading information is to calculate the portion of the load from each major tributary that is above the lower Jefferson River segment target concentrations, and then evaluate how much reduction would be required from the contributing tributary to meet the target concentration in the lower Jefferson River segment. In other words, if each of the major tributaries and the upper Jefferson River segment were to meet the same TMDL targets that apply to the lower Jefferson River segment, how much resulting reduction in loading would occur? These values are determined by subtracting the Jefferson River target concentration from the existing tributary concentration and then translating this to a load by multiplying by the tributary flow and the 0.0054 conversion factor. This approach accounts for variations in hardness based target concentrations that can exist between tributaries and the Jefferson River, or between upper and lower segments of the Jefferson River. If there are no sampling results above the target concentration, then the amount of load above target concentration equates to zero. If the tributary stream had any target exceedances, even if the steam was not impaired because it was within the allowable exceedance rate, the target exceedance concentrations were used to determine the load reduction that would occur if the target were achieved at the time of the sample event. These results are shown in **Table 5-30**. Note that the majority of above target copper and lead loading is from the Jefferson Slough via elevated loading from the Boulder River. Additional lead loading is coming from the upper Jefferson River segment, which originates from within the Big Hole River as discussed in **Section 5.6.5.4**.

Table 5-30. Above Target Loads from the Lower Jefferson River Tributaries

Contributing Waterbody	Flow Regime	Cu Above Target Load (lbs/day)	Pb Above Target Load (lbs/day)
Upper Jefferson River Segment	High Flow (at 11,400 cfs on 6/9/11)	0	36
	Low Flow	0	0
Jefferson Slough	High Flow (at 1,276 cfs on 6/1/2010)	159	52
	Low Flow	0	0
South Boulder River	High Flow	0*	0**
	Low Flow	0	0

* Although copper did slightly exceed the target in South Boulder River at high flow, it did not contribute above target loading to the lower Jefferson River segment because of higher hardness within the Jefferson River.
** Based on recent lead data that show no target exceedances

All copper target exceedances in the lower Jefferson River segment occurred on the same extremely high flow sampling date of 6/9/2011 (**Section 2.1.2**). Four of five lead target exceedances also occurred on this same date. The calculated load reductions needed for the lower Jefferson River where copper and lead targets were exceeded at an upstream location (Jeff-04 in **Figure 5-19**) during the 6/9/2011 high flow event are provided in **Table 5-31**. The total above target copper load on 6/9/2011 was 1,257 lbs/day. The combined above target copper load is 161 lbs (**Table 5-30**), which is well below the 1,257 lbs/day value from **Table 5-31**, suggesting a major loading source of copper to the lower Jefferson River segment is not accounted for. Similarly, the combined above target lead load of 89 lbs/day from **Table 5-30** is also well below the 670 lbs/day value from **Table 5-31**, suggesting a major loading source of lead to the lower Jefferson River segment is not accounted for.

Unfortunately, during the high flow conditions of 6/9/2011, no flow or metals data were collected for the Jefferson Slough below the Boulder River, and no metals data is available from within the Boulder River. The USGS gage site for the Boulder River near the town of Boulder recorded a flow of approximately 3,000 cfs on 6/9/2011, suggesting that on 6/9/2011 the flow within the Jefferson Slough below the Boulder River was significantly higher than the 6/1/2010 1300 cfs flow used within **Table 5-30**. As discussed in the Jefferson Slough source assessment (**Section 5.6.4),** the Boulder River is the primary source of excess metals loading to the Slough, and previous Boulder River TMDL documentation shows a correlation between high flows and elevated copper and lead concentrations in the Boulder River (Montana Department of Environmental Quality, 2012b), with higher flows tending toward higher copper and lead concentrations. It is likely that most or possibly all unaccounted above target copper and lead loads originate from within the Boulder River watershed and cannot be documented within **Table 5-30** due to a lack of sampling in this area during the 6/9/2011 high flow event. This is further supported by 6/10/11 sample data for the Jefferson Slough above the confluence with the Boulder River where both copper and lead concentrations are at below target concentrations **(Appendix B).**

Table 5-31. Measured Above Target Concentration Loads within the Lower Jefferson River Segment

Waterbody	Flow Regime and Location	Cu Above Target Load (lbs/day)	Pb Above Target Load (lbs/day)
Jefferson River (lower segment)	High Flow	1257 (at 13,470 cfs on 6/9/11)	670 (at 13,470 cfs on 6/9/11)
	Low Flow	0	0

A review of the 6/9/2011 upstream to downstream flows, loads, and concentrations within the lower segment of the Jefferson River (**Table B-7** of **Appendix B**) show that copper and lead both decreased about 16 – 17% each in concentration below the South Boulder River, but then increased in concentration (10% for copper and 20% increase for lead) further downstream below Willow Creek. Lead concentrations from a relatively high flow event (853 cfs) on 7/13/2004 show that the sample site below Willow Creek was below the target with lead increasing to above the target near the mouth of the Jefferson River. These results suggest the potential for additional high flow loading along the lower segment of the Jefferson River from Willow Creek and/or other source areas within the lower Jefferson River watershed.

In summary, meeting concentrations of copper and lead in the Boulder River, consistent with water quality standards and Boulder River TMDL requirements during high flows, would greatly contribute to load reductions and probably resolve the copper and lead impairments for the lower Jefferson River segment. Unfortunately, the data gaps discussed above limit the ability to fully analyze loading from a very high flow event. Reductions can also be achieved in other source areas, but the available information points to the Boulder River as the main source of the elevated (above target) metals loading to the lower Jefferson River segment.

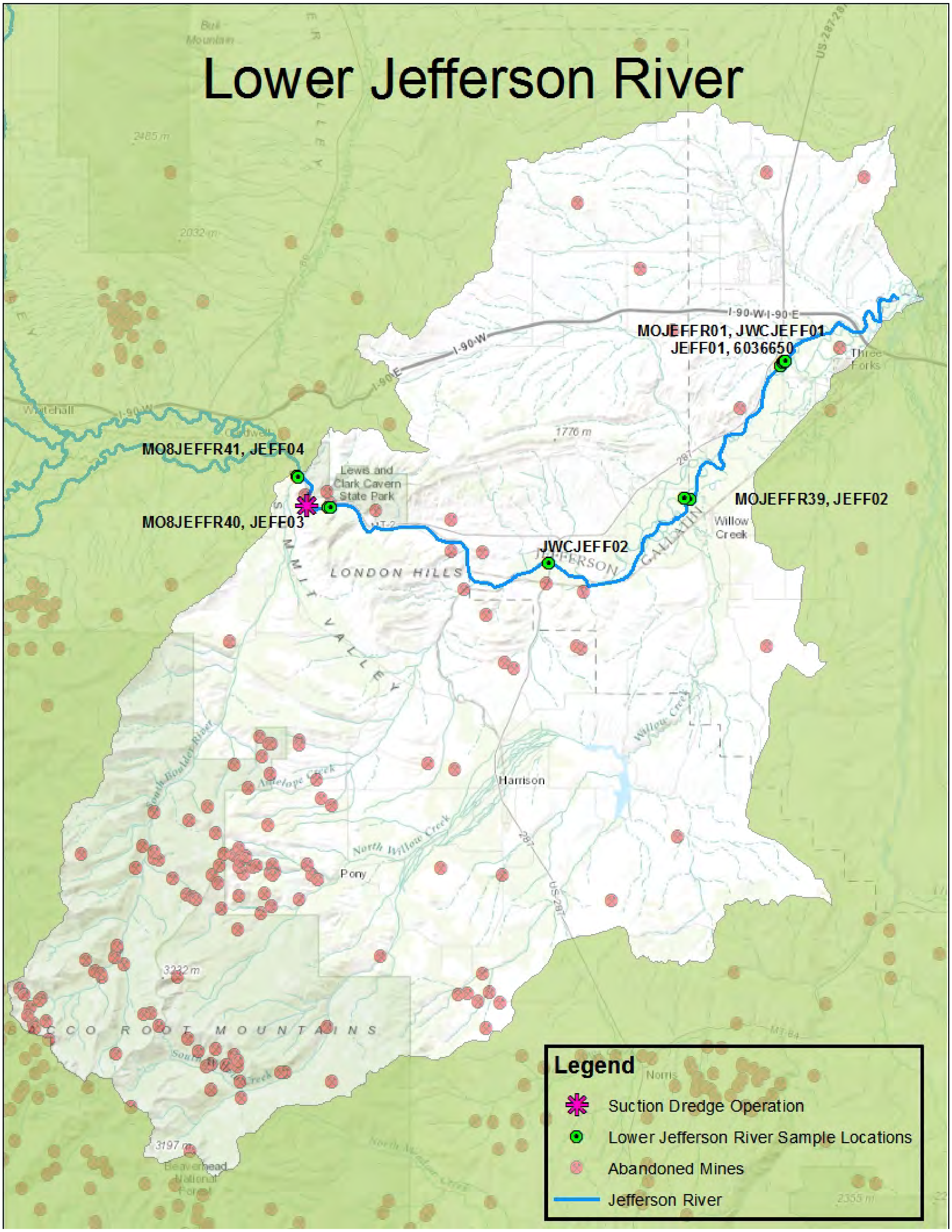

Figure 5-19. Metals Sources and Sampling Locations in the Lower Jefferson Watershed

5.6.7 Natural Background

Natural background loading is assumed to be a result of local geology, with no or negligible influence from human-caused sources. Metals 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 influencing Little Whitetail, Whitetail Deer, Big Pipestone, and the Jefferson Slough is the weathered quartz monzonite rock of the Boulder Batholith. This geology contains metal ores, and the potential to leach metals to surface waters. The geology affecting the upper and lower Jefferson River is more difficult to identify. These sections of river collect runoff from, and flow through a number different geologic settings over a larger geographic area.

The extent of data from background monitoring sites in the Jefferson River TMDL Project Area were limited. As a result there were very few data that could be considered representative of background water quality. This was the case in Little Whitetail Creek, Whitetail Deer Creek, Big Pipestone Creek, and the Jefferson Slough. In the case of Whitetail Deer and Little Whitetail creeks, impairments causes include aluminum, copper, and lead. These happen to be the three metals where natural background values were difficult to define in the Boulder River watershed (Montana Department of Environmental Quality, 2012b). Even where potential background sites existed, the data indicated natural concentrations could be near or above target concentrations leading to uncertainty in defining natural concentrations. Additionally, there is very limited to no natural background data to cover high flow conditions in these drainages. In the case of the Jefferson Slough above the Boulder River, there were limited data available to adequately characterize natural background water quality especially due to the fact that much of the flow in the slough originates from the Whitetail Deer Creek watershed. In the case of the Jefferson Slough below the Boulder River, the majority of the flow is from the Boulder River where natural background metals loading for the lower segments of the Boulder River is defined within the Boulder-Elkhorn document (Montana Department of Environmental Quality, 2012b).

The major river watersheds did have data that could be used to help determine background conditions. These include the upper and lower segments of the Jefferson River. Potential background data for these segments were compiled from the tributaries of the Big Hole, Beaverhead, and Ruby Rivers and is included in **Table 5-32**. Nevertheless, there is potential for human influenced metals loading under all flow conditions for these large river systems.

The data set outlined in **Table 5-32** contains 18 sampling results for most metal parameters. The sites occur primarily near the mouth of each contributing river. These samples were collected during the high and low flow seasons of 2001, 2003-2005, and 2010-2013. The median values in the shaded rows in **Table 5-32** can be used to estimate the upper extent of natural background concentrations and associated natural background loading. Note that these concentrations represent a relatively low percentage of the applicable target concentrations per **Table 5-32**. This suggests natural background concentrations in the Jefferson River are very likely at or below the values in **Table 5-32**.

Table 5-32. Median High and Low Flow Metals Concentrations for the Upper and Lower Jefferson River Segments

Flow Regime	Site ID and Waterbody	Cu (ugL)	Fe (ugL)	Pb (ugL)
High Flow	M03BGHLR02 (Big Hole River)	0.5	290	0.5
	BIGH-01 (Big Hole River)	2	640	0.6
	M03BGHLR02 (Big Hole River)	1	490	0.4
	M08BEAVR01 (Beaverhead River)	0.5	80	0.5
	RBYR3 (Ruby River)	4	1460	1
	RBYR3 (Ruby River)	2	380	1
	RBYR3 (Ruby River)	7	3850	3.8
	RBYR3 (Ruby River)	5		2.2
Median*		2	490	0.8
Percent of Target Concentration		14% (lower Jefferson River)	49% (all streams)	13% (lower Jefferson River)
Low Flow	M08BEAVR01 (Beaverhead River)	0.5	210	0.25
	M03BGHLR02 (Big Hole River)	0.5	180	0.25
	BIGH-01 (Big Hole River)	0.5	220	0.25
	M03BGHLR02 (Big Hole River)	0.5	230	0.25
	RBYR3 (Ruby River)	2	220	1
	RBYR3 (Ruby River)	2	750	0.8
	RBYR3 (Ruby River)	1		0.25
Median*		0.5	220	0.25
Percentage of Target Concentration		6.3% (lower Jefferson River)	22% (all streams)	10% (lower Jefferson River)

*Values can be used to estimate natural background concentrations. Note that where values where reported below the detection limit, a value of one half the detection limit was substituted.

Additional surface water monitoring is recommended to better define natural background levels of metals loading. Often, background loading is accounted for separately from human-caused sources. Within this document, natural background is not provided a separate allocation because of significant uncertainty in natural background concentrations. Regardless of the allocation scheme, the underlying assumption is that natural background sources alone would not exceed the target metals concentrations in the water column, or the PELs in sediment. If future monitoring disproves this assumption, the TMDL targets and associated metals loading analyses may need revision per the adaptive management strategy described in **Section 7.0.**

5.7 Metals Total Maximum Daily Load Allocations

As discussed in **Section 4.0**, a TMDL equals the sum of all the WLAs, LAs, and an MOS. WLAs are allowable pollutant loads that are assigned to permitted (MPDES discharge permit) 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 loads from naturally occurring sources, as well as human-caused nonpoint loading. For all stream in the Jefferson River TMDL Project Area, LAs to human sources are provided in a composite form with naturally occurring sources. All mining related sources are provided WLAs unless the allocation is for a mine-related source where it is known 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. LAs are also applied to upstream segments where TMDLs have already been developed, or for tributary watersheds.

In addition to metals WLAs and LAs, 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 Jefferson River TMDL Project Area are provided for the following source categories:

- WWTP permitted discharges (WLA_{WWTP})
- MPDES suction dredge permits (WLA_{SD})
- MPDES stormwater permit (WLA_{SW})
- Composite of human caused sources and natural background sources (WLA_{HS+NB})
- Upstream river segments and or tributaries ($LA_{\text{Upstream segment or}}$ $LA_{\text{Tributary}}$)

Metals WLAs categories may be combined into composite WLAs in situations where discrete contributing sources cannot be determined. Scenarios such as this are described in detail in the following sections.

5.7.1 Types of Allocations

The WLAs and LAs provided in this document fall into several broad categories. These vary according to the source type and are described below.

5.7.1.1 MPDES permitted discharges

Town of Whitehall Wastewater Treatment Plant (WLA_{WWTP})

The town of Whitehall WWTP is a minor publicly owned treatment works with a MPDES permit (Permit # MT0020133). The permitted discharge is for treated domestic wastewater into Big Pipestone Creek immediately prior to the confluence with the Jefferson Slough.

The town of Whitehall WWTP currently land applies 100% of treated effluent and does not actively discharge to Big Pipestone Creek. The town of Whitehall maintains its MPDES permit and the ability to discharge, as such DEQ has developed a WLA for the potential discharge. The existing permit does not contain effluent limits for arsenic. As discussed in **Section 5.6.3.3,** the Whitehall WWTP has the potential to contribute metals loading to Big Pipestone Creek during low flow conditions when arsenic impairment is a concern. For that reason, the WLA is based on achieving the arsenic standard (10 µg/L) in the discharge to Big Pipestone Creek. The WLA of 10 µg/L is intended as a monthly (30-day) average. The

WLA is calculated as the product of the arsenic standard, the facility design flow discharge, and a conversion factor (0.0054). **Section 5.7.2.3** discusses the WLAs for the town of Whitehall WWTP.

The WWTP discharge load is estimated using the HHS of 10.0 µg/L, the design flow of the WWTP (0.251 million gallons a day or 0.388 cfs) and a conversion factor. The HHS was used, as it is a conservatively high estimate, as it is unlikely that the WWTP is concentrating arsenic from the supply wells enough to have a significant impact on water quality. The calculated resulting arsenic load equals approximately 0.021 lbs/day. The flow near the mouth of Big Pipestone Creek when the arsenic standard was exceeded was less than 1 cfs. The TMDL or allowable load at 1 cfs equates to 0.054 lbs/day based on the target concentration of 10.0 µg/L (**Section 5.4.2.1**). Comparing the Whitehall WWTP load of approximately 0.021 lbs/day of arsenic to the river's allowable load (TMDL) of 0.054 lbs/day under very low flow conditions, shows that there is potential (albeit small) for a contribution from the WWTP discharge to Big Pipestone Creek.

Additional effluent quality monitoring will be required of the WWTP to ensure they are meeting the intent of the WLA. Effluent samples shall be analyzed for a full suite (**Section 7.8**) of metals. Monitoring shall take place quarterly for the first permit cycle after permit renewal. If it is determined that the average arsenic concentration (30 day average) is greater than 10 µg/L, a reasonable potential analysis shall be conducted. See **Section 5.7.2.3** for further information on additional WWTP sampling.

Town of Twin Bridges Wastewater Treatment Plant ($WLA_{\text{Twin Bridges WWTP}}$)

The town of Twin Bridges WWTP is a minor publicly owned treatment works with a MPDES permit (permit # MT0028797). The town of Twin Bridges is permitted to discharge treated wastewater into Bayers Ditch, which has the potential to discharge into the upper Jefferson River under high flow conditions. The existing permit does not contain effluent limits for lead or iron. As discussed in **Section 5.6.5.3,** the Twin Bridges WWTP contributes an estimated 0.0016 lbs/day of lead to the upper Jefferson River during high flow conditions when lead impairment is of a concern. This load represents 0.0015% of the total allowable load (TMDL) for the river. The Twin Bridges WWTP is expected to contribute a load of approximately 0.59 lbs/day iron to the upper Jefferson River during high flow conditions when iron impairment is of concern. This load represents 0.004% of the total allowable load (TMDL) for the river (**Section 5.6.5.3**). Because of the extremely small influence on the lead and iron concentrations and subsequent loads in the upper Jefferson River, the Twin Bridges WWTP is considered an insignificant source of lead and iron and will not be required to reduce the lead and iron concentrations in its effluent for this specific TMDL. Additional effluent quality monitoring will be required of the WWTP to ensure they are meeting the intent of the WLA. Effluent samples shall be analyzed for iron and lead if the facility is discharging. **Section 5.7.2.5** discusses the WLAs for the town of Twin Bridges WWTP.

MPDES suction dredge (WLA_{SD})

As of July 2014, there were three active MPDES general permits in the Jefferson River Project Area for suction dredge operations. Permits MTG370303 and MTG370328 on Big Pipestone Creek and permit MTG370316 on the lower Jefferson River. These general permits require the operators to discharge no visible increase in turbidity at the end of the mixing zone. The general permit does not include specific load limits for metals. The suction dredging operations are not expected to contribute additional metals loading to either Big Pipestone Creek or lower Jefferson River based on the type of activity and requirements contained in the permit that limit suspended sediment. This is made evident by streambed sediment samples from the lower Jefferson River meeting PEL targets. No streambed sediment data is available for Big Pipestone Creek. Therefore, all WLA_{SD} will be set to zero in allocations present below. **Sections 5.7.2.3** and **5.7.2.6** discuss the development of these LAs for Big Pipestone Creek and the lower Jefferson River, respectively.

MPDES stormwater (WLA_{SW})
As of July 2014, there was one active MPDES general stormwater permit (MPDES permit MTR300199) in the Jefferson River Project Area for a stormwater industrial discharge issued to the active GSM. The stormwater general permit requires the operators to minimize harm caused by runoff. This entails the development and maintenance of an approved stormwater pollution prevention plan (SWPPP). The SWPPP sets forth the procedures, methods, and equipment used to prevent pollution from stormwater discharges. In addition, the SWPPP describes general practices used to reduce pollutants in stormwater discharges.

Appendix G contains the discharge monitoring report (DMR) data from GSM and highlights the values used to calculate the metals lode from stormwater runoff. Loads for stormwater contributions were calculated using the maximum reported metal concentration times the maximum flow, times a conversion factor of 0.0054. The high and low flow WLA_{SW} will be set to 0.099 lbs/day (arsenic), 0.007lbs/day (cadmium), 0.552lbs/day (copper), and 0.605 lbs/day (zinc), although implementation of each WLAsw will be based on stormwater permit compliance. **Section 5.7.2.4** provides further discussion regarding the development of this WLA for the Jefferson Slough.

5.7.1.2 Composite wasteload allocation for natural background and humans sources (WLA_{HS+NB})

Within the Jefferson River TMDL Project Area, the major metals sources are related to abandoned and inactive mining. However, there are other human caused sources of metals in the Jefferson River TMDL Project Area. This includes any activity by humans that may cause or contribute metals loading such as the sediment sources (WLA_{HS}) discussed throughout **Section 5.6**. While prominent active and abandoned/inactive mines have been investigated in each of the watersheds (**Section 5.6**), data describing individual loading contributions from historical mining are 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.

Natural background is also a significant source of metals loading in the project area. Natural background loading (WLA_{NB}) is assumed to be a result of local geology, with minimal influence from human-caused sources. The naturally occurring background water quality could not be accurately determined in the Jefferson Slough, Little Whitetail, Whitetail Deer, and Big Pipestone creeks (**Section 5.6.7**). As a result, composite WLAs were developed in these watersheds. These composite WLAs include loads from natural background, mining sources and any other non-MPDES permitted human caused metals loading portions of the TMDL (WLA_{HS+NB}). **Section 5.7.2** describes how the loads are allocated for Little Whitetail, Whitetail Deer Creek, Big Pipestone Creek, and the Jefferson Slough.

The upper Jefferson River segment did have data that could be used to estimate natural background conditions (**Section 5.6.7**), although under all flow conditions in the tributary rivers there is the potential for some human-influence metals loading. The lower Jefferson River segment background conditions would likely be similar to those of the upper segment, although flow inputs from the Jefferson Slough complicate any natural background estimate. For these reasons, and for consistent TMDL presentation within this document, the same composite allocation approach described above for natural background and human sources is applied to the upper and lower Jefferson River segments within **Sections 5.7.2.5** and **5.7.2.6**.

5.7.1.3 Upstream segments or tributary load allocation ($LA_{Upstream\ segment\ or}$ $LA_{Tributary}$)

The LAs to upstream sources ($LA_{Upstream\ segment\ or}$ $LA_{Tributary}$) are to those waterbodies that are considered to be major contributing sources. The major contributing sources are those waterbodies that contribute either a large flow volume, or high concentration, that yields a significant load. In those instances where there are a number of contributing rivers that are major sources, a composite $LA_{Tributary}$ is developed. These allocations may be based on existing TMDLs where developed.

5.7.1.4 Margin of Safety (MOS)

Under most circumstances, DEQ provides an implicit MOS by using assumptions known to be conservative, discussed further in **Section 5.8.** Where an implicit MOS is applied, the MOS in the above TMDL equation is equal to zero and not necessarily included in the equations provided below. In other circumstances, an MOS is explicitly defined where additional loading is available based on tributary watershed allocation approaches.

5.7.2 Allocations by Waterbody Segment

In the sections that follow, LAs and WLAs are provided for each pollutant-waterbody combination for which a TMDL is prepared (**Table 5-21**). Because the TMDL is a function of flow, most allocations are also a function of flow and are defined by one or more equations that allow determination of the TMDL and associated allocations under a particular flow condition.

To provide clarification, example TMDLs and allocations are presented for each stream and each metal pollutant parameter. The TMDL and allocation tables give examples for high-flow or low-flow conditions for each stream segment. In those cases where only high flow examples are provided, metal concentrations and corresponding target exceedances took place only during high flows. In those cases where only low flow examples are provided, metal concentrations and corresponding target exceedances took place only during low flows (Big Pipestone Creek). The TMDLs are calculated according to the TMDL formula provided in **Section 5.7.**

The examples provided for TMDLs, LAs, and WLAs are based upon some of the following conditions:

1. The hardness values used for determining hardness-based example TMDLs, LAs, and WLAs tend to be values consistent with the corresponding flow regime.
2. TMDL and allocation examples generally use existing streamflows provided within **Appendix B.**
3. The TMDL and allocation examples provided in the following sections tend to focus on the most contaminated location that was sampled for each metal.

5.7.2.1 Little Whitetail Creek MT41G002_140 Allocations

The aluminum, copper, and lead allocations for Little Whitetail Creek are expressed by the following formula:

$$TMDL_{Little\ Whitetail\ Creek} = WLA_{HS+NB}$$

As there are no MPDES permitted point sources identified in Little Whitetail Creek, no individual WLAs to point sources are provided. Due to the uncertainty of natural background water quality and resulting background load contributions, uncertainty in contributions from a variety of human sources and their unknown distribution throughout the watershed, a natural background load cannot accurately be established. Therefore, the natural background load and the load contributed by human sources are combined in a composite WLA (WLA_{HS+NB}). This composite WLA is equal to the TMDL. Human sources include all the potential contributors of metals pollution caused by human activity. This includes activities such as active and historical mining and any other human caused activities that increase erosion and have the ability to contribute sediment and subsequent metal pollution to receiving waters. The TMDL components summarized in **Table 5-33** show example TMDLs and allocations for measured high flow conditions in the Little Whitetail Creek watershed. The TMDL is defined for high flow conditions by the equation presented within **Section 5.5.1**. The MOS is implicit for Little Whitetail Creek and therefor equals zero. This allocation scheme assumes that natural loading rates do not cause water quality standards to be exceeded.

Table 5-33. Little Whitetail Creek: Example Metals TMDLs and Allocations

Metal	Flow	TMDL (lbs/day)	WLA_{HS+NB} (lbs/day)
Aluminum	High flow	234.90	234.90
Copper	High flow	8.49	8.49
Lead	High flow	1.69	1.69

High Flow = 500 cfs @ hardness = 28 mg/L

Reductions to metals loading are necessary to achieve the targets and thus the TMDLs for Little Whitetail Creek. **Table 5-22** shows the percent reductions needed for Little Whitetail Creek to meet the TMDLs based on the highest measured concentration. At high flows, these reductions are 62.2% of aluminum, 65.1%for copper and 83.9% for lead. No reductions are necessary at low flows. The source assessment for the Little Whitetail Creek watershed indicates that human sources in the upper and middle area of the watershed (where several abandoned mines exist) contribute the most metals loading; load reductions should focus on limiting and controlling metals loading from these sources. Further source assessment and meeting LAs for Little Whitetail Creek may be achieved through a variety of water quality planning and implementation actions, which are addressed in **Section 7.0**.

5.7.2.2 Whitetail Deer Creek MT41G002_141 Allocations

The aluminum and lead allocations for Whitetail Deer Creek are expressed by the following formula:

$$TMDL_{Whitetail\ Deer\ Creek} = WLA_{HS+NB}$$

As there are no MPDES permitted point sources identified in Whitetail Deer Creek, no individual WLAs to point sources are provided. Due to the uncertainty of natural background water quality and resulting background load contributions, uncertainty in contributions from a variety of human sources and their unknown distribution throughout the watershed, a natural background load cannot accurately be established. Therefore, the natural background load and the load contributed by human sources are combined in a composite WLA (WLA_{NB+HS}). This composite WLA is equal to the TMDL. Human sources include all the potential contributors of metals pollution caused by human activity. This includes activities such as active and historical mining and any other human caused activities that increase erosion and have the ability to contribute sediment and subsequent metal pollution to receiving waters. The TMDL components summarized in **Table 5-34** show example TMDLs and allocations for measured high flow conditions in the Whitetail Deer Creek watershed. The TMDL is defined for high flow conditions by the equation presented in **Section 5.5.1**. The MOS is implicit for Whitetail Deer Creek and therefore equals zero. This allocation scheme assumes that natural loading rates do not cause water quality standards to be exceeded.

Table 5-34. Whitetail Deer Creek: Example Metals TMDLs and Allocations

Metal	Flow	TMDL (lbs/day)	WLA $_{NB+HS}$ (lbs/Day)
Aluminum	High flow	352.4	352.4
Lead	High flow	8.48	8.48

High Flow = 750 cfs @ hardness = 72 mg/L

Reductions to metals loading are necessary to achieve the targets and thus the TMDLs for Whitetail Deer Creek. **Table 5-22** shows the percent reductions needed for Whitetail Deer Creek to meet the TMDLs based on the highest measured concentrations. At high flows, these reductions are 42.0% for aluminum and 49.3% for lead. No reductions are necessary at low flows. The source assessment for the Whitetail Deer Creek watershed indicates that human sources contribute metals loading throughout the watershed including contributions from Little Whitetail Creek; load reductions should focus on limiting and controlling metals loading from these sources. Additional source assessment work and meeting LAs for Whitetail Deer Creek may be achieved through a variety of water quality planning and implementation actions which are addressed in **Section 7.0**.

5.7.2.3 Big Pipestone Creek MT41G002_010 Allocations

The arsenic allocations for Big Pipestone Creek are expressed by the following formula:

$$TMDL_{\text{Big Pipestone}} = WLA_{HS+NB} + WLA_{WWTP} + WLA_{SD}$$

There are several MPDES permitted point sources identified in Big Pipestone Creek. The TMDL for arsenic was allocated to the composite wasteload from human caused sources and natural background (WLA_{HS+NA}), the Whitehall WWTP (WLA_{WWTP}) and two suction dredge operations (WLA_{SD}).

The TMDL components are summarized in **Table 5-35** which show the example TMDLs and allocations for measured low flow conditions in the Big Pipestone Creek watershed. The TMDL is defined for low flow conditions by the equation presented within **Section 5.5.1**. The MOS is implicit for Big Pipestone Creek and therefore equals zero. This allocation scheme assumes that natural loading rates do not cause water quality standards to be exceeded and applying BMPs to the human-caused metals sources will result in the loading reductions necessary to meet the TMDLs and water quality standards.

Table 5-35. Big Pipestone Creek Example Metals TMDLs and Allocations

Metal	Flow Condition	TMDL (lbs/day)	WLA_{HS+NB} (lbs/day)	WLA_{WWTP} (lbs/day)	WLA_{SD} (lbs/day)
Arsenic	Low flow	0.043*	0.022	0.021	0.0

* Based on low flow value of 0.41 cfs in Big pipestone Creek (from **Table 5-21**) with WWTP design flow (0.388 cfs) added to account for the fact that there was no WWTP discharge when the 0.41 cfs flow was measured.

Each of the allocations identified in **Table 5-35** were calculated with the same basic load equation of flow times concentration times a conversion factor (0.0054). Each of the individual allocations is described in detail below, which not only describes the approach used for the specific example allocations within **Table 5-35**, but also defines how all allocations can be computed for the given flow condition.

The WLA_{WWTP} will be 0.021lbs/day, based the target value of 10µg/L and the design flow of the WWTP, as discussed in **Section 5.6.3.3**. Therefore, the arsenic WLA for Whitehall WWTP under low flow conditions can be calculated using the following equation:

WLA_{WWTP} = WWTP design flow (cfs) x target concentration (µg/L) x conversion factor

- WWTP design flow = 0.388 cfs
- Target concentration = 10.0 µg/L
- conversion factor = 0.0054

$$WLA_{WWTP} = 0.388 \text{ cfs} \times 10.0\ \mu g/L \times 0.0054 = 0.021 \text{ lbs/day}$$

The intent of this WLA_{WWTP} will be met by following all permit requirements, including a full suite of metals monitoring. The full metals suite of metals is identified in **Section 7.8**. Quarterly monitoring is required for the first permit cycle; if the monthly average (30-day average) concentration is less than or equal to 10.0 µg/L (the target concentration but still not measurably increasing the concentration in the river), loading from the Whitehall WWTP meets the assumptions of the WLA_{WWTP}, and subsequent monitoring for compliance with the intent of this WLA_{WWTP} may be conducted once per permit cycle.

If the 30-day average effluent concentration exceeds 10.0 µg/L, a reasonable potential analysis should be conducted to determine if a permit limit is needed in the future. However, additional data from Big Pipestone Creek, especially directly upstream of the WWTP outfall, should be collected prior to performing a reasonable potential analysis.

As discussed in **Section 5.6.3.3**, the WLA to the suction dredge operations (WLA_{SD}) is zero. The WLA_{HS+NB} is then calculated by subtracting the sum of the WLA_{SD} and the WLA_{WWTP} from the TMDL as follows:

$$WLA_{HS+NB} = TMDL_{\text{Big Pipestone}} – (WLA_{WWTP} + WLA_{SD}) = TMDL_{\text{Big Pipestone}} – 0.021$$

Reductions to arsenic loading will be necessary to achieve the target and thus the TMDL for Big Pipestone Creek. **Table 5-22** shows the percent reduction needed for Big Pipestone Creek to meet the TMDL, based on the highest measured concentrations. Only a 9.1% reduction at low flow conditions is identified. The source assessment for the Big Pipestone Creek watershed indicates a potential low flow source possibly linked to arsenic loading from groundwater to the lower reaches of Big Pipestone Creek. Additional sources assessment work and meeting LAs for Big Pipestone Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 7.0**.

5.7.2.4 Jefferson Slough MT41G002_170 Allocations

All allocations for Jefferson Slough are expressed by the following formula:

$$TMDL_{\text{Jefferson Slough}} = WLA_{HS+NB} + WLA_{SW} + LA_{\text{Big Pipestone \& Whitetail Deer creeks}} + LA_{\text{Boulder River}} + MOS$$

There is one MPDES permitted point sources identified in the Jefferson Slough. As such, it is given its own WLA, and the remaining allocations are based on the nature of the loading source. The TMDLs for arsenic, cadmium, copper and zinc are allocated to the composite wasteload from human caused sources and natural background loading not addressed via stormwater or tributary allocations (WLA_{HS+NB}), the GSM stormwater discharge (WLA_{SW}), the LA to the major tributaries of Big Pipestone Creek and Whitetail Deer Creek (LA $_{\text{Big Pipestone \& Whitetail Deer creeks}}$), the LA to the Boulder River (LA $_{\text{Boulder River}}$) and an MOS.

The TMDL is defined for high flow conditions by the equation presented within **Section 5.5.1.** The highest metals concentrations and corresponding target exceedances typically take place during high flow, as such only high flow example TMDLs are provided. The TMDL components summarized in **Table 5-36** show the example TMDLs and allocations for a measured high flow condition in the Jefferson Slough (below the Boulder River). This allocation scheme assumes that natural loading rates do not cause water quality standards to be exceeded and applying BMPs to the human-caused metals sources will result in the loading reductions necessary to meet the TMDLs and water quality standards.

Table 5-36. Jefferson Slough Example Metals TMDLs and Allocations

Metal	Flow	TMDL (lbs/day)	WLA_{HS+NB} (lbs/day)	WLA_{SW} (lbs/day)	LA $_{\text{Big Pipestone \& Whitetail Deer creeks}}$ (lbs/day)	LA $_{\text{Boulder River}}$ (lbs/day)	MOS
Arsenic	High flow	199.8	2.7	0.2156	36.72	145.8	14.37
Cadmium	High flow	4.196	0.058	0.0101	0.256	2.77	1.102
Copper	High flow	142.457	3.932	0.552	22.059	89.084	26.83
Zinc	High flow	1,833.56	24.782	0.606	25.650	1,149.196	633.335

Each of the allocations identified in **Table 5-36** were calculated with the same basic load equation of flow times concentration, times a conversion factor (0.0054). Each of the individual allocations are described in detail below, which not only describes the approach used for the specific example allocations within **Table 5-36**, but also defines how all allocations can be computed for all flow conditions. **Appendix F** outlines each of the example TMDL allocation calculations described below.

Jefferson Slough TMDL (TMDL $_{\text{Jefferson Slough}}$)

Each metals TMDL near the mouth or for any location within the Jefferson Slough equates to the measured flow times the specific metals target (**Table 5-21**), times a conversion factor (0.0054). Target concentrations for each metal are hardness dependent with the exception of arsenic. For the example TMDL the combined flows of the Boulder River and the Jefferson Slough measured above the Boulder River were used to represent flow near the mouth of the slough since there was limited high flow data for the mouth of the slough. The combined flows were measured on 6/9/2011 and 6/10/2011 for both the Boulder River and the Slough above the Boulder River, and were reported as 2,700 and 1,000 cfs, respectively. This provides a combined total flow of 3,700 cfs to calculate the example TMDLs provided in **Table 5-36**.

Big Pipestone and Whitetail Deer Creeks Composite Allocation (LA $_{\text{Big Pipestone \& Whitetail Deer creeks}}$)

The **LA** $_{\text{Big Pipestone \& Whitetail Deer creeks}}$ for cadmium, copper and zinc is calculated as the combined flows of both tributaries times the existing water quality concentration within each stream times the conversion factor. As a conservative approach, existing water quality is represented by the 90th percentile of the combined existing data for both streams (**Appendix B**). These 90th percentile values are 0.05 µg/L for cadmium, 4.3 µg/L for copper, and 5.0 µg/L for zinc. For each metal, this value is significantly less than the Jefferson Slough high and low flow target concentrations and therefore results in allocations that provide assimilative or dilution capacity to the Jefferson Slough.

The example **LA** $_{\text{Big Pipestone \& Whitetail Deer creeks}}$ allocations are developed for the 6/1/2010 flow event where Whitetail Deer Creek reported a high flow of 750 cfs. Since there was no high flow data for Big Pipestone

Creek on this date, high flow was estimated to be approximately 200 cfs based on comparative flows in both streams during similar high flow conditions. The combined flow of 950 cfs was used in conjunction with the 90th percentile water quality concentrations to provide the example LAs for **Table 5-36**. Note that this approach does not modify the copper allocations developed for Little Whitetail Deer Creek as defined above in **Section 5.7.2.1**. Achievement of the copper allocations will reduce copper loading to the lower reaches of Whitetail Deer Creek and further ensure that copper concentrations within Whitetail Deer Creek are consistent with the LA and also remain below the target levels of the Jefferson Slough.

For arsenic, the 90th percentile of Whitetail Deer Creek data equates to 6.4 µg/L and is used to calculate the Whitetail Deer Creek portion for the arsenic $\mathbf{LA}_{\text{Big Pipestone \& Whitetail Deer creeks}}$, whereas the Big Pipestone arsenic target of 10 µg/L is used to calculate the Big Pipestone Creek portion of the arsenic $\mathbf{LA}_{\text{Big Pipestone \& Whitetail Deer creeks}}$ to be consistent with the arsenic TMDL developed above (**Section 5.7.2.3**). The combined arsenic loads for Whitetail Deer Creek and Big Pipestone Creek are used in the example TMDL calculations in **Table 5-36.** This approach results in dilution capacity to the Jefferson Slough due to the below target concentration used for developing the Whitetail Deer Creek portion of the allocation.

Boulder River Allocation ($\mathbf{LA}_{\text{Boulder River}}$)

Under all conditions, the $\mathbf{LA}_{\text{Boulder River}}$ is based on the Boulder River flow near the mouth times the target within the Boulder River times the conversion factor. The Boulder River metals targets were chosen to be consistent with the existing Boulder Elkhorn metals TMDL document (Montana Department of Environmental Quality, 2012b). These Boulder River targets represent a more protective approach for all hardness dependent metals since the Boulder River has consistently lower hardness than the Jefferson Slough. The flow value used to calculate the example $\mathbf{LA}_{\text{Boulder River}}$ for the Boulder River was measured on 6/9/2011 (2,700 cfs). The target concentrations for each specific metal are based on the example TMDL values provided within **Table 5-24** of in the Boulder Elkhorn metals TMDL document (Montana Department of Environmental Quality, 2012b).

Golden Sunlight Stormwater Allocation ($\mathbf{WLA}_{SW}$)

The loading associated with $\mathbf{WLA}_{SW}$ was calculated for each impaired metal as well. Development of loading values for each specific metal are discussed in **Section 5.7.1.1.** The data selected to calculate load estimates is outlined in **Appendix G.** These loading values are applied as the $\mathbf{WLA}_{SW}$ for each metal. It is important to note that loads associated with stormwater runoff are periodic. DEQ has chosen a conservative approach in estimating these loads and presenting them as daily loads to the Jefferson Slough by assuming the load is continuous and that the entire load reaches the slough. In reality, the loading from this source equals zero most days of the year based on storm and runoff frequency.

The $\mathbf{WLA}_{SW}$ is not intended to add concentration or load limits to the permit. Consistent with U.S. Environmental Protection Agency (EPA) guidance and the CWA (U.S. Environmental Protection Agency, 2002), DEQ assumes that the $\mathbf{WLA}_{SW}$ will be met by adhering to the permit requirements and reducing either the metals concentrations or the discharge volumes, or both. As identified in the permit, monitoring data should continue to be collected and evaluated along with periodic compliance inspections to assess BMP performance and help identify whether and where additional BMP implementation may be necessary. Arsenic, cadmium, copper and zinc should remain on the list of sample analytes in order to understand loads in stormwater and to quantify the WLAs.

As iterated earlier, under the stipulations of the current stormwater permit, GSM is required to maintain an approved stormwater pollution prevention plan (SWPPP). The SWPPP sets forth the procedures, methods, and equipment used to prevent the pollution of stormwater discharges. In addition, the SWPPP describes general practices used to reduce pollutants in stormwater discharges. It is important to note that DEQ staff conducted a compliance inspection on August 4, 2010. Findings of the site inspection indicated that based on the information and site conditions observed during the inspection, no items of noncompliance permit requirements were observed.

Composite Allocation to Human Sources and Natural Background (WLA_{HS+NB})

The **WLA_{HS+NB}** is a composite allocation to that portion of the human and natural background loading to the Jefferson Slough that is not from Golden Sunlight stormwater runoff, Big Pipestone Creek, Whitetail Deer Creek or the Boulder River. Therefore, **WLA_{HS+NB}** includes any metals load from minor tributaries and other diffuse sources. The WLA_{HS+NB} is calculated as the difference between the TMDL, the MOS, and the sum of all other allocations (WLA_{WWTP}, $LA_{\text{Big Pipestone \& Whitetail Deer creeks}}$ and $LA_{\text{Boulder River}}$).

The extent of the connectivity between the upper Jefferson River and the Jefferson Slough is not well defined. During high flow the upper Jefferson River floodplain may very well intersect with the mouth of the Jefferson Slough and contribute to it an undetermined volume of flow. At low flows it is not clear if flow from the upper Jefferson River, contributions from groundwater or both are adding flow to the Jefferson Slough. For this reason, the **WLA_{HS+NB}** includes any flow and associated metals loading that reaches the Jefferson Slough. If the upper Jefferson River was a significant source of metals pollution, data should indicate a presence of metals from the upper Jefferson River in the Jefferson Slough. **Appendix B** data for the Jefferson River do not show any exceedances of the water quality targets for any of the metals impairment causes (arsenic, cadmium, copper and zinc) within the Jefferson Slough. During high flows, iron and lead have concentrations above target levels within the upper Jefferson River, however neither appears to be a cause of impairment in the Jefferson Slough.

Margin of Safety (MOS)

The MOS for the Jefferson Slough is explicit and originates from two different areas of the watershed (upstream tributaries and the Boulder River). The first is created by the fact that allocations to Whitetail Deer and Big Pipestone Creek watersheds (**$LA_{\text{Big Pipestone \& Whitetail Deer creeks}}$**) are mostly based on existing (90th percentile) concentrations that are below target concentrations for the Jefferson Slough. During infrequent storm events this MOS could be reduced due to loading from Golden Sunlight stormwater flows (WLA_{SW}) if they reach the Jefferson Slough. Near the mouth of the slough, the MOS increases because the Boulder River allocation ($LA_{\text{Boulder River}}$) is based on the existing TMDLs developed within the Boulder Elkhorn TMDL document. Because of lower hardness within the Boulder River, the metals targets within the Boulder River are significantly lower than those for the Jefferson River. The exception is arsenic, where there is no arsenic MOS linked to the Boulder River since the target is not dependent on hardness and set equal to 10 µg/L.

The MOS from the upper tributaries for cadmium, copper, and zinc can all be calculated by the same means using the following equation:

(Big Pipestone flow + Whitetail Deer flow)(Jefferson Slough target concentration – 90th percentile concentration of Big Pipestone and Whitetail Deer data)(0.0054) - (WLA_{SW}).

The high flow example used throughout this section equates to the following upstream copper MOS:

$$(750 + 200)(7.13 - 4.8)(0.0054) – (0.552) = 11.95 \text{ lbs/day}.$$

For arsenic the upstream MOS only originates from Whitetail Deer Creek since the Big Pipestone Creek portion of the tributary allocation is based on the same 10 µg/L as the Jefferson Slough target. Therefore, the upper tributaries arsenic MOS can be calculated for all flows as follows:

(Whitetail Deer Creek flow)(Jefferson Slough target concentration – 90th percentile concentration of Whitetail Deer data)(0.0054) - (WLA_{SW}).

For the high flow example used above, the arsenic MOS is as follows:

(750)(10 - 6.4)(0.0054) – (0.01) = 14.57 lbs/day.

The downstream portion of the MOS, provided by the lower hardness and lower applicable targets in the Boulder River TMDL compared to the slough, can be calculated as follows:

Boulder River flow x (Jefferson Slough target concentration – Boulder River target concentration)(0.0054)

For the high flow example used throughout this section and applying example TMDL information from **Table 5-24** of the Boulder Elkhorn metals TMDL document, this equates to the following Boulder River copper MOS:

(2,700)(7.13 - 6.11)(0.0054) = 14.87 lbs/day.

At a typical low flow in the Boulder River, this equates to a copper MOS of:

(78)(20.97 – 12.13)(0.0054) = 3.7 lbs/day.

The total MOS, if computed at the mouth of the Jefferson Slough, would equate to the sum of the upstream MOS and the downstream (Boulder River) MOS for each specific metal, although for arsenic this defaults to only the MOS created by Whitetail Deer Creek.

Summary

Reductions to metals loading will be necessary to achieve the targets and thus the TMDLs for the Jefferson Slough. **Table 5-22** shows the percent reductions needed for the Jefferson Slough to meet the TMDLs based on the highest measured concentrations. At high flows, these reductions are 23.1% for arsenic, 55.4% for cadmium, 77.0% for copper, and 8.2% for zinc. The source assessment for the Jefferson Slough watershed indicates that the Boulder River is the source of metals impairment. Therefore, load reductions should focus on limiting and controlling metals loading from sources within the Boulder River watershed as described within the Boulder-Elkhorn TMDL document (Montana Department of Environmental Quality, 2012b). Efforts to meet metals TMDLs in Little Whitetail, Whitetail Deer Creek and Big Pipestone Creek will probably also benefit water quality in the Slough. Since the sources are the same for all the metals (generally human caused), any steps to improve metals loading will probably be seen across the entire metals suite, even if a tributary does not share specific metals impairment. A variety of water quality planning and implementation actions particular to metals impairment are addressed in **Section 7.0**.

5.7.2.5 Upper Jefferson River MT41G001_011 Allocations

The allocations for the Upper Jefferson River are expressed by the following formula:

$$TMDL_{\text{Upper Jefferson River}} = WLA_{HS+NB} + WLA_{\text{Twin Bridges WWTP}} + LA_{\text{Beaverhead, Big Hole and Ruby Rivers}}$$

Each permitted point source or major source area is given its own WLA or LA depending on the nature of the loading source. There is one MPDES permitted point source identified in the upper Jefferson River which will receive a WLA. This is the town of Twin Bridges WWTP. The TMDLs for iron and lead were allocated to the load from human caused sources and natural background not addressed via tributary point source allocations (WLA_{HS+NB}), the wasteload allocated to the town of Twin Bridges WWTP (WLA_{WWTP}) and the LA to the major tributaries: the Beaverhead River, the Big Hole River and the Ruby River ($LA_{\text{Beaverhead, Big Hole and Ruby Rivers}}$). The TMDL is defined for all flow conditions by the equation presented within **Section 5.5.1**. The MOS is implicit for the upper Jefferson River segment, and therefore equals zero.

The highest metals concentrations and corresponding target exceedances on the upper Jefferson River typically take place during high flow, as such only high flow example TMDLs are provided. The TMDL components summarized in **Table 5-37** show the example TMDLs and allocations for a measured high flow (11,400) in the upper Jefferson River. This allocation scheme assumes that natural loading rates do not cause water quality standards to be exceeded and applying BMPs to the human-caused metals sources will result in the loading reductions necessary to meet the TMDLs and water quality standards.

Table 5-37. Upper Jefferson River Example Metals TMDLs and Allocations

Metal	Flow	TMDL	WLA_{HS+NB}	$WLA_{\text{Twin Bridges WWTP}}$	$LA_{\text{Beaverhead, Big Hole and Ruby Rivers}}$
Iron	High flow	61,559.881	22,734.000	0.594	38,825.287
Lead	High flow	168.86	62.48	0.0016	106.381

Each of the allocations identified in **Table 5-37** were calculated with the same basic load equation of flow times concentration times a conversion factor (0.0054). Each of the individual allocations is described in detail below, which not only describes the approach used for the specific example allocations within **Table 5-37**, but also defines how all allocations can be computed for all flow conditions.

Twin Bridges WWTP Wasteload Allocation ($WLA_{\text{Twin Bridges WWTP}}$)

Given the uncertainty of the effluent from the town of Twin Bridges WWTP reaching the upper Jefferson River (**Section 5.6.5.3**) and the probability that the WWTP will discharge at or below target concentrations (1,000 µg/L for iron and 2.74 µg/L for lead), DEQ has determined that the discharge will likely have an insignificant impact on water quality. Loads from this WWTP based on these example concentrations and maximum flow volume of the WWTP are negligible when mixed with the flow from upper Jefferson River (**Section 5.6.5.3**), equating to 0.0015% for lead and 0.004% for iron during high flow impairment conditions. It is likely that the existing iron and lead concentrations from the Twin Bridges WWTP are either less than or comparable to the Jefferson River target concentrations based on sampling of similar facilities and discussed further in **Section 5.6.5.3**. Even if discharge concentrations were double or triple that of the Jefferson River targets, the loading contribution from the Twin Bridges WWTP would still represent an insignificant load that would result in unmeasurable affects to water quality in the Jefferson River provided the discharge even made it to the upper Jefferson River.

The WWTP is considered an insignificant source even if its average effluent concentration is up to three times greater than 1,000 µg/L for iron and 2.74 µg/L for lead. Because of the negligible and unmeasurable potential affects to the Jefferson River, the $WLA_{\text{Twin Bridges}}$ for both iron and lead is set based on current performance for each metal and no reductions are necessary as long as current performance (as 30-day average) is within three times the above referenced target values (1,000 µg/L for iron and 2.74 µg/L for lead). The iron and lead $WLA_{Twin\ Bridges}$ should not be incorporated as permit compliance limits, but instead be used to justify collection of metals data to confirm the negligible potential water quality impacts from the discharge.

The WLA_{WWTP} for both iron and lead is based on the following equation.

$$WLA_{WWTP} = \text{WWTP design flow (cfs)} \times \text{target concentration (µg/L)} \times \text{conversion factor}$$

An example iron WLA is provided below using the Jefferson River target concentration (1,000 µg/L) and WWTP design flow to show how the load from the WWTP fits into the TMDL under this existing concentration assumption and the high flow impairment condition example (**Table 5-37**).

$$WLA_{Twin\ Bridges\ WWTP} = 0.11 \text{ cfs} \times 1{,}000 \text{ µg/L} \times 0.0054 = 0.594 \text{ lbs/day}$$

An example lead WLA is provided below using the Jefferson River target concentration (2.74 µg/L) and WWTP design flow to show how the load from the WWTP fits into the TMDL under this existing concentration assumption and the high flow impairment condition example (**Table 5-37**).

$$WLA_{Twin\ Bridges\ WWTP} = 0.11 \text{ cfs} \times 2.74 \text{µg/L} \times 0.0054 = 0.0016 \text{ lbs/day}$$

The intent of the WLA_{WWTP} will be met by following all existing permit requirements, including additional monitoring for iron and lead. Quarterly monitoring is required for the first permit cycle; if the annual average lead concentration is less than 2.74 µg/L and iron concentration is less than 1,000 µg/L (the target concentration but still not measurably increasing the concentration in the river), loading from the Twin Bridges WLA_{WWTP} meets the assumptions of the WLA, and subsequent monitoring for compliance with the intent of this WLA may be conducted once per permit cycle.

If the average effluent concentration exceeds 2.74 µg/L for lead or 1,000, µg/L iron a reasonable potential analysis should be conducted to determine if a permit limit is needed in the future. As long as the WWTP discharge remains at less than three times the Jefferson River target concentration for either iron or lead, the associated iron or lead load will have negligible and unmeasurable impacts to the Jefferson River even at lower flow conditions and no reductions or modifications are necessary for the $WLA_{Twin\ Bridges\ WWTP}$. Additional data from the Jefferson River could also be collected prior to performing a reasonable potential analysis.

Load Allocation to the Beaverhead, Big Hole and Ruby Rivers $LA_{Beaverhead,\ Big\ Hole\ and\ Ruby\ Rivers}$

$LA_{Beaverhead,\ Big\ Hole\ and\ Ruby\ Rivers}$ is calculated by multiplying the target concentration from the upper Jefferson River segment by the combined flows of the Beaverhead, Big Hole and Ruby rivers and a conversion factor. In the TMDL equation, the iron and lead $WLA_{Twin\ Bridges\ WWTP}$ is subtracted from the iron and lead $LA_{Beaverhead,\ Big\ Hole\ and\ Ruby\ Rivers}$ allocations, or the purpose of providing assimilative capacity at the head of the segment for the WWTP.

For the example high flow allocation, the flow from monitoring site JEFF-08 on the upper Jefferson River was used to represent the combined flows. JEFF-08 is considered representative of the combined flows as it is the first monitoring site on the upper Jefferson River segment. JEFF-08 is also a USGS maintained gaging station. The flow measured at JEFF-08 on 6/9/2011 was reported as 7,190 cfs. This flow was multiplied by the high flow iron and lead target concentrations of 1,000 µg/L and 2.74 µg/L, respectively, and a conversion factor of 0.0054. The WLA Twin Bridges was subtracted out to yield iron and lead loads of 38,825.287 and 106.381 lbs/day, respectively.

Human Caused Sources and Natural Background Composite Wasteload Allocation WLA_{HS+NB}
The WLA_{HS+NB} includes an allocation to any metals loading from minor tributaries and sources not identified in the above TMDL equation. The WLA_{HS+NB} is calculated as the difference between the TMDL and the sum of all other allocations (WLA_{WWTP} and $LA_{Beaverhead, Big Hole and Ruby Rivers}$). The **Table 5-37** example WLA_{HS+NB} is also significantly high when compared to the TMDL. This is a result of the flow data that was used to calculate the TMDL value. Flows on 6/9/2011 at the lowest monitoring station were reported as 11,400 cfs. This is a difference in flow from the uppermost monitoring location to the lowest of 4,210 cfs. The WLA_{HS+NB} can alternatively be calculated as the difference between upstream and downstream flows in the upper Jefferson River segment multiplied by the Jefferson River target concentration and the 0.0054 conversion factor

Summary
Reductions to metals loading will be necessary to achieve the targets and thus the TMDLs for Upper Jefferson River. **Table 5-22** shows the percent reductions needed for the upper Jefferson River to meet the TMDLs based on the highest measured concentrations. At high flows, these reductions are 4.8% for iron and 11.5% for lead. No reductions are necessary at low flows. The source assessment discussion and data show that the best way to meet the Jefferson River TMDL for iron is to reduce high flow loading from the Ruby River. Based on this discussion and **Tables 5-27** and **5-28**, meeting the iron target concentration in the Ruby River could result in the creation of more than 4,000 lbs/day of assimilative or dilution capacity for iron in the upper Jefferson River. For lead, the best way to meet the Jefferson River TMDL is to reduce high flow lead loading from the Big Hole River. Based on this discussion and **Tables 5-27** and **5-28**, meeting the lead target concentration in the Big Hole River could result in the creation of close to 100 lbs/day of assimilative or dilution capacity for lead in the upper Jefferson River. Additional work is needed in the Beaverhead and Ruby rivers to update metals assessments. In the case of the Big Hole River, further evaluation is needed on the effectiveness of current TMDL implementation efforts. A variety of water quality planning and implementation actions are addressed in **Section 7.0**.

5.7.2.6 Lower Jefferson River MT41G001_012 Allocations

The allocations for the Lower Jefferson River are expressed by the following formula:

$$TMDL_{Lower\ Jefferson\ River} = WLA_{HS+NB} + WLA_{SD} + LA_{upper\ Jefferson\ River} + LA_{Jefferson\ Slough.}$$

Each permitted point source or major source area is given its own WLA or LA depending on the nature of the loading source. There is one MPDES permitted point source identified in the lower Jefferson River. The TMDLs for copper and lead are allocated to the load from human caused sources and natural background (WLA_{HS+NB}), the wasteload allocated to the suction dredge operation (WLA_{SD}), the LA to the upper Jefferson River segment ($LA_{upper\ Jefferson\ River}$) and the LA to the Jefferson Slough ($LA_{Jefferson\ Slough}$). The TMDL is defined for all flow conditions by the equation presented within **Section 5.5.1**. The MOS is implicit for the lower Jefferson River segment, and therefore equals zero.

The highest metals concentrations and corresponding target exceedances on the lower Jefferson River typically take place during high flow, as such only high flow example TMDLs are provided. The TMDL components summarized in **Table 5-38** show the example TMDLs and allocations for measured high flow conditions in the lower Jefferson River, using a flow of 14,000 cfs measured on 6/9/2011 at a site on the lower reach of the Jefferson River. This allocation scheme assumes that natural loading rates do not cause water quality standards to be exceeded and applying BMPs to the human-caused metals sources will result in the loading reductions necessary to meet the TMDLs and water quality standards.

Table 5-38. Lower Jefferson River Example Metals TMDLs and Allocations

Metal	Flow	TMDL	WLA_{HS+NB}	WLA_{SD}	$LA_{upper\ Jefferson\ River}$	$LA_{Jefferson\ Slough}$
Copper	High flow	601.5	56.65	0.0	490.01	54.84
Lead	High flow	189.7	17.89	0.0	154.52	17.29

Each of the allocations identified in **Table 5-38** were calculated with the same basic load equation of flow times concentration times a conversion factor (0.0054). Each of the individual allocations is described in detail below, which not only describes the approach used for the specific example allocations within **Table 5-38**, but also defines how all allocations can be computed for all flow conditions.

Suction Dredge Wasteload Allocation (WLA_{SD})

As discussed in **Section 5.7.1.1**, the WLA to the suction dredge operation WLA_{SD} is zero.

Upper Jefferson River Segment Load Allocation ($LA_{upper\ Jefferson\ River}$)

The $LA_{upper\ Jefferson\ River}$ is calculated by multiplying the target concentration from the lower Jefferson River segment by flow from the upper Jefferson River segment just above the confluence with the Jefferson Slough. For the example high flow allocation, the flow measured at JEFF-05 on 6/9/2011 was reported as 11,400 cfs (**Appendix B**, **Table B-1**). This flow was multiplied by the high flow copper and lead target concentrations of 7.96 µg/L and 2.51 µg/L, respectively, and a conversion factor of 0.0054. JEFF-05 is considered representative of the entire flow of the upper Jefferson River as it is the lowest sampling location on the river. Flows from 6/9/2011 are considered high flow, and have been used throughout this document. The LA for the upper Jefferson River segment is further distributed into LAs and WLAs as defined above (**Section 5.7.2.5**).

Jefferson Slough Load Allocations ($LA_{Jefferson\ Slough}$)

The $LA_{Jefferson\ Slough}$ is calculated by multiplying the target concentration from the lower Jefferson River segment by the flow value for the slough measured below the Boulder River confluence. The example allocation in **Table 5-38** is based on the flow measured at MO8JEFFS03 on 6/1/2010, which was reported as 1,276 cfs (**Appendix B**, **Table B-1**). This flow was multiplied by the high flow copper and lead target concentrations of 7.96 µg/L and 2.51 µg/L, respectively, and a conversion factor of 0.0054. MO8JEFFS03 is considered representative of the entire flow of the Jefferson Slough as it is the lowest sampling location on the river.

Human Caused Sources and Natural background Composite Wasteload Allocation (WLA_{HS+NB})

The WLA_{HS+NB} includes an allocation to the load from all other potential contributing sources not captured in the TMDL equation listed above. This may include sources such as the South Boulder River and Willow Creek. The WLA_{HS+NB} is calculated as the difference between the TMDL and the sum of all other allocations (WLA_{SD}, $LA_{Jefferson\ Slough}$ and $LA_{Jefferson\ River}$

Summary

Reductions to metals loading will be necessary to achieve the targets and thus the TMDLs for the Lower Jefferson River. **Table 5-22** shows the percent reductions needed for the lower Jefferson River to meet the TMDLs. At high flows, these reductions are 65.4% for copper and 78.4% for lead. No reductions are necessary at low flows. The source assessment for the lower Jefferson River watershed indicates that human caused sources contribute the most metals loading. Load reductions should focus on limiting and controlling metals loading from these sources, particularly those sources contributing to the upper Jefferson River and the Jefferson Slough, with the Boulder River metals loading to the Jefferson Slough representing the most significant source of elevated copper and lead loading that eventually reaches the Jefferson River. Meeting LAs for the lower Jefferson River may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 7.0**.

5.8 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 LAs. TMDL development must also incorporate an MOS 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 an MOS in the Jefferson River metals TMDL development process.

5.8.1 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, overland flow and erosion of metals-contaminated soils and mine wastes tend to be the major cause of elevated metals concentrations. This loading tends to be from tributaries to the impaired segments (Boulder River, Beaverhead, Big Hole and Ruby rivers etc.). During low flow, groundwater and/or adit discharges tend to be the major source of elevated metals concentrations. Additional significant loading sources that are dependent on seasonality include contributions from stormwater runoff and natural background. 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 uses 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.
- In most cases, 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.

5.8.2 Margin of Safety

The MOS 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 may contribute 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 LAs, 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 an MOS 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 measurements used to estimate a daily load, whereas CAL standards are based on average conditions over a 96-hour period. This provides an MOS 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 an MOS necessary for the protection of human health and aquatic life.

5.9 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 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 7.0**.

The metals TMDLs developed for the Jefferson River 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 Priorities List mine sites in federal-lead status.

Monitoring and restoration conducted by other parties (e.g., USFS, the Montana Department of Natural Resources & Conservation's (DNRC) 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.

6.0 Non-Pollutant Impairments and Future TMDL Development

This section discusses non-pollutant impairments, previously completed TMDLs that address some of these impairments, and impairments that will be addressed in future TMDL projects in the Jefferson River TMDL Project Area (which includes both the Upper Jefferson and Lower Jefferson TMDL planning areas). The non-pollutant impairments discussed in this section are not necessarily related to metals impairments; however, this section is included for informational purposes to help with development of overall watershed management goals and objectives, and prioritization of restoration projects. **Section 7.0** discusses management and future monitoring recommendations specific for the metals impairments addressed in this document.

6.1 Non-Pollutant Impairments

A waterbody may be on Montana's list of impaired waters, but does not require a TMDL if it is not impaired for a pollutant, such as sediment, temperature, a nutrient, or metal. Non-pollutant causes of impairment such as "alteration in streamside or littoral vegetative covers" do not require a TMDL. Non-pollutant causes of impairment are often associated with a pollutant cause of impairment; however in some cases, non-pollutant impairments are causing a deleterious effect on beneficial uses without a clearly defined quantitative measurement or direct linkage to a pollutant.

DEQ recognizes that non-pollutant impairments can limit a waterbody's ability to fully support all beneficial uses and these impairment causes are important to consider when improving water quality conditions in both individual streams, and the project area as a whole. **Table 6-1** shows the non-pollutant impairments for the Jefferson River TMDL Project Area on Montana's 2012 list of impaired waters. They are summarized in this section to increase awareness of the non-pollutant impairment definitions and typical sources, and should be considered during planning of watershed-scale restoration efforts. To assist with watershed planning efforts, **Table 6-1** is divided into the Upper Jefferson and Lower Jefferson TMDL planning areas.

It is important to note that water quality issues are not limited to waterbodies with identified pollutant and non-pollutant impairments. In some cases, streams have not yet been reviewed through DEQ's 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.

Table 6-1. Waterbody Segments with Non-Pollutant Impairments in the 2012 Water Quality Integrated Report

Waterbody and Location Description	Waterbody ID	Impairment Cause
Upper Jefferson TMDL Planning Area		
Big Pipestone Creek, Headwaters to mouth (Jefferson Slough), T1N R4W S11	MT41G002_010	Alteration in streamside or littoral vegetative covers*
		Cause Unknown
		Other anthropogenic substrate alterations*
		Physical substrate habitat alterations*
Cherry Creek, Headwaters to mouth (Jefferson River)	MT41G002_110	Alteration in streamside or littoral vegetative covers*
		Low flow alterations

Table 6-1. Waterbody Segments with Non-Pollutant Impairments in the 2012 Water Quality Integrated Report

Waterbody and Location Description	Waterbody ID	Impairment Cause
Fish Creek, Headwaters to mouth (Jefferson Canal) T1S R5W S12	MT41G002_100	Alteration in streamside or littoral vegetative covers[1]
		Low flow alterations
Fitz Creek, Headwaters to mouth (Whitetail Deer Creek)	MT41G002_160	Alteration in streamside or littoral vegetative covers
Halfway Creek, Headwaters to mouth (Big Pipestone Creek – Jefferson River)	MT41G002_020	Alteration in streamside or littoral vegetative covers
Hells Canyon Creek, Headwaters to mouth (Jefferson River)	MT41G002_030	Low flow alterations
		Physical substrate habitat alterations[1]
Jefferson River, Headwaters to confluence of Jefferson Slough	MT41G001_011	Low flow alterations
		Physical substrate habitat alterations
Little Pipestone Creek, Headwaters to mouth (Big Pipestone Creek)	MT41G002_040	Alteration in streamside or littoral vegetative covers[1]
Whitetail Deer Creek, Headwaters to mouth (Jefferson Slough)	MT41G002_141[2]	Alteration in streamside or littoral vegetative covers[1]
		Chlorophyll-*a*
		Low flow alterations
Lower Jefferson TMDL Planning Area		
Charcoal Creek, Headwaters to mouth (Pony Creek)	MT41G002_150	Alteration in streamside or littoral vegetative covers
Jefferson River, Confluence of Jefferson Slough to mouth (Missouri River)	MT41G001_012	Low flow alterations
		Physical substrate habitat alterations
North Willow Creek, Headwaters to mouth (Willow Creek)	MT41G002_050	Alteration in streamside or littoral vegetative covers
		Low flow alterations
		Physical substrate habitat alterations
Norwegian Creek, Headwaters to mouth (Willow Creek Reservoir)	MT41G002_090	Alteration in streamside or littoral vegetative covers
South Boulder River, Headwaters to mouth (Jefferson River)	MT41G002_060	Low flow alterations
South Willow Creek, Headwaters to mouth (Willow Creek)	MT41G002_130	Alteration in streamside or littoral vegetative covers
		Excess Algal Growth
		Low flow alterations
		Physical substrate habitat alterations
Willow Creek, North and South Fork confluence to mouth (Jefferson River)	MT41G002_080	Low flow alterations

[1] A sediment TMDL for this waterbody is contained in the 2009 "Upper Jefferson River Tributary Sediment TMDLs and Framework Water Quality Improvement Plan." It is likely that meeting the sediment TMDL targets will also equate to addressing this impairment.
[2] The assessment unit (waterbody ID), waterbody name, and location description for Whitetail Deer Creek is incorrectly defined in the "2012 Water Quality Integrated Report" (see **Table A-1** and **Figure A-1** in **Appendix A**). The 2014 Integrated Report and this document reflect the corrected and redefined assessment unit.

6.2 Non-Pollutant Impairment Cause Descriptions

Non-pollutants are often used as a probable cause of impairment when available data at the time of a water quality assessment do 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 and potential restoration.

Alteration in Streamside or Littoral Vegetative Covers

"Alteration in streamside or littoral vegetative 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 and Other Anthropogenic Substrate Alterations

"Physical substrate habitat alterations" generally describe cases where the stream channel has been physically altered or manipulated, such as straightening of the channel or 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 placer mine operations. "Other anthropogenic substrate alterations" (human-caused modifications) may include channel alterations due to new infrastructure such as highways, roads, and bridges; and construction of dams or impoundments.

Cause Unknown

A "Cause Unknown" impairment occurs when biological or other indicators suggest that a beneficial use is impaired, but no specific cause of impairment has been determined at that particular time. In the case of Big Pipestone Creek (**Table 6-1**), the cause unknown refers to high pathogen (fecal coliform) counts that could impair the primary contact recreation beneficial use. Because this conclusion is based on one sample from 1978, there is inadequate data to assess impairment from pathogens. Future monitoring and assessment will be required to conduct a pathogen assessment in the form of *E-coli*, which replaced fecal coliform within Montana's water quality standards.

Chlorophyll-*a* / Excess Algal Growth

"Chlorophyll-*a*" and "excess algal growth" impairments occur when excess levels of chlorophyll-*a* or algae in the stream impair aquatic life and/or primary contact recreation (Suplee et al., 2009). "Excess algal growth" refers to the often visual identification of impairment from phytoplankton/algal growth, while "chlorophyll-*a*" is a direct measure of plant productivity. These high levels of chlorophyll-*a* or algae are caused by excess concentrations of nutrients in the stream, which increases algal biomass (Suplee and Sada de Suplee, 2011). "Chlorophyll-*a*" and "excess algal growth" impairments are typically addressed by nutrient TMDLs.

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. Low flow conditions 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 requires monitoring and assessment to identify threatened or impaired waterbodies (MCA 75-5-702) and to subsequently develop TMDLs for these waterbodies (MCA 75-5-703), the law also states that these requirements may not be construed to divest, impair, or diminish any legally-recognized water right (MCA 75-5-705). The identification of low flow alterations as a probable cause of impairment should not be construed to divest, impair, or diminish a water right. Instead, it should be considered an opportunity to characterize the impacts of flow alterations, and pursue solutions that can result in improved streamflows during critical periods, while at the same time ensuring no harm to water rights. It is up to local users, agencies, and entities to voluntarily improve instream flows through water and land management, which may include irrigation efficiency improvements and/or instream water leases, that result in reduced amounts of water diverted from streams.

6.3 Monitoring and BMPs for Non-Pollutant Affected Streams

Streams with non-pollutant impairments should be considered when developing watershed management goals and plans and when prioritizing restoration projects. Additional sediment, nutrient, and/or temperature information should be collected where data is insufficient for pollutant impairment determinations and the linkage between probable cause, non-pollutant listing, and effects to the beneficial uses is not well defined.

Sediment TMDLs were previously completed for six tributaries in the Upper Jefferson TMDL Planning Area in 2009, and a temperature TMDL for the upper segment of the Jefferson River is being completed in 2014. Many BMPs necessary to meet sediment and temperature TMDLs will also address related non-pollutant sources of impairment. The restoration strategies discussed in Section 6.0 of the "Upper Jefferson River Tributary Sediment TMDLs and Framework Water Quality Improvement Plan" (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2009b) and in Section 7.0 of the "Lower Beaverhead River and Upper Jefferson River Temperature TMDLs" (Montana Department of Environmental Quality, 2014) will also apply to the habitat and substrate alteration impairments contained in **Table 6-1** above.

Sediment TMDLs were written in 2009 for Big Pipestone, Cherry, Fish, Hells Canyon, Little Pipestone, and Whitetail Deer creeks. It is likely that meeting the sediment TMDL targets will also equate to addressing the habitat impairment conditions in each of these streams (**Table 6-1**). For streams with habitat and substrate alteration impairments that do not have a sediment TMDL, meeting sediment targets applied to streams of similar size will likely equate to addressing these non-pollutant impairments. Once land, soil, and water conservation practices and restoration measures have been applied, DEQ will conduct a formal evaluation of the waterbody's impairment status and whether beneficial uses are being supported and water quality standards are being met. **Section 7.4** discusses development of a watershed restoration plan (WRP) to accomplish these goals and the Jefferson River Watershed Council's (JRWC's) existing plan that incorporates management objects associated with the sediment TMDLs written in 2009.

6.4 Future TMDL Development

There are nutrients and additional sediment and temperature impairments for tributaries in both the Upper and Lower Jefferson River TMDL planning areas, sediment impairments to both the upper and lower segments of the Jefferson River, and a temperature impairment for the lower segment of the Jefferson River that will be addressed after 2014 (**Table A-1** in **Appendix A**). Future sediment TMDL development will address the habitat and substrate alteration impairments for streams in **Table 6-1** that did not receive sediment TMDLs in the 2009 document. However as discussed above, the suggested restoration strategies and applicable TMDL targets in the 2009 document can be applied to all habitat and substrate alteration impairments in the project area. Future nutrient TMDL development will address the chlorophyll-*a* impairment for Whitetail Deer Creek, and the excess algal growth impairment for South Willow Creek.

7.0 WATER QUALITY IMPROVEMENT PLAN AND MONITORING STRATEGY

7.1 PURPOSE OF IMPROVEMENT AND MONITORING STRATEGY

This section describes an overall strategy and specific on-the-ground measures designed to restore water quality beneficial uses and attain metals water quality standards for streams in the Jefferson River TMDL Project Area. The strategy includes general measures for reducing loading from identified nonpoint sources of metals and historical inactive mining activities in the project area. Effective monitoring is integral to these implementation measures and the foundation of an adaptive management approach. Having a monitoring strategy in place allows for feedback on the effectiveness of restoration activities, the amount of pollutant load reduction (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.

This section should further assist stakeholders in developing or expanding upon an existing WRP that will provide more detailed information about restoration goals and monitoring plans related to metals within the Jefferson River watershed. The WRP may encompass broader goals than the water quality improvement strategy outlined in this document, such as goals related to sediment, temperature, or nutrient impairments. 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 BMPs. As restoration efforts and results are assessed through watershed monitoring, this strategy should be adapted and revised by stakeholders based on new information and ongoing improvements.

7.2 ROLE OF DEQ, OTHER AGENCIES, AND STAKEHOLDERS

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:

- Jefferson River Watershed Council (JRWC)
- Jefferson Valley Conservation District
- U.S. Forest Service (USFS)
- Bureau of Land Management (BLM)
- Natural Resources Conservation Service (NRCS)
- Montana Department of Natural Resources & Conservation (DNRC)

- Montana Fish, Wildlife & Parks (FWP)
- Montana Department of Environmental Quality (DEQ)
- Montana Trout Unlimited
- Golden Sunlight Mine (GSM)
- Montana State University Extension Water Quality Program

7.3 Adaptive Management and Uncertainty

The implementation goals and monitoring strategy presented in this section provide a starting point for the development of more detailed planning efforts regarding restoration and monitoring needs; it does not assign monitoring responsibility. Recommendations provided are intended to assist local land managers, stakeholder groups, and federal and state agencies in developing appropriate plans to meet the water quality improvement goals outlined in this document.

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 BMPs have been applied to determine whether compliance with water quality standards has been attained, water quality is improving, or if revisions to current goals are necessary. This aligns with an adaptive management approach that is incorporated into DEQ's assessment and water quality impairment determination process. The Watershed Protection Section administers and monitors TMDL implementation and works with local watershed groups to identify waterbodies where there have been sufficient activities to warrant an evaluation of current stream conditions.

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 LAs, and determining effects of BMP implementation. Use of an adaptive management approach based on continued monitoring of project implementation helps manage resource commitments and 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 7-1** below in their technical guide as a visual explanation of the iterative process of adaptive management (Williams et al., 2009).

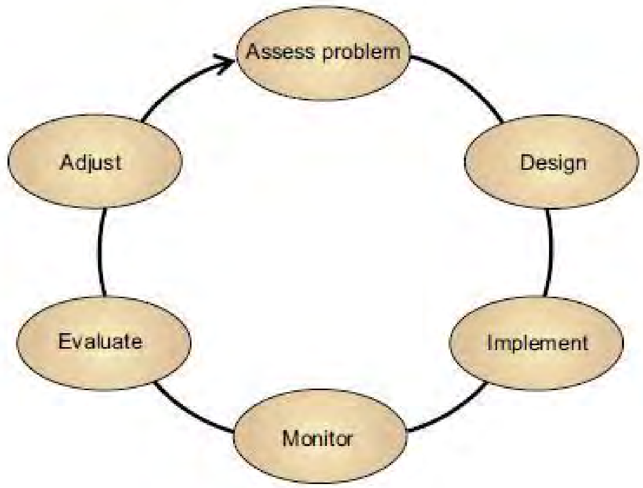

Figure 7-1. Diagram of the Adaptive Management Process

Funding for future implementation and 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 determine whether TMDL targets and water quality standards are being met.

7.4 Water Quality Restoration and Monitoring Objectives

The water quality restoration objective for the Jefferson Metals TMDL Project Area is to reduce metals 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 metals TMDLs provided in this document will achieve this objective for the identified metals pollutant-impaired streams. Based on the assessment provided in this document, the TMDLs can be achieved through proper implementation of appropriate BMPs for both point and nonpoint sources, and restoration of abandoned mine sites.

Specific objectives for watershed restoration activities should be identified by local watershed groups and other stakeholders through the development of a WRP. A WRP can provide a framework strategy for water quality restoration and monitoring in the Jefferson River watershed, 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 provide more detailed information about restoration goals and spatial considerations but may also encompass broader 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. A complete description can be found at http://www.epa.gov/region9/water/nonpoint/9elements-WtrshdPlan-EpaHndbk.pdf and are 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 for addressing metals water quality impairments. Water quality goals for metals are detailed in **Section 5.0**, which include water quality 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 Jefferson River TMDL Project Area. It is presumed that meeting all water quality targets will achieve the water quality goals for each impaired waterbody.

After sediment TMDLs were completed in 2009 for tributaries in the Upper Jefferson TPA (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2009b), the JRWC adopted a WRP in 2010 that includes management objectives associated with sediment water quality impairments, drought management and irrigation efficiency improvements, riparian health and habitat improvements, noxious weed control, and other resource concerns. The plan is available on their website at: http://www.jeffersonriverwc.org/index.html. The JRWC is currently working with DEQ to update their plan. If other organizations or individuals are interested in the WRP planning and development process, they should coordinate efforts with the JRWC to ensure a comprehensive and effective implementation process.

7.5 Overview of Management Recommendations

TMDLs were completed for metals on the Jefferson River, the Jefferson Slough, and Big Pipestone, Little Whitetail, and Whitetail Deer creeks in this document. Other tributaries to the upper segment of the Jefferson River 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 in this document. Details specific to each stream and related impairments are found within **Section 5.0**.

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 because it is generally more cost effective, less labor intensive, and will not result in short term increase of pollutant loads as may occur from active restoration activities. However in many metals-related 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).

Metal mining; cattle grazing in riparian areas; and metals loading from the Boulder, Beaverhead, Big Hole, and Ruby rivers are the principal sources of excess metals loading in the Jefferson River and tributaries to the upper segment of the Jefferson River. Restoration approaches for each of these source categories is identified below.

To date, 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 of historical mining areas. 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 7.10** and **Appendix H.** Past efforts through DEQ's abandoned mine land program and by the Montana Bureau of Mines and Geology 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 7.7**.

7.6 Restoration Approaches by Source

General management recommendations are outlined below for the major sources of human caused pollutant loads for the waterbodies included in this project. 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 for nonpoint sources such as cattle grazing, 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 for both passive and active restoration strategies, and monitoring recommendations are outlined in **Section 7.7**.

7.6.1 Grazing

Grazing in areas with elevated metals concentrations from historic mining activity has the potential to increase sediment-bound metals loads to waterbodies, but these effects can be mitigated with appropriate management. Development of riparian grazing management plans should be a goal for anyone that 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:

- U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) located in Whitehall
  (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. Riparian buffers reduce the rate of runoff, promote infiltration of the soil (instead of delivering runoff directly to the stream), and intercept pollutants. The primary recommended BMPs 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.

7.6.2 Mining

The Jefferson River watershed 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 7.7**.
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 Jefferson River TMDL Project Area include:

- The state of Montana 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).

More detailed information is included in **Appendix H**.

7.6.2.1 The Surface Mining Control and Reclamation Act (SMCRA)

DEQ's Abandoned Mines Lands program is responsible for reclamation of abandoned mines in Montana. The AML 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 7-1** lists the priority abandoned mines within the Jefferson River TMDL Project Area. Additional information about each mine can be found on DEQ's AMLs website at: http://deq.mt.gov/AbandonedMines/priority.mcpx

Table 7-1. Priority Abandoned Mine Sites in the Jefferson River TMDL Project Area

Site Name	Receiving Stream	Disturbance Area (acres)	County
Dry Gulch (South)	Dry Gulch / Spring Creek	135.1	Madison
Pete & Joe and B&H	Bear Gulch	21.1	Madison
Ohio	Hellroaring Canyon	13.9	Madison
Atlantic/ Pacific	Park Creek (tributary to South Boulder River)	85.7	Madison

7.6.2.2 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 Jefferson River 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.

7.7 Strengthening Source Assessment and Increasing Available Data

The identification of pollutant sources in this project area was conducted largely through tours of the watershed, assessments of aerial photographs, the incorporation of GIS 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 sub-watersheds. Strategies for strengthening source assessments for each of the pollutant categories are outlined below.

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 in areas with multiple sources. The following is recommended:

- Additional monitoring of all metals parameters for all the impaired waterbodies addressed in this document. Monitoring should include a full suite of metals (**Table 7-2**) and should take place during both high and low flow conditions.
- Additional monitoring of all metals parameters in Big Pipestone Creek, as there were limited data, particularly high flow data and arsenic data. Subsequent DEQ completion of a water quality assessment of Big Pipestone Creek for metals impairment determinations.
- Additional monitoring of all metals parameters for the upper segment of the Jefferson River. Established sampling locations do not provide good spatial representation of the entire segment. Additional sampling downstream of tributaries with mining impacts, including those with priority abandoned mines, will allow for more accurate metals source assessments. Additionally, bracketing a tributary (sampling directly upstream and downstream of the tributary) can help determine loading from that specific tributary.
- Monitoring of Cherry Creek, Fish Creek and Bear Gulch, tributaries to the upper segment of the Jefferson River, and South Boulder River and Willow Creek, tributaries to the lower segment of the Jefferson River. These tributaries have witnessed historical mining, and have limited water quality characterization. Additional monitoring will yield a better understanding of the metals sources located along these waterbodies.
- Additional metals water quality data is needed for the Ruby and Beaverhead rivers to perform updated metals water quality assessments and to provide additional data for possible future metals TMDL development.
- Additional water quality data is needed for the Big Hole River to evaluate whether the river is still impaired, given the elevated lead loading.
- Investigate natural background concentrations of metals in order to separate the load attributed to natural conditions, as opposed to the load from human sources.

The descriptions of several of the priority abandoned mines in **Table 7-1** are based on information collected during early 1990s site inventories completed by DEQ's Abandoned Mine Lands program (Montana Department of Environmental Quality, Abandoned Mine Lands Bureau, 2014). 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, and also other abandoned mine sites in the project area.

- A more detailed characterization of mine tailings associated with the abandoned and priority mines in the Jefferson River TMDL Project Area.
- A more detailed surface water monitoring regime directed at defining sources of metals pollution from the waterbodies that collect runoff from abandoned mine and priority mine sites.
- 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.

While remediation and restoration activities have taken place in the Jefferson River TMDL Project Area, 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.

Additional monitoring may be helpful to better partition pollutant loading at mine sites with multiple sources, such as those having permitted discharges versus more diffuse runoff from mine waste accumulations. The needed refinements may require more 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 GSM:

- Increased frequency of storm event monitoring
- Stormwater monitoring should take place at Outfalls 001, 002 and 003 during storm events, and monitoring should include a full suite of metals
- Consider BMP effectiveness monitoring by comparisons of stormwater sample analysis results with metals targets. Also, photo documentation of BMP-affected source reductions may be appropriate in cases where significant lag time may occur between BMP application and water quality improvement.

Additional monitoring may be helpful to better partition pollutant loading at point sources with permitted discharges such as wastewater treatment plants. The needed refinements may require more sampling or a more detailed field reconnaissance and follow-up sampling to better characterize effluent streams, and the potential for metals loading from these discharges. The following additional data collection is recommended for the town of Twin bridges WWTP and the town of Whitehall WWTP:

- Sampling of the town of Twin bridges WWTP effluent stream for a full suite of metals (**Table 7-2)** prior to discharge to Bayer's ditch.
- Sampling of the town of Whitehall WWTP influent and effluent stream for a full metals suite (**Table 7-2**). Influent samples are necessary to determine if arsenic or other metals are originating in sources water. Effluent samples are necessary to determine if waster that is being land applied has the potential to affect Big Pipestone Creek in the event the WWTP must discharge to the Big Pipestone Creek.

Follow up monitoring for all waterbodies in the project area should focus on defining the contribution from sources and defining background water quality in all the waterbodies mentioned above. As this information becomes available, TMDL allocations may be modified to include LAs to background sources, as opposed to the current composite WLAs.

7.8 Consistent Data Collection and Methodologies

Data has been collected throughout the Jefferson River 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 the Comprehensive Environmental Response, Compensation, and Liability Act (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.

Metals monitoring should use appropriate analytical methods and include sediment metals chemistry, hardness, pH, discharge, and TSS. **Table 7-2** identifies DEQ's required metals laboratory methodologies and reporting limits. Field procedures for sample collection can be found in DEQ's Field Procedure's Manual (Montana Department of Environmental Quality, 2012d) at: http://deq.mt.gov/wqinfo/qaprogram/sops.mcpx.

Table 7-2. DEQ Metals Monitoring Analytical Requirements

Parameter*	Preferred Method	Alternate Method	Required Reporting Limit (µg/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

Table 7-2. DEQ Metals Monitoring Analytical Requirements

Parameter*	Preferred Method	Alternate Method	Required Reporting Limit (µg/L)	Holding Time (days)	Bottle	Preservative
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			
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			
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

7.9 Effectiveness Monitoring for Restoration Activities

As restoration activities are implemented, monitoring is valuable to determine if restoration activities are improving water quality 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, changes in communities and distribution of fish and other bio-indicators, and changes in water column metals concentrations. 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 from cattle grazing is addressed or bank stabilizations projects are implemented after mine tailings removal, pre and post bank erosion analyses on the subject banks will be valuable to understand the extent of improvement and the amount of sediment-bound metals concentrations reduced.

Recommendations for monitoring in the 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 where metals sources may be present, 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.

7.10 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.

In addition to the information presented below, 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, 2012e) and information regarding additional funding opportunities can be found at http://www.epa.gov/nps/funding.html.

7.10.1 Section 319 Nonpoint Source Grant Program

DEQ issues a call for proposals every year to award Section 319 grant funds administered under the federal CWA. 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 WRP 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.

7.10.2 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 Jefferson River TMDL 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/.

7.10.3 Renewable Resource Project Planning Grants

The DNRC administers watershed grants to pay for contracted costs associated with the development of a watershed assessment. Grant are available for a maximum of $75,000 per project. Eligible applicants include conservation districts and irrigation districts, among many others. For additional information about the program and how to apply, please visit http://dnrc.mt.gov/cardd/ResourceDevelopment/ProjectPlanningGrants.asp.

7.10.4 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/.

7.10.5 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 Jefferson

River watershed or Upper Missouri Basin, please visit: http://www.fws.gov/mountain-prairie/pfw/montana/.

7.10.6 Wetland Reserve Easements

The NRCS provides technical and financial assistance to private landowners and Indian tribes to restore, enhance, and protect wetlands through permanent easements, 30 year easements, or term easements. Land eligible for these easements includes farmed or converted wetland that can be successfully and cost-effectively restored. For additional information about the program and how to apply, please visit http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/easements/acep/.

7.10.7 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.

7.10.8 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.

7.10.9 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.

7.10.10 Resource Indemnity Trust / Reclamation and Development Grants Program

The Resource Indemnity Trust / Reclamation and Development Grants (RIT/RDG) program 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 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.

8.0 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 a watershed advisory group 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 Jefferson River TMDL Project Area.

8.1 PARTICIPANTS AND ROLES

Throughout completion of the metals TMDLs in this document, DEQ worked to keep stakeholders apprised of project status and solicited input from a TMDL watershed advisory group. A description of the participants in the development of the TMDLs in the Jefferson River 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.

U.S. Environmental Protection Agency
EPA is the federal agency responsible for administering and coordinating requirements of the 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.

Conservation Districts
The majority of the project area for these TMDLs falls within Jefferson and Madison Counties, and DEQ provided both the Jefferson Valley Conservation District and the Madison Conservation District with consultation opportunity during development of these 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 TMDL advisory group for this project consisted of selected resource professionals who possess a familiarity with water quality issues and processes in the Jefferson River watershed, 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; 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.

8.2 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 comment period for the draft Jefferson River Metals Project Area TMDL document was initiated on September 30, 2014 and closed on October 31, 2014. Electronic copies of the draft document were made available at the Twin Bridges, Three Forks, Whitehall, and Butte public libraries. A public informational meeting was held in Whitehall, Montana, on October 14, 2014. At the meeting, DEQ provided an overview of the metals TMDLs, answered questions, solicited input and comment on the document, and made copies of the document available. Both the public comment period and public meeting were announced in a September 26, 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: The Montana Standard, Bozeman Daily Chronicle, Whitehall Ledger, The Madisonian, and The Three Forks Herald. Additionally, the announcement was distributed to the project's TMDL watershed advisory group, the Statewide TMDL Advisory Group, and other identified interested parties via e-mail.

Several public comments were received and responses are included in **Appendix I**. Original comment letters and submissions are held on file at DEQ and may be viewed upon request.

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APPENDIX A – TABLE OF IMPAIRMENTS IN THE JEFFERSON RIVER TMDL PROJECT AREA ON THE 2012 INTEGRATED REPORT AND THEIR STATUSES

Table A-1 contains a list of the impaired waterbodies in the Jefferson River TMDL Project Area that are in the "2012 Water Quality Integrated Report" and also contains the status of their impairment causes. To assist with watershed planning efforts, waterbodies in the table are listed alphabetically under their applicable TMDL planning area (i.e., the Upper Jefferson or Lower Jefferson TMDL planning area). Note that multiple new impairments were identified during this project (**Table 1-1**) and those impairments are included in the "2014 Water Quality Integrated Report."

Table A-1. Status of Waterbody Impairments in the Jefferson River TMDL Project Area based on the 2012 Integrated Report

Waterbody and Location Description	Waterbody ID	Impairment Cause	TMDL Pollutant Category	Impairment Cause Status
Upper Jefferson TMDL Planning Area				
BIG PIPESTONE CREEK Headwaters to mouth (Jefferson Slough), T1N R4W S11	MT41G002_010	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Addressed by a sediment TMDL in a previous document (2009)[1]
		Cause Unknown	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Nitrogen (Total)	Nutrients	To be completed in a future project
		Other anthropogenic substrate alterations	Not Applicable; Non-Pollutant	Addressed by a sediment TMDL in a previous document (2009)[1]
		Phosphorus (Total)	Nutrients	To be completed in a future project
		Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Addressed by a sediment TMDL in a previous document (2009)[1]
		Sedimentation / Siltation	Sediment	Sediment TMDL contained in previous document (2009)[1]
		Temperature, water	Temperature	To be completed in a future project
		Total Suspended Solids (TSS)	Sediment	Addressed by sediment TMDL in previous document (2009)[1]
CHERRY CREEK Headwaters to mouth (Jefferson River)	MT41G002_110	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Addressed by a sediment TMDL in a previous document (2009)[1]
		Low flow alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Sedimentation / Siltation	Sediment	Sediment TMDL contained in previous document (2009)[1]
		Zinc	Metals	Not impaired based on updated assessment

Table A-1. Status of Waterbody Impairments in the Jefferson River TMDL Project Area based on the 2012 Integrated Report

Waterbody and Location Description	Waterbody ID	Impairment Cause	TMDL Pollutant Category	Impairment Cause Status
FISH CREEK Headwaters to mouth (Jefferson Canal) T1S R5W S12	MT41G002_100	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Addressed by a sediment TMDL in a previous document (2009)[1]
		Low flow alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Sedimentation / Siltation	Sediment	Sediment TMDL contained in previous document (2009)[1]
FITZ CREEK Headwaters to mouth (Little Whitetail Creek)[3]	MT41G002_160	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Phosphorus (Total)	Nutrients	To be completed in a future project
		Sedimentation / Siltation	Sediment	To be completed in a future project
HALFWAY CREEK Headwaters to mouth (Big Pipestone Creek – Jefferson River)	MT41G002_020	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Sedimentation / Siltation	Sediment	To be completed in a future project
HELLS CANYON CREEK Headwaters to mouth (Jefferson River)	MT41G002_030	Low flow alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Addressed by a sediment TMDL in a previous document (2009)[1]
		Sedimentation / Siltation	Sediment	Sediment TMDL contained in previous document (2009)[1]
JEFFERSON RIVER Headwaters to confluence of Jefferson Slough	MT41G001_011	Copper	Metals	Not impaired based on updated assessment
		Lead	Metals	Lead TMDL contained in this document
		Low flow alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Sedimentation / Siltation	Sediment	To be completed in a future project
		Solids (Suspended/Bedload)	Sediment	To be completed in a future project
		Temperature, water	Temperature	Temperature TMDL contained in separate document (2014)[4]

Table A-1. Status of Waterbody Impairments in the Jefferson River TMDL Project Area based on the 2012 Integrated Report

Waterbody and Location Description	Waterbody ID	Impairment Cause	TMDL Pollutant Category	Impairment Cause Status
LITTLE PIPESTONE CREEK Headwaters to mouth (Big Pipestone Creek)	MT41G002_040	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Addressed by a sediment TMDL in a previous document (2009)[1]
		Nitrogen (Total)	Nutrients	To be completed in a future project
		Phosphorus (Total)	Nutrients	To be completed in a future project
		Sedimentation / Siltation	Sediment	Sediment TMDL contained in previous document (2009)[1]
LITTLE WHITETAIL CREEK[5] Headwaters to mouth (Whitetail Creek)	MT41G002_141[5]	Not assessed in the 2012 Water Quality Integrated Report[5]		
WHITETAIL CREEK[6] Whitetail Reservoir to mouth (Jefferson Slough)	MT41G002_140[6]	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Addressed by a sediment TMDL in a previous document (2009)[1]
		Aluminum	Metals	Aluminum TMDL contained in this document
		Ammonia (Un-ionized)	Nutrients	To be completed in a future project
		Chlorophyll-*a*	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Copper	Metals	Not impaired based on updated assessment
		Lead	Metals	Lead TMDL contained in this document
		Low flow alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Nitrate/Nitrite (Nitrite + Nitrate as N)	Nutrients	To be completed in a future project
		Nitrogen (Total)	Nutrients	To be completed in a future project
		Phosphorus (Total)	Nutrients	To be completed in a future project
		Sedimentation / Siltation	Sediment	Sediment TMDL contained in previous document (2009)[1]
		Silver	Metals	Not impaired based on updated assessment

Table A-1. Status of Waterbody Impairments in the Jefferson River TMDL Project Area based on the 2012 Integrated Report

Waterbody and Location Description	Waterbody ID	Impairment Cause	TMDL Pollutant Category	Impairment Cause Status
Lower Jefferson TMDL Planning Area				
CHARCOAL CREEK Headwaters to mouth (Pony Creek)	MT41G002_150	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Sedimentation / Siltation	Sediment	To be completed in a future project
JEFFERSON RIVER Confluence of Jefferson Slough to mouth (Missouri River)	MT41G001_012	Copper	Metals	Copper TMDL contained in this document
		Lead	Metals	Lead TMDL contained in this document
		Low flow alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Sedimentation / Siltation	Sediment	To be completed in a future project
		Solids (Suspended/Bedload)	Sediment	To be completed in a future project
		Temperature, water	Temperature	To be completed in a future project
NORTH WILLOW CREEK Headwaters to mouth (Willow Creek)	MT41G002_050	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Lead	Metals	To be completed in a future project
		Low flow alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Mercury	Metals	To be completed in a future project
		Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
NORWEGIAN CREEK Headwaters to mouth (Willow Creek Reservoir)	MT41G002_090	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Arsenic	Metals	To be completed in a future project
		Nitrogen (Total)	Nutrients	To be completed in a future project
		Phosphorus (Total)	Nutrients	To be completed in a future project
		Sedimentation / Siltation	Sediment	To be completed in a future project
		Temperature, water	Temperature	To be completed in a future project

Table A-1. Status of Waterbody Impairments in the Jefferson River TMDL Project Area based on the 2012 Integrated Report

Waterbody and Location Description	Waterbody ID	Impairment Cause	TMDL Pollutant Category	Impairment Cause Status
SOUTH BOULDER RIVER Headwaters to mouth (Jefferson River)	MT41G002_060	Arsenic	Metals	To be completed in a future project
		Copper	Metals	To be completed in a future project
		Lead	Metals	To be completed in a future project
		Low flow alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Mercury	Metals	To be completed in a future project
		Phosphorus (Total)	Nutrients	To be completed in a future project
SOUTH WILLOW CREEK Headwaters to mouth (Willow Creek)	MT41G002_130	Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Excess Algal Growth	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Low flow alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Physical substrate habitat alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Sedimentation / Siltation	Sediment	To be completed in a future project
		Zinc	Metals	To be completed in a future project
WILLOW CREEK North and South Fork confluence to mouth (Jefferson River)	MT41G002_080	Low flow alterations	Not Applicable; Non-Pollutant	Not yet addressed[2]
		Temperature, water	Temperature	To be completed in a future project
		Zinc	Metals	To be completed in a future project

[1] Sediment TMDLs previously completed in the Upper Jefferson TMDL Planning Area are contained in the 2009 "Upper Jefferson River Tributary Sediment TMDLs and Framework Water Quality Improvement Plan"

[2] Future TMDL development work in this project area may address this non-pollutant impairment. See **Section 6.4**.

[3] The location description for Fitz Creek was changed to "headwaters to mouth (Whitetail Deer Creek)" in the "2014 Water Quality Integrated Report"

[4] Temperature TMDL contained in 2014 "Lower Beaverhead River and Upper Jefferson River Temperature TMDLs" document

[5] Little Whitetail Creek is incorrectly defined in the "2012 Water Quality Integrated Report." In the "2014 Water Quality Integrated Report," the waterbody ID was changed to MT41G002_140 (versus MT41G002_141), and the location description was changed to "Little Whitetail Creek, Whitetail Reservoir to mouth (Whitetail Deer Creek)." See **Figure A-1** below.

[6] Whitetail Creek is incorrectly defined in the "2012 Water Quality Integrated Report." In the "2014 Water Quality Integrated Report," the waterbody ID was changed to MT41G002_141 (versus MT41G002_140). The waterbody name and location description were changed to "Whitetail Deer Creek, headwaters to mouth (Jefferson Slough)" to reflect the fact that the waterbody no longer originates at Whitetail Reservoir (see **Figure A-1** below).

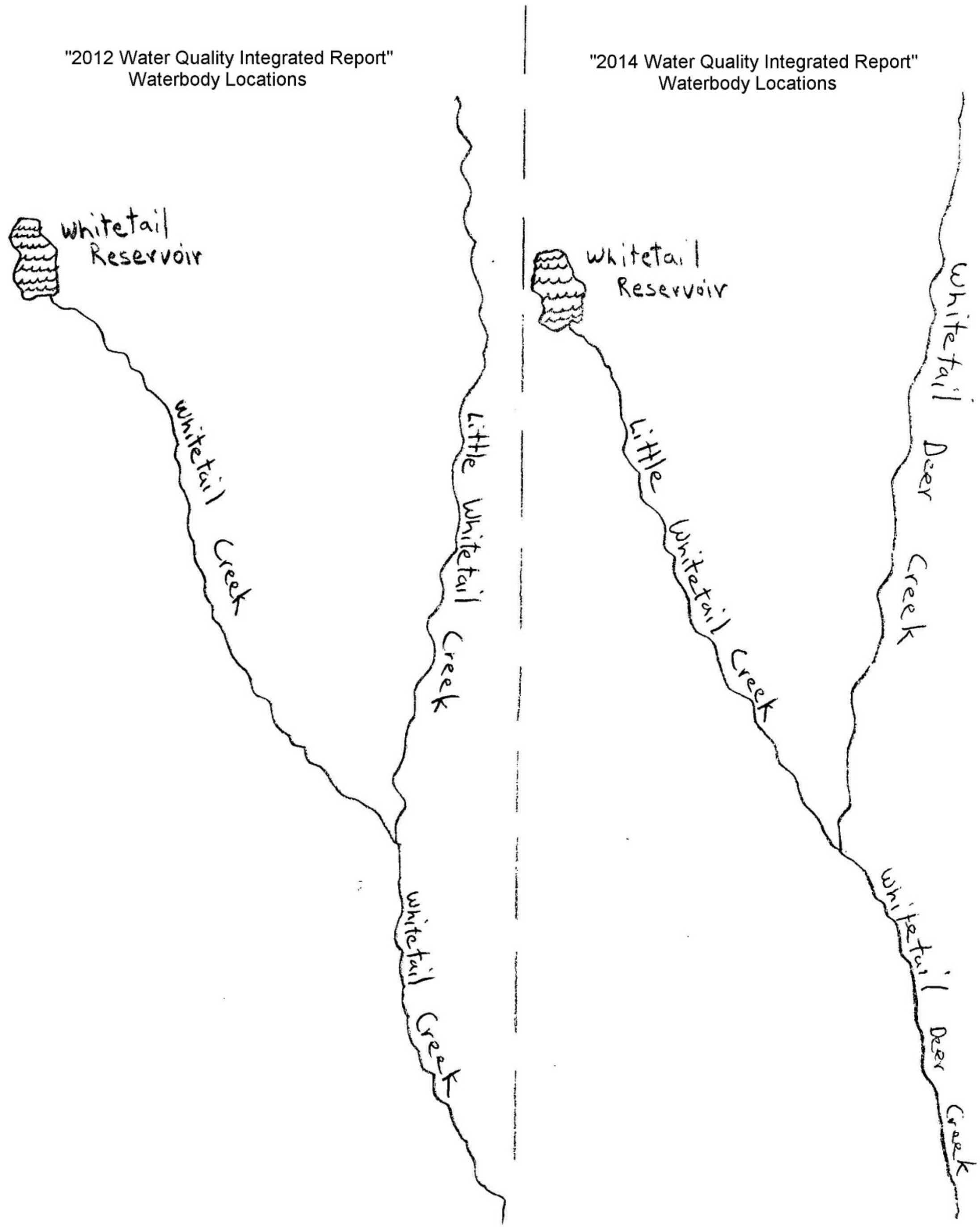

Figure A-1. Diagram of original and corrected waterbody locations of Little Whitetail Creek and Whitetail Deer Creek

APPENDIX B – SURFACE WATER METALS DATA, JEFFERSON RIVER TMDL PROJECT AREA

LIST OF TABLES

This appendix contains seven data tables. **Table B-1** contains all the data DEQ used to assess each of the waterbodies for attainment of the metals water quality standards. This table includes surface water flow and water column metals concentration data for all the stream sampling locations discussed in the Jefferson River metals TMDL document. **Tables B-2** through **B-7** contain surface water flow and water column metals concentration data specific to each individual stream in the Jefferson River metals TMDL document, and only include the data that was used in the TMDL calculations in **Section 5.0**; these tables are included to aid readers in finding data more easily. Note that where no value is given, no data was collected.

The following codes appear in some of the tables:

- "<" symbols indicate non-detect samples where the detection limit is populated as the value
- CAL= Chronic Aquatic Life Standard
- AAL= Acute aquatic Life Standard
- E = Estimated flow measurement
- C = Calculated hardness value (Total Hardness as $CaCO_3$). The calculated hardness values presented in this table are computed from the results of separate determinations of calcium and magnesium (**Section 7.8** provides a table of the analytical methods used). Hardness values that are not prefaced with a "C" are direct measurements of hardness using a different analytical procedure.

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Little Whitetail Creek above confluence with Whitetail Deer Creek	JWCLWHTL01	6/10/2011 13:30	C 28	E500	6.97	230	–	–	9	–	3.9	< 0.5	–
DEQ	Little Whitetail Creek above confluence with Whitetail Deer Creek	JWCLWHTL01	9/8/2011 13:40	C 101	5.5	7.49	40	–	–	3	–	0.8	< 0.5	–
DEQ	Little Whitetail Creek 4 miles below Whitetail Reservoir	M08LWHTC01	6/9/2004 11:30	25	17.9	6.31	100	4	< 0.1	5	660	1	< 3	< 10
DEQ	Little Whitetail Creek downstream Whitetail Reservoir	M08LWHTC02	5/7/2013 13:45	C 40	23.43	7.72	30	7	0.07	4	1490	1.4	< 0.2	< 8

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Little Whitetail Creek upstream Whitetail Deer Creek confluence	M08LWHTC03	10/2/2012 10:30	C 175	0.54	7.8	–	4	< 0.08	1	410	< 0.5	–	< 10
DEQ	Little Whitetail Creek upstream Whitetail Deer Creek confluence	M08LWHTC03	5/7/2013 19:00	C 80	3.35	7.64	29	4	0.04	3	800	0.6	< 0.2	< 8
DEQ	Little Whitetail Creek (lower) about 300 ft downstream railroad crossing	WWHI-01	5/25/2010 12:15	C 46	24.87	7.34	160	–	–	5	–	2.1	< 0.5	–
DEQ	Little Whitetail Creek (lower) about 300 ft downstream railroad crossing	WWHI-01	9/8/2010 10:15	C 71	11.82	7.4	210	–	–	3	–	1.1	< 0.5	–
DEQ	Little Whitetail Creek (upper) at Whitetail Road crossing	WWHI-02	6/2/2010 12:15	C 22	70.03	7.03	110	–	–	6	–	2.4	< 0.5	–
DEQ	Little Whitetail Creek (upper) at Whitetail Road crossing	WWHI-02	9/7/2010 15:30	C 30	13.1	7.91	290	–	–	5	–	1.8	< 0.5	–
DEQ	Little Whitetail Creek (upper)	WWHI-03	6/10/2011 10:20	C 25	E 500	6.65	160	–	–	9	–	6	< 0.5	–
DEQ	Little Whitetail Creek (upper)	WWHI-03	9/8/2011 10:30	C 36	24.3	7.56	100	–	–	5	–	1.8	< 0.5	–
DEQ	Whitetail Deer Creek (East Fork Whitetail) u/s of fence and road crossing	EWHI-01	5/25/2010 13:00	C 139	8.76	7.83	250	–	–	4	–	1.4	< 0.5	–

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Whitetail Deer Creek (East Fork Whitetail) u/s of fence and road crossing	EWHI-01	9/8/2010 8:00	C 200	5.18	7.5	70	–	–	1	–	< 0.5	< 0.5	–
DEQ	Whitetail Deer Creek (East Fork Whitetail) u/s of fence and road crossing	EWHI-01	6/10/2011 13:10	C 92	E 250	7.57	150	–	–	4	–	1	< 0.5	–
DEQ	Whitetail Deer Creek (East Fork Whitetail) u/s of fence and road crossing	EWHI-01	9/8/2011 14:10	C 215	2.6	7.53	< 30	–	–	2	–	< 0.5	< 0.5	–
DEQ	Whitetail Deer Creek (East Fork Whitetail) upstream of Keogh Reservoir	EWHI-03	5/25/2010 14:30	C 70	14.61	7.52	40	–	–	4	–	4	< 0.5	–
DEQ	Whitetail Deer Creek (East Fork Whitetail) upstream of Keogh Reservoir	EWHI-03	9/8/2010 15:15	C 58	4.18	7.76	40	–	–	1	–	1.1	< 0.5	–
DEQ	Whitetail Deer Creek (East Fork Whitetail) upstream of Keogh Reservoir	EWHI-03	6/10/2011 12:30	C 47	73.8	7.12	520	–	–	5	–	2.4	< 0.5	–
DEQ	Whitetail Deer Creek (East Fork Whitetail) upstream of Keogh Reservoir	EWHI-03	9/8/2011 12:40	C 65	5.4	6.37	< 30	–	–	3	–	1.7	< 0.5	–

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Whitetail Deer Creek at Hay Canyon Road crossing	M08WHTDC01	10/2/2012 9:00	C 73	1.38	7.94	–	5	< 0.08	2	650	0.9	–	< 10
DEQ	Whitetail Deer Creek at Hay Canyon Road crossing	M08WHTDC01	5/7/2013 17:30	C 73	–	8.01	–	4	0.04	1	380	0.9	< 0.2	< 8
DEQ	Whitetail Deer Creek about 100 ft downstream Hwy 69 crossing	M08WHTDC03	5/9/2013 11:00	C 180	5.8	8.18	< 9	6	0.04	2	370	0.5	0.3	< 8
DEQ	Whitetail Deer Creek abt 1/4 mile upstream of Whitehall	M08WHTDC04	6/9/2004 17:15	206	0.46	–	< 100	7	< 0.1	1	200	< 0.5	< 3	< 10
DEQ	Whitetail Deer Creek abt 1/4 mile upstream of Whitehall	M08WHTDC04	10/3/2012 15:00	C 222	4.85	8.21	< 30	4	< 0.08	1	400	< 0.5	–	< 10
DEQ	Whitetail Deer Creek abt 1/4 mile upstream of Whitehall	M08WHTDC04	5/9/2013 12:15	C 170	5.92	8.53	< 9	6	0.03	2	410	0.5	< 0.2	< 8
DEQ	Whitetail Deer Creek downstream of Hwy 69 about 3/4 mile	M08WHTDC05	10/2/2012 12:30	C 230	4.85	8.01	< 30	4	< 0.08	2	830	1.1	–	< 10
DEQ	Whitetail Deer Creek about 500 ft downstream of railroad crossing	WHIT-01	5/24/2010 14:40	C 118	29.18	7.93	110	–	–	4	–	1.9	< 0.5	–

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Whitetail Deer Creek about 500 ft downstream of railroad crossing	WHIT-01	8/31/2010 13:00	C 91	18.93	9.75	130	–	–	4	–	0.9	< 0.5	–
DEQ	Whitetail Deer Creek about 500 ft downstream of railroad crossing	WHIT-01	6/10/2011 14:10	C 72	E 750	7.41	150	–	–	6	–	2.4	< 0.5	–
DEQ	Whitetail Deer Creek about 500 ft downstream of railroad crossing	WHIT-01	9/8/2011 15:10	C 163	5.6	7.92	< 30	–	–	2	–	< 0.5	< 0.5	–
DEQ	Whitetail Deer Creek upstream of I-90	WHIT-02	5/24/2010 10:40	C 117	26.88	7.8	110	–	–	4	–	1.9	< 0.5	–
DEQ	Whitetail Deer Creek upstream of I-90	WHIT-02	8/31/2010 10:15	C 151	16.28	7.77	140	–	–	3	–	1.5	< 0.5	–
DEQ	Whitetail Deer Creek upstream of I-90	WHIT-02	6/10/2011 14:00	C 66	E 750	7.39	130	–	–	6	–	1.9	< 0.5	–
DEQ	Whitetail Deer Creek upstream of I-90	WHIT-02	9/8/2011 14:40	C 171	E 8.2	8.06	< 30	–	–	2	–	< 0.5	< 0.5	–
DEQ	Big Pipestone Creek at Division Street crossing	M08BGPSC04	10/1/2012 16:00	C 237	1.89	–	–	5	< 0.08	< 1	100	< 0.5		< 10
DEQ	Big Pipestone Creek at Division Street crossing	M08BGPSC04	5/9/2013 8:15	C 164	1.02	–	–	4	< 0.03	2	400	0.3	< 0.2	< 8

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Big Pipestone Creek about 70 yards downstream of WWTP	M08BGPSC03	5/9/2013 10:00	C 247	0.41	–	–	11	0.04	2	470	< 0.3	< 0.2	< 8
DEQ	Jefferson Slough upstream Boulder River, upstream Hwy 2	JEFS-01	5/24/2010 16:30	C 170	E 190	8.05	–	6	< 0.08	4	970	1.1	–	< 10
DEQ	Jefferson Slough upstream Boulder River, upstream Hwy 2	JEFS-01	8/30/2010 10:00	C 203	34.47	7.87	–	5	< 0.08	1	270	0.5	–	< 10
DEQ	Jefferson Slough upstream Boulder River, upstream Hwy 2	JEFS-01	6/10/2011 15:00	C 91	E 1000	7.55	–	–	–	7		2.4	–	–
DEQ	Jefferson Slough upstream Boulder River, upstream Hwy 2	JEFS-01	9/8/2011 16:40	C 229	36.3	8.65	–	–	–	2		< 0.5	–	–
DEQ	Jefferson Slough at mouth (Jefferson River)	M08JEFFS03	6/1/2010 10:10	73	1276		60	13	0.48	31	1780	10	< 0.5	100
DEQ	Jefferson Slough at mouth (Jefferson River)	M08JEFFS03	8/1/2010 11:54	148	142.97	8.2	< 30	11	0.13	8	280	1.6	< 0.5	20
DEQ	Jefferson Slough at mouth (Jefferson River)	M08JEFFS03	9/2/2010 11:05	164	140.14	8.7	< 30	7	< 0.08	4	260	0.8	< 0.5	< 10
DEQ	Jefferson Slough upstream Boulder River at Hwy 359 crossing	M08JEFFS04	10/1/2012 18:30	C 260	11.82	8.67	–	5	< 0.08	1	70	< 0.5	–	< 10

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Jefferson Slough upstream Boulder River at Hwy 359 crossing	M08JEFFS04	5/9/2013 16:00	C 213	25.14	8.82	–	5	< 0.03	1	490	0.6	< 0.2	< 8
DEQ	Jefferson Slough downstream from Whitetail Creek	M08JEFFS05	10/3/2012 8:30	C 258	21.75	8.05	–	5	< 0.08	1	220	< 0.5	–	< 10
DEQ	Jefferson Slough downstream from Whitetail Deer Creek	M08JEFFS05	5/9/2013 13:30	C 170	37.2	8.31	–	5	0.04	2	950	1.1	< 0.2	< 8
DEQ	Jefferson Slough at Tebay Lane crossing	M08JEFFS06	5/9/2013 14:45	C 184	26.8	8.44	–	5	< 0.03	2	1000	0.9	< 0.2	< 8
DEQ	Jefferson Slough ab mouth	SLOU01	6/10/2011 14:40	C 80	E 1000	7.49	–	–	–	7	–	2.2	–	–
DEQ	Jefferson Slough ab mouth	SLOU01	9/8/2011 15:40	C 215	30.9	8.21	–	–	–	2	–	< 0.5	–	–
DEQ	Jefferson River below Pipestone Creek	JEFF-05	6/9/2011 14:50	C 89	E 11400	–	–	–	–	5	–	3.1	–	–
DEQ	Jefferson River below Pipestone Creek	JEFF-05	9/7/2011 18:00	C 231	E 1227	8.12	–	–	–	1	–	< 0.5	–	–
DEQ	Jefferson River downstream Parson's Bridge fishing access, at USGS gage	JEFF-06	6/1/2010 18:30	C 135	2740	8.01	–	5	< 0.08	3	1050	1.1	–	< 10
DEQ	Jefferson River downstream Parson's Bridge fishing access, at USGS gage	JEFF-06	9/7/2010 13:15	C 244	993	8.4	–	3	< 0.08	< 1	210	0.5	–	< 10

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Jefferson River downstream Parson's Bridge fishing access, at USGS gage	JEFF-06	6/9/2011 14:20	C 83	10700	7.35	–	–	–	5	–	2.6	–	–
DEQ	Jefferson River downstream Parson's Bridge fishing access, at USGS gage	JEFF-06	9/7/2011 17:10	C 229	1070	8.28	–	–	–	< 1	–	< 0.5	–	–
DEQ	Jefferson River between USGS gage and Hells Canyon fishing access	JEFF-07	6/1/2010 15:00	C 126	–	8.05	–	4	< 0.08	3	970	1	–	< 10
DEQ	Jefferson River between USGS gage and Hells Canyon fishing access	JEFF-07	8/30/2010 15:00	C 247	–	8.31	–	4	< 0.08	1	560	0.6	–	< 10
DEQ	USGS Gage 06026500 - Jefferson River near Twin Bridges	JEFF-08	6/9/2011 12:30	C 71	7190	7.8	–	–	–	5	–	2.8	–	–
DEQ	USGS Gage 06026500 - Jefferson River near Twin Bridges	JEFF-08	9/7/2011 16:30	C 234	1270	8.08	–	–	–	1	–	< 0.5	–	–
DEQ	Jefferson River at Mayflower fishing access	JWCJEFF03	4/20/2004	126	E 1100	8.4	–	–	–	1	–	2	–	–
DEQ	Jefferson River at Mayflower fishing access	JWCJEFF03	5/18/2004	150	E 655	8.1	–	–	–	3	–	1	–	–

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Jefferson River at Mayflower fishing access	JWCJEFF03	6/16/2004	135	E 1690	8.1	–	–	–	1	–	< 0.02	–	–
DEQ	Jefferson River at Mayflower fishing access	JWCJEFF03	7/13/2004	168	E 815	8.4	–	–	–	1	–	2	–	–
DEQ	Jefferson River at Mayflower fishing access	JWCJEFF03	8/11/2004	204	E 200	8	–	–	–	2	–	< 0.02	–	–
DEQ	Jefferson River at Mayflower fishing access	JWCJEFF03	5/24/2010 17:20	C 133	–	8.37	–	3	< 0.08	2	660	0.6	–	< 10
DEQ	Jefferson River at Mayflower fishing access	JWCJEFF03	8/30/2010 11:30	C 234	–	8.17	–	3	< 0.08	< 1	170	< 0.5	–	< 10
DEQ	Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	4/20/2004	125	E 1085	8.4	–	–	–	2	–	1	–	–
DEQ	Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	5/18/2004	120	E 1190	8.3	–	–	–	2	–	1	–	–
DEQ	Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	6/16/2004	121	E 1385	8.4	–	–	–	1	–	< 0.02	–	–
DEQ	Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	7/13/2004	155	E 885	8.9	–	–	–	1	–	1	–	–

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	8/11/2004	226	E 361	8.8	–	–	–	2	–	< 0.02	–	–
DEQ	Jefferson River about 100 yds downstream from USGS gaging station	M08JEFFR30	10/1/2012 14:00	C 245	E 690	8.57	–	4	< 0.08	< 1	220	< 0.5	–	< 10
DEQ	Jefferson River about 100 yds downstream from USGS gaging station	M08JEFFR30	5/8/2013 11:30	C 109	E 860	8.46	–	3	< 0.03	1	440	0.4	< 0.2	< 8
DEQ	Jefferson River near Three Forks MT	6036650	5/20/2003 12:30	88.8	2620	8.4	–	3	< 0.2	5.9	–	1.51	–	11
DEQ	Jefferson River near Three Forks MT	6036650	7/29/2003 13:00	177	290	8.6	–	4	< 0.035	1.5	–	0.08	–	< 2
DEQ	Jefferson River downstream of Hwy 2 and at USGS gage	JEFF-01	5/27/2010 11:30	C 131	2330	8.15	–	6	0.12	8	960	2.5	–	20
DEQ	Jefferson River downstream of Hwy 2 and at USGS gage	JEFF-01	8/29/2010 10:00	C 197	853	8.19	–	4	< 0.08	2	190	< 0.5	–	< 10
DEQ	Jefferson River downstream of Hwy 2 and at USGS gage	JEFF-01	6/9/2011 16:00	C 83	14000	7.48	–	–	–	22	–	11.4	–	–
DEQ	Jefferson River downstream of Hwy 2 and at USGS gage	JEFF-01	9/7/2011 19:30	C 217	1280	8.41	–	–	–	1	–	< 0.5	–	–
DEQ	Jefferson River downstream Willow Creek	JEFF-02	5/27/2010 11:00	C 129	–	8.07	–	5	0.11	8	900	2.5	–	20

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Jefferson River downstream Willow Creek	JEFF-02	8/29/2010 11:00	C 201	–	8.28	–	4	< 0.08	2	180	0.7	–	< 10
DEQ	Jefferson River downstream Willow Creek	JEFF-02	6/9/2011 15:50	C 83	14000	7.68	–	–	–	23	–	11.6	–	–
DEQ	Jefferson River downstream Willow Creek	JEFF-02	9/7/2011 19:00	C 223	1280	8.29	–	–	–	1	–	< 0.5	–	–
DEQ	Jefferson River at Sheep Gulch, downstream South Boulder River	JEFF-03	5/27/2010 8:45	C 129	–	8.01	–	5	0.1	7	790	2.1	–	20
DEQ	Jefferson River at Sheep Gulch, downstream South Boulder River	JEFF-03	8/29/2010 14:00	C 213	–	8.35	–	4	< 0.08	1	100	< 0.5	–	< 10
DEQ	Jefferson River at Sheep Gulch, downstream South Boulder River	JEFF-03	6/9/2011 15:20	C 80	13670	7.56	–	–	–	21	–	9.6	–	–
DEQ	Jefferson River at Sheep Gulch, downstream South Boulder River	JEFF-03	9/7/2011 18:30	C 231	E 1265	8.46	–	–	–	1	–	< 0.5	–	–
DEQ	Jefferson River just upstream of SF Boulder River confluence	JEFF-04	5/24/2010 13:30	C 119	–	8.07	–	6	0.14	10	1060	3.3	–	30
DEQ	Jefferson River just upstream of SF Boulder River confluence	JEFF-04	8/29/2010 15:30	C 220	–	8.34	–	4	< 0.08	1	110	< 0.5	–	< 10

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Jefferson River just upstream of SF Boulder River confluence	JEFF-04	6/9/2011 15:10	C 80	E 13470	7.62	–	–	–	25	–	11.6	–	–
DEQ	Jefferson River just upstream of SF Boulder River confluence	JEFF-04	9/7/2011 18:15	C 226	E 1275	8.41	–	–	–	1	–	< 0.5	–	–
DEQ	Jefferson River at Three Forks USGS gage	JWCJEFF01	4/20/2004	139	E 1205	8.2	–	–	–	2	–	2	–	–
DEQ	Jefferson River at Three Forks USGS gage	JWCJEFF01	5/18/2004	152	E 735	8.2	–	–	–	4	–	2	–	–
DEQ	Jefferson River at Three Forks USGS gage	JWCJEFF01	6/16/2004	135	E 1890	7.9	–	–	–	4	–	< 0.02	–	–
DEQ	Jefferson River at Three Forks USGS gage	JWCJEFF01	7/13/2004	164	E 853	8.1	–	–	–	1	–	8	–	–
DEQ	Jefferson River at Three Forks USGS gage	JWCJEFF01	8/11/2004	207	E 206	7.9	–	–	–	3	–	< 0.02	–	–
DEQ	Jefferson River at Sappington fishing access	JWCJEFF02	4/20/2004	132	E 1175	8.4	–	–	–	2	–	2	–	–
DEQ	Jefferson River at Sappington fishing access	JWCJEFF02	5/18/2004	146	E 730	8.3	–	–	–	4	–	2	–	–
DEQ	Jefferson River at Sappington fishing access	JWCJEFF02	6/16/2004	132	E 1900	8	–	–	–	3	–	< 0.02	–	–

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Jefferson River at Sappington fishing access	JWCJEFF02	7/13/2004	165	E 853	8.4	–	–	–	1	–	2	–	–
DEQ	Jefferson River at Sappington fishing access	JWCJEFF02	8/11/2004	205	E 200	7.9	–	–	–	2	–	< 0.02	–	–
DEQ	Jefferson River near Three Forks, 400 yards above bridge	M08JEFFR01	7/30/2004 11:00	164.33	E 200	7.86	–	4	< 0.1	1	30	< 1	< 1	1
DEQ	Jefferson River near Three Forks, 400 yards above bridge	M08JEFFR01	8/5/2005 12:30	182	E 325	8.1	–	5	< 0.08	< 1	40	< 0.5	< 1	1
DEQ	Jefferson River near Three Forks, 400 yards above bridge	M08JEFFR01	10/2/2012 15:20	C 241	E 669	8.54	–	4	< 0.08	2	210	0.6	–	< 10
DEQ	Jefferson River near Three Forks, 400 yards above bridge	M08JEFFR01	5/8/2013 19:45	C 157	E 570	8.54	–	4	< 0.03	2	250	0.4	< 0.2	< 8
DEQ	Jefferson River downstream Willow Creek	M08JEFFR39	10/2/2012 16:00	C 235	E 669	8.49	–	4	< 0.08	1	220	< 0.5	–	< 10
DEQ	Jefferson River downstream Willow Creek	M08JEFFR39	5/8/2013 19:15	C 155	–	8.57	–	4	< 0.03	2	300	0.5	< 0.2	< 8
DEQ	Jefferson River about 2 miles below South Boulder River	M08JEFFR40	10/2/2012 18:30	C 243	677	8.44	–	4	< 0.08	1	220	< 0.5	–	< 10
DEQ	Jefferson River about 2 miles below South Boulder River	M08JEFFR40	5/8/2013 17:30	C 152	E 477	8.51	–	4	0.04	2	300	0.5	< 0.2	< 8

Table B-1. Surface Water Metals Data for the Jefferson River TMDL Project Area

Data Collection Entity	Station Location and description	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (µg/L)	As (µg/L)	Cd (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Ag (µg/L)	Zn (µg/L)
DEQ	Jefferson River just upstream South Boulder River	M08JEFFR41	10/3/2012 10:30	C 239	E 826	8.27	–	4	< 0.08	1	280	< 0.5	–	< 10
DEQ	Jefferson River just upstream South Boulder River	M08JEFFR41	5/8/2013 16:00	C 151	E 570	8.47	–	4	0.03	2	330	0.5	< 0.2	< 8

Table B-2. Little Whitetail Creek Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	Al (µg/L)	Cu (µg/L)	AAL Cu (µg/l)	CAL Cu (µg/l)	Pb (µg/L)	AAL Pb (µg/l)	CAL Pb (µg/l)
Little Whitetail Creek (upper)	WWHI-03	6/10/2011 10:20	C 25	E 500	160	9	3.79	2.85	6	13.98	0.54
Little Whitetail Creek (upper)	WWHI-03	9/8/2011 10:30	C 36	24.3	100	5	5.35	3.90	1.8	22.24	0.87
Little Whitetail Creek downstream Whitetail Reservoir	M08LWHTC02	5/7/2013 13:45	C 40	23.43	30	4	5.90	4.26	1.4	25.43	0.99
Little Whitetail Creek (upper) at Whitetail Road crossing	WWHI-02	6/2/2010 12:15	C 22	70.03	110	6	3.79	2.85	2.4	13.98	0.54
Little Whitetail Creek (upper) at Whitetail Road crossing	WWHI-02	9/7/2010 15:30	C 30	13.1	290	5	4.50	3.33	1.8	17.63	0.69
	M08LWHTC01	6/9/2004 11:30	C 25	17.9	100	5	3.79	2.85	1	13.98	0.54
Little Whitetail Creek (lower) about 300 ft downstream railroad crossing	WWHI-01	5/25/2010 12:15	C 46	24.87	160	5	6.74	4.80	2.1	30.38	1.18
Little Whitetail Creek (lower) about 300 ft downstream railroad crossing	WWHI-01	9/8/2010 10:15	C 71	11.82	210	3	10.14	6.96	1.1	52.79	2.06
Little Whitetail Creek above confluence with Whitetail Deer Creek	JWCLWHTL01	5/18/2004 12:30	–	8.6	–	–	–	–	–	–	–

Table B-2. Little Whitetail Creek Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	Al (µg/L)	Cu (µg/L)	AAL Cu (µg/l)	CAL Cu (µg/l)	Pb (µg/L)	AAL Pb (µg/l)	CAL Pb (µg/l)
Little Whitetail Creek above confluence with Whitetail Deer Creek	JWCLWHTL01	6/16/2004 12:43	–	3.25	–	–	–	–	–	–	–
Little Whitetail Creek above confluence with Whitetail Deer Creek	JWCLWHTL01	7/13/2004 10:56	–	0.61	–	–	–	–	–	–	–
Little Whitetail Creek above confluence with Whitetail Deer Creek	JWCLWHTL01	8/11/2004 12:55	–	2.04	–	–	–	–	–	–	–
Little Whitetail Creek above confluence with Whitetail Deer Creek	JWCLWHTL01	9/10/2004 12:55	–	0.4	–	–	–	–	–	–	–
Little Whitetail Creek above confluence with Whitetail Deer Creek	JWCLWHTL01	6/10/2011 13:30	C 28	E 500	230	9	4.22	3.14	3.9	16.15	0.63
Little Whitetail Creek above confluence with Whitetail Deer Creek	JWCLWHTL01	9/8/2011 13:40	C 101	5.5	40	3	14.13	9.41	0.8	82.69	3.22
Little Whitetail Creek upstream Whitetail Deer Creek confluence	M08LWHTC03	10/2/2012 10:30	C 175	0.54	-	1	23.72	15.05	< 0.5	166.46	6.49
Little Whitetail Creek upstream Whitetail Deer Creek confluence	M08LWHTC03	5/7/2013 19:00	C 80	3.35	29	3	11.34	7.71	0.6	61.46	2.39

Table B-3. Whitetail Deer Creek Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	Al (µg/L)	Pb (µg/L)	AAL Pb (µg/l)	CAL Pb (µg/l)
Whitetail Deer Creek (East Fork Whitetail) upstream of Keogh Reservoir	EWHI-03	5/25/2010 14:30	C 70	14.61	40	4	51.85	2.02
Whitetail Deer Creek (East Fork Whitetail) upstream of Keogh Reservoir	EWHI-03	9/8/2010 15:15	C 58	4.18	40	1.1	40.81	1.59
Whitetail Deer Creek (East Fork Whitetail) upstream of Keogh Reservoir	EWHI-03	6/10/2011 12:30	C 47	73.8	520	2.4	31.23	1.22

Table B-3. Whitetail Deer Creek Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	Al (µg/L)	Pb (µg/L)	AAL Pb (µg/l)	CAL Pb (µg/l)
Whitetail Deer Creek (East Fork Whitetail) upstream of Keogh Reservoir	EWHI-03	9/8/2011 12:40	C 65	5.4	< 30	1.7	47.18	1.84
Whitetail Deer Creek (East Fork Whitetail) downstream of Keogh Reservoir	EWHI-02	5/25/2010 15:15	–	13.5	–	–	–	
Whitetail Deer Creek (East Fork Whitetail) downstream of Keogh Reservoir	EWHI-02	9/8/2010 16:30	–	6.38	–	–	–	
Whitetail Deer Creek at Hay Canyon Road crossing	M08WHTDC01	10/2/2012 9:00	C 73	1.38	–	0.9	54.69	2.13
Whitetail Deer Creek at Hay Canyon Road crossing	M08WHTDC01	5/7/2013 17:30	C 73	–	–	0.9	54.69	2.13
Whitetail Deer Creek (East Fork Whitetail) u/s of fence and road crossing	EWHI-01	5/25/2010 13:00	C 139	8.76	250	1.4	124.16	4.84
Whitetail Deer Creek (East Fork Whitetail) u/s of fence and road crossing	EWHI-01	9/8/2010 8:00	C 200	5.18	70	< 0.5	197.31	7.69
Whitetail Deer Creek (East Fork Whitetail) u/s of fence and road crossing	EWHI-01	6/10/2011 13:10	C 92	250	150	1	73.42	2.86
Whitetail Deer Creek (East Fork Whitetail) u/s of fence and road crossing	EWHI-01	9/8/2011 14:10	C 215	2.6	< 30	< 0.5	216.33	8.43
Whitetail Deer Creek at Whitetail Road Crossing	JWCWHTL04	8/11/2004 11:45	–	1.6	–	–	–	–
Whitetail Deer Creek upstream of I-90	WHIT-02	5/24/2010 10:40	C 117	26.88	110	1.9	99.71	3.89
Whitetail Deer Creek upstream of I-90	WHIT-02	8/31/2010 10:15	C 151	16.28	140	1.5	137.96	5.38
Whitetail Deer Creek upstream of I-90	WHIT-02	6/10/2011 14:00	C 66	E 750	130	1.9	48.11	1.87
Whitetail Deer Creek upstream of I-90	WHIT-02	9/8/2011 14:40	C 171	E 8.2	< 30	< 0.5	161.63	6.30
Whitetail Deer Creek abt 1/4 mile upstream of Whitehall	M08WHTDC04	6/9/2004 17:15	206	0.46	< 100	< 0.5	204.87	7.98
Whitetail Deer Creek abt 1/4 mile upstream of Whitehall	M08WHTDC04	10/3/2012 15:00	C 222	4.85	< 30	< 0.5	225.34	8.78

Table B-3. Whitetail Deer Creek Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	Al (µg/L)	Pb (µg/L)	AAL Pb (µg/l)	CAL Pb (µg/l)
Whitetail Deer Creek abt 1/4 mile upstream of Whitehall	M08WHTDC04	5/9/2013 12:15	C 170	5.92	< 9	0.5	160.43	6.25
Whitetail Deer Creek at Hwy 2 crossing	JWCWHTL03	6/16/2004 9:53	–	1.71	–	–	–	–
Whitetail Deer Creek at Hwy 2 crossing	JWCWHTL03	7/13/2004 8:30	–	2.8	–	–	–	–
Whitetail Deer Creek at Hwy 2 crossing	JWCWHTL03	9/10/2004 9:20	–	1.9	–	–	–	–
Whitetail Deer Creek about 100 ft downstream Hwy 69 crossing	M08WHTDC03	5/9/2013 11:00	C 180	5.8	< 9	0.5	172.54	6.72
Whitetail Deer Creek about 500 ft downstream of railroad crossing	WHIT-01	5/24/2010 14:40	C 118	29.18	110	1.9	100.79	3.93
Whitetail Deer Creek about 500 ft downstream of railroad crossing	WHIT-01	8/31/2010 13:00	C 91	18.93	130	0.9	72.41	2.82
Whitetail Deer Creek about 500 ft downstream of railroad crossing	WHIT-01	6/10/2011 14:10	C 72	E 750	150	2.4	53.74	2.09
Whitetail Deer Creek about 500 ft downstream of railroad crossing	WHIT-01	9/8/2011 15:10	C 163	5.6	< 30	< 0.5	152.07	5.93
Whitetail Deer Creek downstream of Hwy 69 about 3/4 mile	M08WHTDC05	5/20/2009 14:49	–	12.1	–	–	–	–
Whitetail Deer Creek downstream of Hwy 69 about 3/4 mile	M08WHTDC05	5/20/2009 14:49	–	C 8.35	–	–	–	–
Whitetail Deer Creek downstream of Hwy 69 about 3/4 mile	M08WHTDC05	5/21/2009 15:15	–	12.62	–	–	–	–
Whitetail Deer Creek downstream of Hwy 69 about 3/4 mile	M08WHTDC05	7/27/2009 17:15	–	13.79	–	–	–	–
Whitetail Deer Creek downstream of Hwy 69 about 3/4 mile	M08WHTDC05	9/24/2009 9:15	–	9.69	–	–	–	–
Whitetail Deer Creek downstream of Hwy 69 about 3/4 mile	M08WHTDC05	10/8/2009 13:10	–	8.88	–	–	–	–
Whitetail Deer Creek downstream of Hwy 69 about 3/4 mile	M08WHTDC05	10/2/2012 12:30	C 230	4.85	< 30	1.1	235.73	9.19

Table B-3. Whitetail Deer Creek Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	Al (µg/L)	Pb (µg/L)	AAL Pb (µg/l)	CAL Pb (µg/l)
Whitetail Deer Creek above confluence with Jefferson Slough	JWCWHTL02	5/18/2004 10:24	–	5.8	–	–	–	–
Whitetail Deer Creek 200 yards upstream center-pivot	M08WHTDC02	6/4/2010 12:29	–	88.89	–	–	–	–
Whitetail Deer Creek 200 yards upstream center-pivot	M08WHTDC02	6/8/2010 16:10	–	73.23	–	–	–	–
Whitetail Deer Creek 200 yards upstream center-pivot	M08WHTDC02	7/14/2010 12:15	–	12.59	–	–	–	–
Whitetail Deer Creek 200 yards upstream center-pivot	M08WHTDC02	10/10/2010 13:40	–	10.61	–	–	–	–

Table B-4. Big Pipestone Creek Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	As (µg/L)
Big Pipestone Creek at Division Street crossing	M08BGPSC04	10/1/2012 16:00	C 237	1.89	8.59	5
Big Pipestone Creek at Division Street crossing	M08BGPSC04	5/9/2013 8:15	C 164	1.02	8.19	4
Big Pipestone Creek about 70 yards downstream of WWTP	M08BGPSC03	5/9/2013 10:00	C 247	0.41	7.81	11

Table B-5. Jefferson Slough Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	As (µg/L)	Cd (µg/L)	AAL Cd (µg/l)	CAL Cd (µg/l)	Cu (µg/L)	AAL Cu (µg/l)	CAL Cu (µg/l)	AAL Zn (µg/l)	Zn (µg/L)
Jefferson Slough ab mouth	SLOU01	6/10/2011 14:40	80	1000	–	–	1.70	0.23	7	11.34	7.71	99.18	–
Jefferson Slough ab mouth	SLOU01	9/8/2011 15:40	215	30.9	–	–	4.64	0.48	2	28.80	17.94	229.19	–
Jefferson Slough downstream from Whitetail Creek	M08JEFFS05	10/3/2012 8:30	258	21.75	5	< 0.08	5.59	0.55	1	34.19	20.97	267.47	< 10
Jefferson Slough downstream from Whitetail Deer Creek	M08JEFFS05	5/9/2013 13:30	170	37.2	5	0.04	3.66	0.40	2	23.08	14.68	187.83	< 8
Jefferson Slough at Tebay Lane crossing	M08JEFFS06	5/9/2013 14:45	184	26.28	5	< 0.03	3.96	0.43	2	24.87	15.71	200.86	< 8

Table B-5. Jefferson Slough Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	As (µg/L)	Cd (µg/L)	AAL Cd (µg/l)	CAL Cd (µg/l)	Cu (µg/L)	AAL Cu (µg/l)	CAL Cu (µg/l)	AAL Zn (µg/l)	Zn (µg/L)
Jefferson Slough upstream Boulder River, upstream Hwy 2	JEFS-01	5/24/2010 16:30	170	190	6	< 0.08	3.66	0.40	4	23.08	14.68	187.83	< 10
Jefferson Slough upstream Boulder River, upstream Hwy 2	JEFS-01	8/30/2010 10:00	203	34.47	5	< 0.08	4.38	0.46	1	27.28	17.08	218.30	< 10
Jefferson Slough upstream Boulder River, upstream Hwy 2	JEFS-01	6/10/2011 15:00	91	1000	–	–	1.94	0.25	7	12.81	8.61	110.61	–
Jefferson Slough upstream Boulder River, upstream Hwy 2	JEFS-01	9/8/2011 16:40	229	36.3	–	–	4.95	0.50	2	30.56	18.94	241.77	–
Jefferson Slough upstream Boulder River at Hwy 359 crossing	M08JEFFS04	10/1/2012 18:30	260	11.82	5	< 0.08	5.63	0.55	1	34.44	21.11	269.23	< 10
Jefferson Slough upstream Boulder River at Hwy 359 crossing	M08JEFFS04	5/9/2013 16:00	213	25.14	5	< 0.03	4.60	0.47	1	28.54	17.80	227.38	< 8
Jefferson Slough at mouth (Jefferson River)	M08JEFFS03	6/1/2010 10:10	73	1276	13	0.48	1.55	0.21	31	10.41	7.13	91.77	100
Jefferson Slough at mouth (Jefferson River)	M08JEFFS03	8/1/2010 11:54	148	142.97	11	0.13	3.18	0.36	8	20.25	13.04	167.02	20
Jefferson Slough at mouth (Jefferson River)	M08JEFFS03	9/2/2010 11:05	164	140.14	7	< 0.08	3.53	0.39	4	22.31	14.24	182.20	< 10

Table B-6. Upper Jefferson River Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Fe (µg/L)	Pb (µg/L)	AAL Pb (µg/l)	CAL Pb (µg/l)
USGS Gage 06026500 - Jefferson River near Twin Bridges	JEFF-08	6/9/2011 12:30	C 71	7190	7.8	–	2.8	52.79	2.06
USGS Gage 06026500 - Jefferson River near Twin Bridges	JEFF-08	9/7/2011 16:30	C 234	1270	8.08	–	0.25	240.96	9.39

Table B-6. Upper Jefferson River Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Fe (µg/L)	Pb (µg/L)	AAL Pb (µg/l)	CAL Pb (µg/l)
Jefferson River about 100 yds downstream from USGS gaging station	M08JEFFR30	10/1/2012 14:00	C 245	E 690	8.57	220	0.25	255.47	9.96
Jefferson River about 100 yds downstream from USGS gaging station	M08JEFFR30	5/8/2013 11:30	C 109	E 860	8.46	440	0.4	91.11	3.55
Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	4/20/2004	125	E 1085	8.4	–	1	108.47	4.23
Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	5/18/2004	120	E 1190	8.3	–	1	102.97	4.01
Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	6/16/2004	121	E 1385	8.4	–	0.01	104.07	4.06
Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	7/13/2004	155	E 885	8.9	–	1	142.63	5.56
Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	8/11/2004	226	E 361	8.8	–	0.01	230.52	8.98
Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	6/8/2006 13:10	–	–	8.48	–	0.9	–	–
Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	9/21/2006 14:20	–	–	8.62	–	0.5	–	–
Jefferson River between USGS gage and Hells Canyon fishing access	JEFF-07	6/1/2010 15:00	126	–	8.05	970	1	109.57	4.27
Jefferson River between USGS gage and Hells Canyon fishing access	JEFF-07	8/30/2010 15:00	247	–	8.31	560	0.6	258.13	10.06
Jefferson River downstream Parson's Bridge fishing access, at USGS gage	JEFF-06	6/1/2010 18:30	C 135	2740	8.01	1050	1.1	119.63	4.66
Jefferson River downstream Parson's Bridge fishing access, at USGS gage	JEFF-06	9/7/2010 13:15	C 244	993	8.4	210	0.5	254.14	9.90
Jefferson River downstream Parson's Bridge fishing access, at USGS gage	JEFF-06	6/9/2011 14:20	C 83	10700	7.35	–	2.6	64.40	2.51
Jefferson River downstream Parson's Bridge fishing access, at USGS gage	JEFF-06	9/7/2011 17:10	C 229	1070	8.28	–	0.25	234.42	9.14
Jefferson River at Mayflower fishing access	JWCJEFF03	4/20/2004	126	E 1100	8.4	–	2	109.57	4.27
Jefferson River at Mayflower fishing access	JWCJEFF03	5/18/2004	150	E 655	8.1	–	1	136.80	5.33
Jefferson River at Mayflower fishing access	JWCJEFF03	6/16/2004	135	E 1690	8.1	–	0.01	119.63	4.66
Jefferson River at Mayflower fishing access	JWCJEFF03	7/13/2004	168	E 815	8.4	–	2	158.03	6.16

Table B-6. Upper Jefferson River Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Fe (µg/L)	Pb (µg/L)	AAL Pb (µg/l)	CAL Pb (µg/l)
Jefferson River at Mayflower fishing access	JWCJEFF03	8/11/2004	204	E 200	8		0.01	202.34	7.89
Jefferson River at Mayflower fishing access	JWCJEFF03	6/7/2006 15:00	–	–	8.72	–	0.6	–	–
Jefferson River at Mayflower fishing access	JWCJEFF03	9/21/2006 15:00	–	–	8.7	–	0.5	–	–
Jefferson River at Mayflower fishing access	JWCJEFF03	5/24/2010 17:20	133	–	8.37	660	0.6	117.38	4.57
Jefferson River at Mayflower fishing access	JWCJEFF03	8/30/2010 11:30	234	–	8.17	170	0.25	240.96	9.39
Jefferson River below Pipestone Creek	JEFF-05	6/9/2011 14:50	C 89	E 11400	7.51	–	3.1	70.39	2.74
Jefferson River below Pipestone Creek	JEFF-05	9/7/2011 18:00	C 231	E 1227	8.12	–	0.25	237.03	9.24

Table B-7. Lower Jefferson River Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Cu (µg/L)	CAL Cu (µg/l)	Pb (µg/L)	CAL Pb (µg/l)
Jefferson River just upstream South Boulder River	M08JEFFR41	10/3/2012 10:30	C 239	E 826	8.27	1	19.64	< 0.5	9.65
Jefferson River just upstream South Boulder River	M08JEFFR41	5/8/2013 16:00	C 151	E 570	8.47	2	13.27	0.5	5.38
Jefferson River just upstream of SF Boulder River confluence	JEFF-04	5/24/2010 13:30	C 119	–	8.07	10	10.82	3.3	3.97
Jefferson River just upstream of SF Boulder River confluence	JEFF-04	8/29/2010 15:30	C 220	–	8.34	1	18.30	< 0.5	8.68
Jefferson River just upstream of SF Boulder River confluence	JEFF-04	6/9/2011 15:10	C 80	E 13470	7.62	25	7.71	11.6	2.39
Jefferson River just upstream of SF Boulder River confluence	JEFF-04	9/7/2011 18:15	C 226	E 1257	8.41	1	18.72	< 0.5	8.98
Jefferson River at Sheep Gulch, downstream South Boulder River	JEFF-03	5/27/2010 8:45	C 129	–	8.01	7	11.60	2.1	4.40
Jefferson River at Sheep Gulch, downstream South Boulder River	JEFF-03	8/29/2010 14:00	C 213	–	8.35	1	17.80	< 0.5	8.33

Table B-7. Lower Jefferson River Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Cu (µg/L)	CAL Cu (µg/l)	Pb (µg/L)	CAL Pb (µg/l)
Jefferson River at Sheep Gulch, downstream South Boulder River	JEFF-03	6/9/2011 15:20	C 80	13670	7.56	21	7.71	9.6	2.39
Jefferson River at Sheep Gulch, downstream South Boulder River	JEFF-03	9/7/2011 18:30	C 231	E 1265	8.46	1	19.08	< 0.5	9.24
Jefferson River about 2 miles below South Boulder River	M08JEFFR40	10/2/2012 18:30	C 243	677	8.44	1	19.92	< 0.5	9.85
Jefferson River about 2 miles below South Boulder River	M08JEFFR40	5/8/2013 17:30	C 152	E 477	8.51	2	13.34	0.5	5.42
Jefferson River at Sappington fishing access	JWCJEFF02	4/20/2004	132	E 1175	8.4	2	11.83	2	4.53
Jefferson River at Sappington fishing access	JWCJEFF02	5/18/2004	146	E 730	8.3	4	12.89	2	5.15
Jefferson River at Sappington fishing access	JWCJEFF02	6/16/2004	132	E 1900	8	3	11.83	< 0.02	4.53
Jefferson River at Sappington fishing access	JWCJEFF02	7/13/2004	165	E 853	8.4	1	14.31	2	6.02
Jefferson River at Sappington fishing access	JWCJEFF02	8/11/2004	205	E 200	7.9	2	17.23	< 0.02	7.93
Jefferson River at Sappington fishing access	JWCJEFF02	8/11/2004 8:00	–	–	8.41	–	–	–	–
Jefferson River at Sappington fishing access	JWCJEFF02	6/7/2006 14:00	–	–	8.67	3	–	0.8	–
Jefferson River at Sappington fishing access	JWCJEFF02	9/21/2006 15:30	–	–		1	–	0.5	–
Jefferson River downstream Willow Creek	M08JEFFR39	10/2/2012 16:00	C 235	E 669	8.49	1	19.36	< 0.5	9.44
Jefferson River downstream Willow Creek	M08JEFFR39	5/8/2013 19:15	155	–	8.57	2	13.57	0.5	5.56
Jefferson River downstream Willow Creek	JEFF-02	5/27/2010 11:00	129	–	8.07	8	11.60	2.5	4.40
Jefferson River downstream Willow Creek	JEFF-02	8/29/2010 11:00	201	–	8.28	2	16.94	0.7	7.74
Jefferson River downstream Willow Creek	JEFF-02	6/9/2011 15:50	83	14000	7.68	23	7.96	11.6	2.51
Jefferson River downstream Willow Creek	JEFF-02	9/7/2011 19:00	C 223	1280	8.29	1	18.51	< 0.5	8.83
Jefferson River near Three Forks, 400 yards above bridge	M08JEFFR01	8/1/2003 9:30	–	150	7.85	–	–	–	–
Jefferson River near Three Forks, 400 yards above bridge	M08JEFFR01	7/30/2004 11:00	164.33	E 200	7.86	1	14.26	< 1	5.99
Jefferson River near Three Forks, 400 yards above bridge	M08JEFFR01	8/5/2005 12:30	182	325	8.1	0.5	15.56	< 0.5	6.82
Jefferson River near Three Forks, 400 yards above bridge	M08JEFFR01	10/2/2012 15:20	C 241	E 669	8.54	2	19.78	0.6	9.75
Jefferson River near Three Forks, 400 yards above bridge	M08JEFFR01	5/8/2013 19:45	157	E 570	8.54	2	13.72	0.4	5.65
Jefferson River at Three Forks USGS gage	JWCJEFF01	4/20/2004	139	E 1205	8.2	2	12.36	2	4.84
Jefferson River at Three Forks USGS gage	JWCJEFF01	5/18/2004	152	E 735	8.2	4	13.34	2	5.42

Table B-7. Lower Jefferson River Water Quality Data used in TMDL Calculations

Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Cu (µg/L)	CAL Cu (µg/l)	Pb (µg/L)	CAL Pb (µg/l)
Jefferson River at Three Forks USGS gage	JWCJEFF01	6/16/2004	135	E 1890	7.9	4	12.06	< 0.02	4.66
Jefferson River at Three Forks USGS gage	JWCJEFF01	7/13/2004	164	E 853	8.1	1	14.24	8	5.97
Jefferson River at Three Forks USGS gage	JWCJEFF01	8/11/2004	207	E 206	7.9	3	17.37	< 0.02	8.03
Jefferson River downstream of Hwy 2 and at USGS gage	JEFF-01	5/27/2010 11:30	C 131	2330	8.15	8	11.75	2.5	4.49
Jefferson River downstream of Hwy 2 and at USGS gage	JEFF-01	8/29/2010 10:00	C 197	853	8.19	2	16.65	< 0.5	7.54
Jefferson River downstream of Hwy 2 and at USGS gage	JEFF-01	6/9/2011 16:00	C 83	14000	7.48	22	7.96	11.4	2.51
Jefferson River downstream of Hwy 2 and at USGS gage	JEFF-01	9/7/2011 19:30	C 217	1280	8.41	1	18.09	< 0.5	8.53
Jefferson River near Three Forks MT	6036650	5/20/2003 12:30	88.8	2620	8.4	5.9	8.43	1.51	2.74
Jefferson River near Three Forks MT	6036650	7/29/2003 13:00	177	290	8.6	1.5	15.20	0.08	6.58

APPENDIX C –SEDIMENT METALS DATA, JEFFERSON RIVER TMDL PROJECT AREA

This appendix contains one data table. **Table C-1** contains stream channel sediment metals concentration data.

Table C-1. Stream Channel Sediment Metals Concentration Data for the Jefferson River TMDL Project Area

Org ID	Station (Site) Name	Site ID	Activity Date	A (ug/g)	As (ug/g)	Cd (ug/g)	Cu (ug/g)	Fe (ug/g)	Pb (ug/g)	Ag (ug/g)	Zn (ug/g)
DEQ	Jefferson River at Three Forks USGS gage	JWCJEFF01	7/9/2004				42.5		23.6		
DEQ	Jefferson River at Sappington fishing access	JWCJEFF02	7/9/2004				56.3		29.6		
DEQ	Jefferson River near Three Forks, 400 yards above bridge	M08JEFFR01	7/12/2001	8120	6	1	32	11000	19	< 5	140
DEQ	Jefferson River at Mayflower fishing access	JWCJEFF03	7/9/2004				25		20.3		
DEQ	Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	7/9/2004				18.7		17.3		
DEQ	Jefferson Slough at mouth (Jefferson River)	M08JEFFS03	8/1/2010		54	8.3	294	34000	130		1440
DEQ	Whitetail Deer Creek about 1/4 mile upstream of Whitehall	M08WHTDC04	6/9/2004		8.1	0.84	18.8	24700	20.6	< 1	49
DEQ	Little Whitetail Creek 4 miles below Whitetail Reservoir	M08LWHTC01	6/9/2004		14.5	1.26	33.3	22600	44.1	< 1	51

APPENDIX D –SURFACE WATER METALS DATA, BIG HOLE, RUBY AND BEAVERHEAD RIVERS

Table D-1 contains surface water flow and water column metals concentration data for stream sampling locations upstream of the upper segment of the Jefferson River.

Table D-1. Surface Water Quality Data for the Big Hole, Ruby and Beaverhead Rivers

FLOW	Station Name	Station ID	Activity Date	Hardness mgL	Flow cfs	Cu (ug/L)	Fe (ug/L)	Pb (ug/L)
	Big Hole River near Twin Bridges	M03BGHLR02	5/8/2013 10:45	58	504	1	490	0.4
	Big Hole River at High Road FAS	ML05LWBH02	5/16/2006 10:30	39.4	2860	2	730	<0.5
	Big Hole River at High Road FAS	ML05LWBH02	6/4/2005 11:45	51.354	2670	3	680	<1
	Big Hole River at High Road FAS	ML05LWBH02	6/9/2011 12:00	42	9880	6		4.9
	Big Hole River downstream of Melrose Bunch Road at USGS gage	BIGH-01	6/1/2010 13:40	52	2120	2	640	0.6
				Average	*3606.8*			
HIGH FLOW	Ruby River at USGS gauge station near Twin Bridges	RBYR3	9/1/2010 11:15	302	348	2	750	0.8
	Ruby River at USGS gauge station near Twin Bridges	RBYR3	6/11/2003 10:15			4	1460	<2
	Ruby River at USGS gauge station near Twin Bridges	RBYR3	6/30/2003 13:20			2	380	<2
	Ruby River at USGS gauge station near Twin Bridges	RBYR3	6/9/2011 10:50	245	1200	5		2.2
	Ruby River at USGS gauge station near Twin Bridges	RBYR3	6/1/2010 12:45	311	322	7	3850	3.8
				Average	*623.3*			
HIGH FLOW	Beaverhead River near Mooney Ranch	BVD-BVHR-3	6/3/2009 13:50			0.8	290	0.3
	Beaverhead River at Road 17 crossing	BVD-BVHR-5	6/4/2009 13:00	225	5805.1	2	830	1.1
	Beaverhead River upstream of I-15 crossing	BVD-BVHR-4	6/4/2009 16:00	223	261	2	1000	1
	Beaverhead River at road crossing u/s of Selway Slough	BVD-BVHR-6	6/4/2009 16:55	242		1.8	980	0.9
	Beaverhead River at Silver Bow Road crossing	BVD-BVHR-8	6/11/2009 18:45	315		1.9	140	0.2
	Beaverhead River at Hwy 41 crossing at USGS gage	BEAV-01	6/1/2010 12:00	309	401	2	710	0.8
	Beaverhead River at Hwy 41 crossing at USGS gage	BEAV-01	6/9/2011 11:30	280	660	5		3.6
	Beaverhead River at USGS gage at Hwy 41 crossing	M02BVHDR03	5/8/2013 10:00	356	76	<1	160	<0.3
				Average	*1440.62*			

Note: “<” This value indicates a non-detect sample. The detection limit is populated as the value

APPENDIX E – WATER QUALITY DATA FROM SOUTH BOULDER RIVER

Table E-1 contains surface water flow and water column metals concentration data for stream sampling locations on the South Boulder River.

Table E-1. Surface Water Quality Data for South Boulder River

Org ID	Station (Site) Name	Site ID	Activity Date	Hardness (mg/L)	Flow (cfs)	pH	Al (ug/L)	As (ug/L)	Cd (ug/L)	Cu (ug/L)	Fe (ug/L)	Pb (ug/L)	Zn (ug/L)
MTWTRSHD_ WQX	Boulder River South Fork about 100 ft upstream of mouth	SFBD-01	5/24/2010	C 116	28.94	8.23		< 3	< .08	4	490	0.5	< 10
MTWTRSHD_ WQX	Boulder River South Fork about 100 ft upstream of mouth	SFBD-01	8/30/2010	C 196	16.87	7.98		< 3	< .08	2	170	< .5	< 10
MTWTRSHD_ WQX	Boulder River South Fork about 100 ft upstream of mouth	SFBD-01	6/13/2011	C 55	200	7.51		< 3		6		0.7	
MTWTRSHD_ WQX	Boulder River South Fork about 100 ft upstream of mouth	SFBD-01	9/9/2011	C 200	8.15	6.83		< 3		1		< .5	
MDEQ_WQ_ WQX	Boulder River South Fork near mouth	M08BDSFR01	10/3/2012	C 294	1.94	8.08		< 3	< .08	2	< 50	< .5	< 10
MDEQ_WQ_ WQX	Boulder River South Fork near mouth	M08BDSFR01	5/8/2013	C 196	4.18	8.72		2	0.05	2	60	< .3	< 8

APPENDIX F – JEFFERSON SLOUGH EXAMPLE TMDL AND ALLOCATION CALCULATIONS

This appendix contains 4 sets of example TMDL calculations for the Jefferson Slough. Example TMDLs have been calculated for arsenic, cadmium, copper and zinc. cf= Conversion factor of 0.0054

Arsenic
TMDL: (3700 cfs)(10.0 ug/l)(cf) = 199.8
LA (WDC) = (750 cfs)(6.4 ug/l)(cf) = 25.92
LA (BP) = (200 cfs)(10 ug/l)(cf) = 10.8
LA Combined = 36.72
LA (Bldr Rvr) = (2700 cfs)(10 ug/l)(cf) = 145.8
WLA (strmwtr) = 0.21
WLA (HS & NB) = 199.8 - ((0.21 + 36.72 + 145.8) + (14.37)) = 2.7
MOS = (750 cfs)(10 – 6.4 ug/l)(cf) – 0.21 =14.37

Cadmium
TMDL: (3700 cfs)(0.21 ug/l)(cf) = 4.196
LA (BPC + WDC) = (950 cfs)(0.05 ug/l)(cf) = 0.256
LA (Bldr Rvr) = (2700 cfs)(0.19 ug/l)(cf) = 2.77
WLA (strmwtr) = 0.0101
WLA (HS & NB) = 4.196 - ((0.256 + 2.77 + 0.010) + (1.102)) = 0.058
MOS (upper) = (950 cfs)(0.21 – 0.05 ug/l)(cf) – 0.0101 = 0.81
MOS (lower) = (2700 cfs)(0.21 – 0.19 ug/l)(cf) = 0.292
MOS combined = 0.81 + 0.292 = 1.102

Copper
TMDL: (3700 cfs)(7.13 ug/l)(cf) = 142.457
LA (BPC + WDC) = (950 cfs)(4.3 ug/l)(cf) = 22.059
LA (Bldr Rvr) = (2700 cfs)(6.11 ug/l)(cf) = 89.084
WLA (strmwtr) = 0.552
WLA (HS & NB) = 142.457 - ((22.059 + 89.084 + 0.552) + (26.83)) = 3.932
MOS (upper) = (950 cfs)(7.13 – 4.8 ug/l)(cf) – 0.552 = 11.95
MOS (lower) = (2700 cfs)(7.13 – 6.11 ug/l)(cf) = 14.872
MOS combined = 26.83

Zinc
TMDL: (3700 cfs)(91.77 ug/l)(cf) = 1,833.564
LA (BPC + WDC) = (950 cfs)(5.0 ug/l)(cf) = 25.650
LA (Bldr Rvr) = (2700 cfs)(78.82 ug/l)(cf) = 1,149.196
WLA (strmwtr) = 0.606
WLA (HS & NB) = 1,833.564 – ((25.650 + 1,149.196 + 0.606) + (633.33))= 24.782
MOS (upper) = (950 cfs)(91.77 – 5.0 ug/l)(cf) – 0.606 = 444.524
MOS (lower) = (2700 cfs)(91.77 – 78.82 ug/l)(cf) = 188.811
MOS combined = 633.335

APPENDIX G – GOLDEN SUNLIGHT MINE STORMWATER DATA

This appendix contains stormwater data collected by Golden Sunlight mine and submitted to DEQ via discharge monitoring reports (DMRs) associated with their general permit to discharge stormwater runoff (MTR300199). The data presented are from outfall 002, which has the largest and most consistent dataset of the permitted outfalls. This is important because of the intermittent nature of stormwater discharge. Maximum loads are presented in units of pounds per day, and are calculated by multiplying the highest effluent concentration for each metal (**bolded**) by the highest reported discharge (and a conversion factor of 0.0054).

Parameter	Reported value (mg/L)	Value in µg/L	Monitoring period start date	Monitoring period end date	Maximum Load
Copper, total recoverable	.073	73	7/1/2008	12/31/2008	0.552 lbs/day
	.032	32	1/1/2009	06/30/2009	
	.068	68	7/1/2009	12/31/2009	
	.31	310	1/1/2010	06/30/2010	
	.014	14	7/1/2010	12/31/2010	
	.17	170	1/1/2011	06/30/2011	
	.009	9	7/1/2011	12/31/2011	
	.13	130	1/1/2012	06/30/2012	
	.047	47	7/1/2012	12/31/2012	
Zinc, total recoverable	.01	10	7/1/2010	12/31/2010	0.606 lbs/day
	.01	10	7/1/2011	12/31/2011	
	.02	10	1/1/2009	06/30/2009	
	.03	30	7/1/2012	12/31/2012	
	.06	60	7/1/2008	12/31/2008	
	.078	78	7/1/2009	12/31/2009	
	.11	110	1/1/2012	06/30/2012	
	.21	210	1/1/2011	06/30/2011	
	.34	340	1/1/2010	06/30/2010	
Arsenic, total recoverable	.008	8	7/1/2007	12/31/2007	0.2156 lbs/day
	.013	13	7/1/2006	12/31/2006	
	.018	18	1/1/2006	06/30/2006	
	.028	28	1/1/2004	06/30/2004	
	.029	29	1/1/2008	06/30/2008	
	.06	60	1/1/2007	06/30/2007	
	.11	110	1/1/2005	06/30/2005	
	.115	115	7/1/2004	12/31/2004	
	.121	121	7/1/2005	12/31/2005	

Parameter	Reported value (mg/L)	Value in µg/L	Monitoring period start date	Monitoring period end date	Maximum Load
Cadmium, total recoverable	.0003	.3	7/1/2006	12/31/2006	0.0101 lbs/day
	.0004	.4	1/1/2006	06/30/2006	
	.0008	.8	1/1/2008	06/30/2008	
	.0013	1.3	7/1/2007	12/31/2007	
	.003	3	1/1/2007	06/30/2007	
	.0037	3.7	1/1/2005	06/30/2005	
	.0056	5.6	7/1/2004	12/31/2004	
	.0057	5.7	7/1/2005	12/31/2005	
Parameter	**Reported value (gpm)**	**Flow in cfs**	**Monitoring period start date**	**Monitoring period end date**	**Maximum Flow**
Flow rate	40.	0.088	1/1/2011	06/30/2011	0.33 cfs
	100.	0.22	7/1/2008	12/31/2008	
	150.	**0.33**	1/1/2009	06/30/2009	
	100.	0.22	7/1/2009	12/31/2009	
	150.	**0.33**	1/1/2010	06/30/2010	
	150.	**0.33**	7/1/2010	12/31/2010	
	60.	0.132	7/1/2011	12/31/2011	
	60.	0.132	1/1/2012	06/30/2012	
	80	0.176	7/1/2012	12/31/2012	

APPENDIX H – CLEANUP/RESTORATION AND FUNDING OPTIONS FOR MINE OPERATIONS OR OTHER SOURCES OF METALS CONTAMINATION

TABLE OF CONTENTS

There are several approaches for cleanup of mining operations or other sources of metals contamination in the state of Montana. Most of these are discussed below, with focus on abandoned or closed mining operations.

H1.0 THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA)

CERCLA is a federal law that addresses cleanup on sites, such as historic mining areas, where there has been a hazardous substance release or threat of release. Sites are prioritized on the National Priority List (NPL) using a hazard ranking system with significant focus on human health. Petroleum related products and associated raw materials are not covered under CERCLA. Other federal regulations such as Resource Conservation and Recovery Act and associated Leaking Underground Storage Tank cleanup requirements tend to address petroleum.

Under CERCLA, the potentially responsible party or parties must pay for all remediation efforts based upon the application of a strict joint and several liability approach whereby any existing or historical land owner can be held liable for restoration costs. Where viable landowners are not available to fund cleanup, funding can be provided under Superfund authority. Federal agencies can be delegated Superfund authority, but cannot access funding from Superfund.

Cleanup actions under CERCLA must be based on professionally developed plans and can be categorized as either Removal or Remedial. Removal actions can be used to address the immediate need to stabilize or remove a threat where an emergency exists. Once removal activities are completed, a site can then undergo Remedial Actions or may end up being scored low enough from a risk perspective that it no longer qualifies to be on the NPL for Remedial Action. Under these conditions the site is released back to the state for a "no further action" determination. At this point there may still be a need for additional cleanup since there may still be significant environmental threats or impacts, although the threats or impacts are not significant enough to justify Remedial Action under CERCLA. Any remaining threats or impacts would tend to be associated with wildlife, aquatic life, or aesthetic impacts to the environment or aesthetic impacts to drinking water supplies versus threats or impacts to human health. A site could, therefore, still be a concern from a water quality restoration perspective, even after CERCLA removal activities have been completed.

Remedial actions may or may not be associated with, or subsequent to, removal activities. A remedial action involves cleanup efforts whereby Applicable or Relevant and Appropriate Requirements and Standards (ARARS), which include state water quality standards, are satisfied. Once ARARS are satisfied, then a site can receive a "no further action" determination.

H2.0 The Montana Comprehensive Cleanup and Restoration Act (CECRA)

The 1985 Montana Legislature passed the Environmental Quality Protection Fund Act. This Act created a legal mechanism for the Department of Environmental Quality (Department, DEQ) to investigate and clean up, or require liable persons to investigate and clean up, hazardous or deleterious substance facilities in Montana. The 1985 Act also established the Environmental Quality Protection Fund (EQPF). The EQPF is a revolving fund in which all penalties and costs recovered pursuant to the EQPF Act are deposited. The EQPF can be used only to fund activities relating to the release of a hazardous or deleterious substance. Although the 1985 Act established the EQPF, it did not provide a funding mechanism for the Department to administer the Act. Therefore, no activities were conducted under this Act until 1987.

The 1987 Montana Legislature passed a bill creating a delayed funding mechanism that appropriated 4 percent of the Resource Indemnity Trust (RIT) interest money for Department activities at non-National Priority List facilities beginning in July 1989 (§ 15-38-202 MCA). In October 1987, the Department began addressing state Superfund facilities. Temporary grant funding was used between 1987 and 1989 to clean up two facilities and rank approximately 250 other facilities. Beginning in fiscal year 1995, the 4 percent allocation was changed to 6 percent to adjust for other legislative changes in RIT allocations. Effective July 1, 1999, the 6 percent allocation was increased to 9 percent.

The 1989 Montana Legislature significantly amended the Act, changing its name to the Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA) (§75-10-75 MCA) and providing the Department with similar authorities as provided under the federal Superfund Act (CERCLA) (U.S. Environmental Protection Agency, 2011). With the passage of CECRA, the state Superfund program became the CECRA Program. Major revisions to CECRA did not occur until the 1995 Legislature, when the Voluntary Cleanup and Redevelopment Act (VCRA) (§75-10-730 MCA), a mixed-funding pilot program, and a requirement to conduct a collaborative study on alternative liability schemes were added and provisions related to remedy selection were changed. Based on the results of the collaborative study, the 1997 Legislature adopted the Controlled Allocation of Liability Act, which provides a voluntary process for the apportionment of liability at CECRA facilities and establishes an orphan share fund. Minor revisions to CECRA were also made by the 1999 and 2001 Legislatures.

As of June 20, 2013, there were 208 facilities on the CECRA Priority List (Montana Department of Environmental Quality, 2011a). CECRA facilities are ranked maximum, high, medium, low and operation and maintenance priority based on the severity of contamination at the facility and the actual and potential impacts of contamination to public health, safety, and welfare and the environment. The Department maintains database narratives that explain contamination problems and status of work at each state Superfund facility.

H2.1 The Controlled Allocation of Liability Act (CALA)

The Montana Legislature added the Controlled Allocation of Liability Act (CALA; §§ 75-10-742 through 752, Montana Code Annotated (MCA)) to the Comprehensive Environmental Cleanup and Responsibility Act (CECRA; §§ 75-10-701 through 752, MCA), the state Superfund law, in 1997. The Department administers CALA, including the orphan share fund it establishes.

CALA (Montana Department of Environmental Quality, 2011b) is a voluntary process that allows Potentially Responsible Parties (PRP) to petition for an allocation of liability as an alternative to the strict, joint and several liability scheme included in CECRA. CALA provides a streamlined alternative to litigation that involves negotiations designed to allocate liability among persons involved at facilities requiring cleanup, including bankrupt or defunct persons. Cleanup of these facilities must occur concurrently with the CALA process and CALA provides the funding for the orphan share of the cleanup. Since CECRA cleanups typically involve historical contamination, liable persons often include entities that are bankrupt or defunct and not affiliated with any viable person by stock ownership. The share of cleanup costs for which these bankrupt or defunct persons are responsible is the orphan share. Department represents the interests of the orphan share throughout the CALA process.

The funding source known as the orphan share fund is a state special revenue fund created from a variety of sources. These include an allocation of 8.5 percent of the metal mines license tax, certain penalties and additional funds from the resource indemnity trust fund and 25 percent of the resource indemnity and groundwater assessment taxes (which will increase to 50 percent when the RIT reaches $100 million). The current balance of the Orphan Share Fund is around $4 million and revenues projected for the rest of this biennium are about $2 million.

In the absence of a demonstrated hardship, claims for orphan share reimbursement may not be submitted until the cleanup is complete. This ensures that facilities are fully remediated before reimbursement. The result is that a PRP could be expending costs it anticipates being reimbursed for some time before the PRP actually submits a claim.

CALA was designed to be a streamlined, voluntary allocation process. For facilities where a PRP does not initiate the CALA process, strict, joint and several liability remains. Any person who has been noticed as being potentially liable as well as any potentially liable person who has received approval of a voluntary cleanup plan can petition to initiate the CALA process. CALA includes fourteen factors to be considered in allocating liability. Based on these factors causation weighs heavily in allocation but is not the only factor considered.

H2.2 The Voluntary Cleanup and Redevelopment Act (VCRA)

The 1995 Montana Legislature amended the Comprehensive Environmental Cleanup and Responsibility Act (CECRA) (Section 75-10-705 MCA), creating the Voluntary Cleanup and Redevelopment Act (VCRA) (Sections 75-10-730 through 738, MCA). VCRA formalizes the voluntary cleanup process in the state. It specifies application requirements, voluntary cleanup plan requirements, agency review criteria and time frames, and conditions for and contents of no further action letters (Montana Department of Environmental Quality, 2012a).

The act was developed to permit and encourage voluntary cleanup of facilities where releases or threatened releases of hazardous or deleterious substances exist, by providing interested persons with a method of determining what the cleanup responsibilities will be for reuse or redevelopment of existing facilities. Any entity (such as facility owners, operators, or prospective purchasers) may submit an application for approval of a voluntary cleanup plan to the Department. Voluntary Cleanup Plans (VCPs) may be submitted for facilities whether or not they are on the CECRA Priority List (Montana Department of Environmental Quality, 2011a). The plan must include (1) an environmental assessment of the facility; (2) a remediation proposal; and (3) the written consent of current owners of the facility or property to both the implementation of the voluntary cleanup plan and access to the facility by the applicant and its agents and Department. The applicant is also required to reimburse the Department for any costs that the state incurs during the review and oversight of a voluntary cleanup effort.

The act offers several incentives to parties voluntarily performing facility cleanup. Any entity can apply and liability protection is provided to entities that would otherwise not be responsible for site cleanup. Cleanup can occur on an entire facility or a portion of a facility. The Department cannot take enforcement action against any party conducting an approved voluntary cleanup. The Department review process is streamlined: the Department has 30 to 60 days to determine if a voluntary cleanup plan is complete, depending on how long the cleanup will take. When the Department determines an application is complete, it must decide within 60 days whether to approve or disapprove of the application; these 60 days also includes a 30-day public comment period. The Department's decision is based on the proposed uses of the facility identified by the applicant and the applicant conducts any necessary risk evaluation. Once a plan has been successfully implemented and Department costs have been paid, the applicant can petition the Department for closure. The Department must determine whether closure conditions are met within 60 days of this petition and, if so, the Department will issue a closure letter for the facility or the portion of the facility addressed by the voluntary cleanup.

The act is contained in §§ 75-10-730 through 738, MCA. Major sections include: § 75-10-732 - eligibility requirements; § 75-10-733 and § 75-10-734 - environmental property assessment and remediation proposal requirements; § 75-10-735 - public participation; § 75-10-736 - timeframes and procedures for Department approval/disapproval; § 75-10-737 - voluntary action to preclude remedial action by DEQ; and § 75-10-738 - closure process. Section 75-10-721, MCA of CECRA must also be met.

The Department does not currently have a memorandum of agreement (MOA) with the Environmental Protection Agency (EPA) for its Voluntary Cleanup Program. However, the Department and EPA are in the process of negotiating one. EPA has indicated that Montana's Voluntary Cleanup Program includes the necessary elements to establish the MOA. Currently, EPA is reviewing the latest draft of the MOA.

The Department has produced a VCRA Application Guide (Montana Department of Environmental Quality, 2012a) to assist applicants in preparing a new application; this guide is not a regulation and adherence to it is not mandatory.

As of May 2014, the Department had 16 currently approved voluntary clean plans, including mining, manufactured gas, wood treating, dry cleaning, salvage, pesticide, fueling, refining, metal plating, defense, and automotive repair facilities (Montana Department of Environmental Quality, 2012b). Applicants have expressed interest and/or submitted applications for voluntary cleanup at fifteen other facilities. The Department maintains a registry of VCRA facilities.

H3.0 Abandoned Mine Lands Cleanup

The purpose of the Abandoned Mine Lands Reclamation (AML) Program is to protect human health and the environment from the effects of past mining and mineral processing activities. Funding for cleanup is via the Federal Abandoned Mine Fund, which is distributed to the state of Montana via a grant program. The Abandoned Mine Fund is generated by a per ton fee levied on coal producers and the annual grant it based on coal production. There are no collections or contributions to the Abandoned Mine Fund from mineral production beyond coal production fees. Expenditures under the abandoned mine program can only be made on “eligible” abandoned mine sites. For a site to be eligible, mining must have ceased prior to August 4, 1977 (private lands, other dates apply to federal lands). In addition, there must be no continuing reclamation responsibility under any state or federal law. No continuing reclamation responsibility can mean no mining bonds or permits have been issued for the site, however, it has also been interpreted to mean that there can be no viable responsible party under State or Federal laws such as CERCLA or CECRA. While lands eligible for the Abandoned Mine Funds include hard rock mines and gravel pits (collectively categorized as “non-coal”), abandoned coalmines have the highest priority for expenditures from the Fund. As part of the approved plan for Montana, abandoned coal mines are required to be prioritized and funded for reclamation ahead of eligible non-coal mine sites. . Cleanup of any eligible site is prioritized based primarily on human health, which can include health risks such as open shafts, versus risks only associated with hazardous substances, as is the case under CERCLA.

Montana's AML Program maintains an inventory of all potential cleanup sites, and also has a list of non-coal priority sites from which to work from. The Department conducts cleanups under the Abandoned Mine Funds as public works contracts utilizing professional engineers for design purposes and private construction contractors to perform the actual work.

Limited scoping and ranking of water pollution from discharging abandoned coal mines has been completed and Montana’s AML program is evaluating how to proceed with funding water treatment and stream quality restoration at the highest priority abandoned coal mine sites. In cases of non-coal cleanups, mitigating impacts associated with discharging adits can be included within the cleanup, although ongoing water treatment is not pursued as a reclamation option to avoid long-term operational commitments, which are outside the scope of the program and funding source. Therefore, even after cleanup, an abandoned non-coal mine site could still represent a source of contaminant loading to a stream, especially if there is a discharging adit associated with the site. Where discharging adits are not of concern, cleanup of either coal or non-coal mines may generally represent efforts to achieve all reasonable land, water, and soil conservation practices for that site.

A Guide to Abandoned Mine Reclamation (Noble and Koerth, 1996) provides further description of the Abandoned Mine Lands Program and how cleanup activities are pursued.

H4.0 Cleanup on Federal Agency Lands

A Federal land management agency may pursue cleanup actions outside of any requirements under CERCLA or CECRA where such activities are consistent with overall land management goals and funding availability.

H5.0 Permitted or Bonded Sites

Newer mining sites that are or have been in recent operation are required to post bonds as part of their permit conditions. These bond and permit conditions help ensure cleanup to levels that will satisfy Montana Water Quality Standards during operation and after completion of a mining operation. Such sites also include larger placer mines greater than five acres in size. The Golden Sunlight Mine is the only bonded site in the Jefferson River TMDL project area. The Madison Mine is currently operating under a Small Miners Exclusion (SME) and has an exploration bond in place.

H6.0 Voluntary Cleanup Agreement

At least one location within Montana (the Upper Blackfoot Mining Complex) is being addressed via a voluntary cleanup approach based on an agreement between the responsible person and the state of Montana. Although similar in nature to the goals of CECRA, this cleanup effort is currently not considered a remedial action under CECRA. The responsible person is responsible for cleanup costs in this situation.

H7.0 Landowner Voluntary Cleanup Outside of a State Directed or State Negotiated Effort

A landowner could pursue cleanup outside the context of CECRA or other state negotiated cleanup approaches. Under such conditions, liability would still exist since there is presumably a lack of professional oversight and assurance of meeting appropriate environmental and human health goals. Regulatory requirements such as where waste can be disposed, stormwater runoff protection, and multiple other environmental conditions would still need to be followed to help ensure that the cleanup activity does not create new problems. This approach can be risky since the potential for additional future work would likely make it more cost effective to pursue cleanup under CECRA or some other state negotiated approach where PRP liability can be resolved.

H8.0 State Emergency Actions

Where a major emergency exists, the State can undertake remedial actions and then pursue reimbursement from a responsible party. This situation does not exist within the Jefferson River TMDL project area.

H9.0 REFERENCES

Montana Department of Environmental Quality. 2011a. Comprehensive Environmental Compensation Responsibility Act (CECRA) Priority List. http://deq.mt.gov/StateSuperfund/cecralistformats.mcpx. Accessed 2/21/2013a.

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Noble, Cassandra and John Koerth. 1996. Montana ... Bringing the Land Back to Life: A Guide to Abandoned Mine Reclamation. Helena, MT: Montana Department of Environmental Quality.

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APPENDIX I – RESPONSES TO PUBLIC COMMENTS

As described in **Section 8.2**, the formal public comment period for the Jefferson River Metals Project Area TMDL document extended from September 30, 2014 to October 31, 2014. Formal written comments were received from two organizations and one individual. DEQ evaluates all comments and related information to ensure no critical information was excluded from the document. Excerpts of the public comments received are contained below, and responses follow each comment. The original comment letters are located in the project files at DEQ and may be reviewed upon request.

Comment 1: I think you answered the issue of seemingly highlighting metals in Jefferson Slough, and you were able to clarify that the primary source of metals in Jefferson Slough is the Boulder River. However, improving general wording in the document that makes it more clear that elevated metals are present in the slough downstream of the confluence with Boulder River would be helpful.

> **Response 1**: DEQ understands that TMDL documents can often contain a lot of information and that gathering specific pieces of information from a lengthy document may be difficult. That being said, the TMDL document does clearly indicate the Boulder River as the primary source of metals to the Jefferson Slough. **Section 5.6.4.3** of the document discusses loading contributions from tributaries to the Jefferson Slough. In this section, the Boulder River is identified as the major contributing source: "a review of the **Table 5-23** data shows that the Boulder River loading tends to dominate the overall loading to the Jefferson Slough," and "Note that the above target loads within the Jefferson Slough are significantly less than those within the Boulder River…." **Section 5.7.2.4** provides a load allocation specifically to the Boulder River and is presented in **Table 5-36**. This section also assigns allocations to all the potential sources in the Jefferson Slough and the load allocation given to the Boulder River makes up the majority of the TMDL for the Jefferson Slough for all metal impairments.

Comment 2: Improving the display of all the sampling locations will help future folks understand what was really sampled and what stream reaches were not sampled. This also helps understand how "background" effects were assessed, or not assessed.

> **Response 2:** DEQ has reviewed **Figures 5-14** through **5-19** in the source assessment section of the TMDL document and acknowledges that a few of the figures contained a lot of information, and could been seen as cumbersome. DEQ has updated **Figures 5-18** and **5-19**. The updated figures more clearly show sampling locations in the upper and lower portions of the Jefferson River watershed.

Comment 3: A brief summary of the Boulder River metals source trend would help the reader know how this big source for the Jefferson is trending. My general understanding has been that we have fewer acute events compared to the early work in the 1970's, but I have not really dug into this to see if your data confirms my impression that there has been general improvement. Also, have you documented improvements from the Upper Boulder clean-up efforts at abandoned mines?

> **Response 3**: To the extent possible, DEQ has calculated loads from tributaries to the Jefferson Slough, including the Boulder River. **Table 5-23** in **Section 5.6.4.3** of the TMDL document provides example metals loading from Whitetail Deer Creek, Big Pipestone Creek and the Boulder River. These example loads are not long term trend analysis, rather they are based on

high and low flow events. Development of a long term trend analyses, for the metals pollution from the Boulder River is out of the scope of this TMDL document, particularly due to the limited amount of historical metals data that could be used for such an analysis for most of the streams.

Documentation of any improvements to abandoned mines in the upper Boulder River watershed is also out of the scope of this document, although the "Boulder–Elkhorn Metals TMDLs and Framework Water Quality Improvement Plan" document, referenced within **Section 5.0**, does discuss remediation activities in the upper portions of the Boulder River. That being said, this document contains information and identifies sources of information that may be useful in determining the status of mine reclamation activities in the upper Boulder River watershed. This information can be found in **Section 7.6.2**. A more direct source of information regarding ongoing mine reclamation activities in the upper Boulder River watershed can be found on DEQ's Abandoned Mines website (http://deq.mt.gov/AbandonedMines/default.mcpx).

Comment 4: Perhaps you could elaborate on the link between the various TMDLs (metals, nutrients, sediment, temperature) and put these efforts into context. They are obviously all important, but sometimes a watershed group needs some guidance on prioritizing which impairments are having the most negative effect on their most important local beneficial uses.

Response 4: The TMDL documents that have been written for the Jefferson River watershed have been developed independently. Comparison of pollutant groups (nutrients, metals, sediment or temperature) across TMDL documents to ascertain which pollutant group is having the most deleterious effect on the watershed is outside the scope of this particular TMDL document.

The Watershed Protection Section at DEQ assists in developing watershed restoration plans that serve as roadmaps to help prioritize implementation projects based on local input. TMDL implementation practices tend to be specific to each pollutant group, and should be based on those pollutant groups and/or waterbodies identified as priorities by stakeholders. It is important to note that implementation practices for one pollutant group often have beneficial effects on others. For example, controlling sediment runoff into streams will often have a beneficial effect on controlling potential sources of metals and nutrients pollution as well.

Comment 5: One would think that with continued rinsing of the upstream mine dumps, the levels in the Jefferson would eventually fall. I suggest testing the levels of the heavy metals, especially mercury, be done monthly for two years. This would document the problem and tell us if the sources of these metals are or are not being exhausted.

Response 5: While metals concentrations in waterbodies downstream of mining operations may decrease with time, the length of time it may take is highly variable. There are a number of factors that may contribute to metals concentrations in waterbodies that receive metals pollution. Factors such as the type of mining operation, the duration of the mining, the type of ore that was mined, how that ore was processed, and if the mine site was remediated all play a role in potential contributions of metals pollution. Many of the metals problems throughout the state of Montana are linked to abandoned mines from more than a century ago. Generally some form of active remediation is necessary to obtain reduced metals loading due to the nature of metals contamination from historic mining. Remediation activities to address some forms of mine waste may be necessary for an indefinite period of time.

DEQ does not normally conduct long term trend analysis as part of a TMDL project. See Response to Comment # 3 regarding trend analysis. We agree that the type of suggested monitoring has the potential to help define the severity of the problem and might identify a trend. Without significant remediation in the areas where the abandoned mines and associated metals loading occurs, identifying a trend could be difficult, if one even existed, based on the persistent nature of metals loading from previously mined areas. Normally the best place to evaluate water quality trends is within waterbodies closest to areas of active mine remediation, which for the Jefferson River would be toward the headwaters of the major tributary rivers. On the other hand, some metals and sediment loading are potentially linked. Therefore, if there were significant sediment reducing activities within areas that have sediment bound metals loading, it could result in a trend of reduced metals concentrations. Any trend analysis for this project area would be further confounded by the fact that many of the metals impairment problems were linked to a very high flow event that is somewhat of an outlier. As DEQ develops monitoring plans and strategies for areas throughout Montana, these considerations along with available resources are taken into account.

Each of the streams discussed in this TMDL document were sampled for DEQ's normal suite of metals (see **Section 7.8**), which does not include mercury. Samples may be analyzed for mercury if there is existing mercury impairment or a reason to suspect elevated levels of mercury. The presence of mercury in a watershed is normally linked to its use in the mining process. DEQ did not sample for mercury, based on the history of mining in the watershed, the lack of previously identified mercury impairment conditions for the streams of interest, and an overall lack of mercury detections associated with similar TMDL activity.

It is worth pointing out that DEQ evaluated several waterbodies in the upper portion of the Boulder River watershed during TMDL development for the Boulder–Elkhorn TMDL Project Area, and all mercury results were below the applicable water quality standards.

Comment 6: The report identifies specific components to be included in developing TMDLs and water quality improvement strategies, including quantifying the magnitude of pollutant contribution from their sources, and allocating the TMDL into individual loads for each source. It also states that all significant pollution sources, including natural background loading, are quantified so that the relative pollution contributors can be determined. We feel that these components have not been met in this effort and the necessary effort to do so is being pushed down to local entities to accomplish with very limited resources. Given the amount and location of data collected, it appears a general assumption of pollution sources has been attributed to old mining activities. No background data was collected above these potential mining sources, and as such, no natural background loading was determined in this investigation. This makes any effort at allocating the TMDL into individual loads for each source questionable.

Response 6: DEQ acknowledges the extent of data from background monitoring sites in the Jefferson River TMDL Project Area was limited. **Section 5.6.7** discusses why natural background data could not be determined in the Jefferson Slough, Whitetail Deer, Little Whitetail and Big Pipestone creeks. **Table 5-32** does however provide information that can be used for an estimate of background concentrations for the upper Jefferson River.

The following text has been added to this section to explain how this data is being used: "**Table 5-32** can be used to estimate the upper extent of natural background concentrations and associated natural background loading. Note that these concentrations represent a relatively low percentage of the applicable target concentrations per **Table 5-32**. This suggests natural background concentrations in the Jefferson River are very likely at or below the values in **Table 5-32**.**".**

Natural background was included in the allocations for each TMDL. A composite approach was used primarily because of the difficulty in determining what could be considered natural background. The composite wasteload allocation approach merges the loads from human caused sources and natural background sources. Language has been added in several places within the document to point out that the human portion of this composite wasteload allocation is generally focused on mining activities (active or abandoned), as well as natural background.

Composite load allocations are regularly used in allocating loads in other Montana TMDL documents. For example, in the Boulder–Elkhorn metals TMDL document, natural background concentrations were determined for some waterbodies, whereas for others, natural background concentrations for wasteload allocations were composited. **Section 5.7.1.3** provides additional information on how and why natural background is incorporated into each TMDL.

DEQ agrees that the introductory material in **Section 4.0** of the document implies that TMDLs are routinely broken into multiple load and wasteload allocations that include natural background. We have added language to **Section 4.4** to clarify that this approach is often simplified to composite allocations, frequently because of data limitations. This approach also gives stakeholders or those involved with remediation decisions the flexibility to address those sources identified as local priorities with the most appropriate best management practices.

One goal of the TMDL document is to identify specific sources of metals loading. However, given the available data, we could not be as detailed as we would have liked. This is one reason DEQ employs an adaptive management approach to TMDL implementation. Adaptive management can include the collection of additional data to help define the specific sources and can also provide a better estimate of natural background (**Section 7.7** of the TMDL document).

Comment 7: We do not feel that the report should take credit for something not done. It should be made clear in the report that insufficient data was collected to identify pollutant contribution from any sources, or additional data should be collected to accomplish this.

Response 7: The source assessment portion of the TMDL document does identify the general locations (often linked to a number of historical mining operations) where elevated metals loads originate. Furthermore, the major tributaries, often with linkages to previous TMDL work, are evaluated for loading contributions throughout the document. Major source loading from within the Big Hole and Boulder rivers are identified, as are source loading areas for metals loading throughout the Whitetail Deer Creek, Little Whitetail Creek, and Big Pipestone Creek watersheds. This level of metals loading information and detail has not been previously compiled like it is within this document. The TMDLs in this document provide information on the magnitude of the problem and likely sources in a form that allows one to further focus assessment and remediation activities. We agree that more data collection and analysis is necessary, which is the normal case for metals TMDL work in areas where there are no major Superfund or other mine remediation activities underway. **Section 7.7** specifically identifies the need for additional water quality sampling for majority of the impaired waterbodies and several of the point sources identified in the TMDL document.

Comment 8: The report identifies that source quantification approach may produce reasonably accurate estimates or gross allotments, depending on data available and techniques used for predicting the loads. This seems to be the rationale DEQ used in identifying the sources and their contributions; however, DEQ is also the entity that decided to limit the data available. The most glaring example of limited data is on Pipestone Creek where only three samples were taken, all near Whitehall. While the report states “metal loads are quantified for natural background conditions, abandoned mines, and diffuse sources,” no metal loads were quantified for Pipestone Creek above Whitehall. Thus natural background conditions, abandoned mines, and diffuse sources could not have possibly been quantified. Arsenic is the identified pollutant triggering a TMDL for Pipestone Creek, and with arsenic being a not uncommon naturally occurring element, we are essentially starting from zero knowing the potential source of the pollutant.

Response 8: Limited data were collected for Big Pipestone Creek since the sampling was initially only intended for Jefferson Slough source assessment purposes. Big Pipestone Creek was assessed and found to be impaired for arsenic based on an exceedance of the Human Health standard (HH). According to DEQ impairment listing criteria, only one sample need exceed the HH standard to obtain impairment status. The project scope and schedule did not allow for additional metals sampling within Big Pipestone Creek for TMDL development purposes.

Regarding the statement “metal loads are quantified for natural background conditions, abandoned mines, and diffuse sources,” this statement is in the document summary and is intended to provide an overarching description of what can be found in the TMDL document. This statement was not intended solely for Big Pipestone Creek; rather it is a broad description of how the document addresses loads for all streams. See Response to Comment 6 above regarding determination of natural background and use of composite allocations.

Arsenic is normally sampled by DEQ when evaluating potential metals impairment. Arsenic is naturally occurring in a number of waterbodies in Montana. Whether or not it is naturally occurring at levels above the water quality standard in Big Pipestone Creek is difficult to discern. As pointed out in the source assessment discussion, on the date when arsenic exceeded the target near the mouth of Big Pipestone Creek, a sample location just upstream in the vicinity of Whitehall had a relatively low value for arsenic consistent with many of the arsenic sample results in other local watersheds. This suggests a local groundwater source of arsenic, given the low flow conditions during this sampling event. This groundwater source could be linked to upstream abandoned mines, although the results suggest a more localized arsenic source that could include or be significantly influenced by natural background loading. **Section 7.7** of the TMDL document specifically identifies the need for additional water quality sampling on Big Pipestone Creek.

Comment 9: Examples of our concerns include the failure to identify the significant hot springs, a potential natural source of arsenic, on Pipestone Creek upstream of the sampling conducted; failure to identify low flow impairment on the Pipestone Creek which could significantly impact arsenic levels; failure to recognize that a significant portion of the flow in the Jefferson Slough comes from the

Slaughterhouse Slough; failure to include the Jefferson Slough in previous Integrated Reports and failure to include it in the sediment TMDL study. These previous oversights or misunderstanding of the Jefferson and Slaughterhouse Sloughs systems continue to carry into this report. While we understand this is a metals TMDL effort, we feel DEQ should correct its understanding of these systems.

Response I.9: DEQ acknowledges the limited amount of data for Big Pipestone Creek (see response to Comment 8). The hot springs may be a potential source of arsenic, and this language has been added to the document.

Regarding low flow impairments, DEQ did not include an evaluation of flow alterations, including low flow, as an independent cause of impairment within this metals TMDL document. However, the elevated arsenic sample was collected during very low flow conditions that may be linked to flow limitations and upstream water withdrawals. DEQ has recommended additional sampling be conducted in Big Pipestone Creek (see response to Comment 8) during high and low flow conditions to determine likely sources of elevated arsenic.

Regarding flow contributions from Slaughterhouse Slough, we agree that the extent of connectivity of the Jefferson River to the Jefferson Slough needs to be better defined. For that reason, the Jefferson Slough composite allocation includes any flow, whether surface or subsurface, that originates within the Jefferson River and reaches the Jefferson Slough. By acknowledging this connectivity and including the information within the allocations, we feel that we have addressed any potential oversight or misunderstanding regarding these waterbodies. Note that the Slaughterhouse Slough does not appear to be recognized by the United States Board of Geographic Names, the U.S. Geological Survey, USDA Forest Service, or the Bureau of Land Management in any of their recent mapping efforts.

There are many factors linked to the Jefferson Slough not being included within previous integrated reports and not being addressed via DEQ’s 2009 sediment TMDL document for the Upper Jefferson TMDL Planning Area. At the time of sediment TMDL development, DEQ was working on completion of a lawsuit that included a finite number of impairments dating back to 1996. Since the Jefferson Slough had never been assessed for sediment and was not included within the 1996 list of impaired waters, it was not included as part of the sediment TMDL work. Later, while working on metals TMDLs and associated source assessment for the Jefferson River, DEQ decided to sample the slough for metals given its linkage to the Boulder River and high potential for elevated metals loading to the lower segment of the Jefferson River. This resulted in a full metals assessment for the Jefferson Slough, with the impairment results being captured within the 2014 Integrated Report (the sample results were not yet available for the 2012 Integrated Report). Additional sampling and assessment for sediment or other pollutants was outside the metals TMDL scope. When DEQ and EPA negotiated a new agreement for completion of the above referenced lawsuit, DEQ and EPA committed to completing metals TMDLs within portions of the Jefferson River TMDL Project Area, and have since expanded the work to include metals TMDL development for the Jefferson Slough. Thus, the resulting metals assessment and TMDL development for the Jefferson Slough represent an expansion of our water quality protection planning efforts above and beyond the minimum lawsuit requirements. We acknowledge that more assessment work is required to evaluate sediment and other pollutant impairments within the Jefferson Slough, as well as other waterbodies in the project area, but we do not consider this a failure on our part given the extent of water quality monitoring, assessment, and TMDL work that has occurred within the Jefferson area and throughout Montana over the past several years.

Comment 10: Current language in the report (i.e., Section 5.4.3.4 infer that no impairments were found on these two steams. When in fact, they were not included or sampled in earlier DEQ TMDL efforts. Had DEQ understood the local river system, they would not have failed to include two of the major streams in our valley. In particular, they would have recognized that the Jefferson Slough is a continuation of Pipestone and Whitetail Creeks, runs for over 11 miles, and has serious sediment and flow issues. There are also data points and descriptions identified that make no sense and raise the question of basic understanding of the system such as the data point identified as "Jefferson River downstream of Pipestone", and the notation in Section 5.4.3.4 "Jefferson Slough from the Jefferson River to the mouth (Jefferson River).

Response 10: **Section 5.4.3.4** only discusses the Jefferson Slough. This section states "The Jefferson Slough, from the Jefferson River to the mouth (Jefferson River) is not listed in the 2012 IR as being impaired for any metals." The Jefferson Slough was sampled, and sampling efforts are discussed in **Section 5.4.3.4** along with identification of new metals impairment determinations captured within the 2014 Integrated Report. **Section 5.4.3.4** makes no mention of other waterbodies, and you are correct in that no impairments were identified in Slaughterhouse Slough (assuming that is the second waterbody that is being referring to) since DEQ did not sample or assess this water. See Response 9 above for additional clarification.

With regard to the sampling site description "Jefferson River downstream of Pipestone", all sampling locations in the Jefferson River TMDL Project Area follow the same naming system. The naming system provides a site name and a brief description of the sampling location. The brief description is not always intended to be used as a means of pinpointing the exact location where the sample was collected. Latitude and longitude coordinates collected at each monitoring site are the more accurate means of identifying sampling locations. DEQ has included **Table I-1** at the end of this appendix containing the station (site) name, the site ID, and the latitude and longitude for each of the sampling site in the Jefferson River TMDL Project Area. Latitude and longitude coordinates and associated dated in spreadsheet format are available for all monitoring points via EPA's national STORET database http://www.epa.gov/storet/dbtop.html. The spreadsheets containing the sampling locations, water quality data, and associated latitudes and longitudes are also available via request from DEQ.

Comment 11: We are also concerned that the entire Jefferson Slough is identified as being impaired by metals, when only the bottom most section after its confluence with the North Boulder River is impaired. We recognize that you have added wording in the document that points this out, but it still leaves the entire stream listed as being impaired by metals when it isn't. The Jefferson Slough after it's confluence with the North Boulder is a significantly different stream in character and should be identified separately or included in the Boulder metals TMDL for metals pollution. As the report states, all efforts to correct the metals problem in this section will have to be addressed as part of efforts directed at the metals TMDLs on the North Boulder, not as part of efforts conducted on the Jefferson Slough. Leaving the entire Slough identified as impaired under the metals TMDLs will just cause confusion and difficulties rather than support future efforts. It is a peculiar state of affairs when DEQ lists the entire Jefferson Slough as being impaired by metals when it isn't, but doesn't list it as impaired by sediment or low flows when it is.

Response 11: It is important to remember that streams are broken into segments, referred to as assessment units (AUs), for the purpose of determining if the waterbody is exceeding water quality standards. The Jefferson Slough from the Jefferson River to the mouth (Jefferson River) is identified as a single AU. AUs are established based on consideration of the following criteria: minimum and maximum lengths established by DEQ, changes in waterbody use class, changes to hydrologic unit codes (4^{th} Code HUC), changes in geomorphology, confluences with other rivers of the same order and changes in ecoregion (Level III). By following these criteria, each AU is established to be sufficiently homogenous so that data collected from sites within the AU can be considered representative. Sampling locations in each AU must be far enough apart that each sample collected can be considered independent of the other. This is especially important when using statistical methods for determining compliance with water quality standards. DEQ uses these criteria to determine an AU and establishing an AU based solely on water quality (e.g., the Jefferson Slough from the confluence with the Boulder River to the confluence with the Jefferson River) is not an efficient and practical approach to managing state waters since there often can be varying levels of water quality throughout the different reaches of each waterbody. Additionally, it does not satisfy minimum length requirement for an AU breakout.

While it is not practical to split AUs based solely on water quality, DEQ has at times identified specific reaches within an AU segment to facilitate assessment activities and inform stakeholders regarding water quality protection activities. For example one reach could be defined as the slough upstream of the Boulder River and the other reach defined as the slough from the Boulder River to the Jefferson River. This approach may be pursued in the future for water quality assessment purposes for the Jefferson Slough. Note that throughout the document we identify that the metals problems within the Jefferson Slough only occur within the lower reach due to Boulder River metals loading.

The Jefferson Slough was not assessed for sediment during the sediment TMDL process. The Jefferson Slough has also not been assessed for low flow alterations. As such DEQ has not yet made a determination for the need for TMDL development for sediment on the Jefferson Slough. This does not necessarily mean that the Jefferson Slough is not impaired for sediment or flow, only that the impairment determinations have not been made. It is also important to keep in mind that these impairment determinations are outside of the scope of the metals TMDL document. See above Response to Comment 9 for more information on this topic.

Comment 12: A significant number of data issues and errors have been identified in the tables provided in Appendix B of the report. Examples of these errors were previously identified to DEQ and were to be corrected but are still present. The extent of errors identified in just a cursory review gives us great concern regarding the validity of the findings in the report. Unless a complete data review is conducted that identifies and corrects errors, omissions and confusion, local stakeholders will be greatly hampered in their ability to use this report and the data it includes in future efforts.

Response 12: Corrections were made to tables in **Appendix B** as a result of comments received during the stakeholder review period. DEQ performed a complete review of the flow and water chemistry data presented in **Appendix B**, and determined that the data issues described in the comments were all caused by formatting error, as some rows were accidentally misaligned. DEQ has confirmed the accuracy of the data presented in **Appendix B** and corrected all the errors.

Comment 13: It is not clear what metals were sampled for when, and at which of the sampling locations. There are many blanks in the tables in Appendix B. In response to earlier stakeholder comments, DEQ added a notation that where blanks occur no data was collected, yet in the report and in response to the early comment on this issue, DEQ stated that all sampling locations were sampled for the complete suite of metals. Both of these statements cannot be accurate.

> **Response 13**: DEQ acknowledges that some of the data tables may be difficult to read, and has made changes to help the reader. **Appendix B** lists all the metals data used in development of the TMDLs in this document. Each sample has a site name (with a brief description of its location, see comment 10) associated with it. It is important to remember that the site name is not the best means of identifying the sampling location. Latitude and longitude data is available in **Table I-1** at the end of this appendix (see comment 10). Where no data was reported, no value is given in the table and is left blank. With the exception of aluminum in the Jefferson River and Big Pipestone Creek, all streams were sampled for a full suite of metals (see **Table 7-2** in **Section 7.8**) from at least one sample site during the sampling process. Not every sample location on each stream was sampled for a full suite of metals every time.

Comment 14: It is very difficult to determine where sampling took place, in the absence of an accurate map of sampling locations or GPS coordinates. Many of the location descriptions are vague and in some cases possibly inaccurate. Accurate sampling location information could be greatly helpful to stakeholders in their future efforts.

> **Response 14**: See the response to Comment 2 for an explanation on how figures were updated to more clearly show sampling locations and responses to Comments 10 and 13 for further explanation of how site names are established. **Table I-1** included at the end of this appendix that contains the station (site) name, the site ID, and the latitude and longitude for each of the sampling sites in the Jefferson River TMDL Project Area. Latitude and longitude coordinates and associated data are available for all monitoring locations in the Jefferson River TMDL Project Area via the EPA's national STORET database http://www.epa.gov/storet/dbtop.html. The spreadsheets containing the sampling locations, water quality data, and associated latitudes and longitudes are also available via request from DEQ.

Comment 15: There are a number of instances where this metals TMDL process came up with different findings than the 2012 and 2014 water quality integrated report. It would be helpful to know why the findings are different.

> **Response 15**: The information contained within the 2012 303(d) List and associated 2012 Integrated Report provides the baseline for the updated sampling and assessments discussed in this document. Significant new data were collected and evaluated for updating assessments, as is the case for most TMDL development. As a result, one stream previously identified as impaired for metals was no longer considered impaired for metals (Cherry Creek), and three new streams were identified as having metals impairment (Big Pipestone Creek, Little Whitetail Creek, and the Jefferson Slough). Furthermore, for those streams that remained impaired for metals, the individual metals impairment causes changed, with some new impairment causes identified and others eliminated. All these impairment modifications are described within this TMDL document and captured within the 2014 303(d) List portion of the 2014 Integrated Report.

DEQ discusses the differences between metals impairment causes in the 2012 vs. 2014 integrated reports and provides justification for developing specific metals TMDLs in several locations including Table 1-1, Table A-1, Table 5-20, Section 5.2, Section 5.4.3.1, Section 5.4.3.2, Section 5.4.3.3, Section 5.4.3.4, Section 5.4.3.5 and Section 5.4.3.6.

Comment 16: There are still a significant number of errors in Appendix B. For example, several of the spring 2010 Jefferson River data appear to be incorrect with several -9999 being listed for flow; JEFS-01 on 8/30/10 is listed at 1276 cfs which is obviously incorrect (and is exactly the same as M08JEFFS03 on 6/1/10); JEFS-01 on 6/10/11 is listed at 142.9 cfs which is obviously incorrect and is exactly the same as M08JEFFS03 on 8/1/10; SLOU01 is listed at 26.28 cfs on 6/10/11 which is obviously wrong; JEFF-05 is listed for the Jefferson River below Pipestone Creek and no such place exists in the system; JEFF-04 is listed at 200cfc on 6/9/11, JEFF-03 is listed at 1175 cfs on 6/9/11, and M08JEFFR40 is listed at 14000 cfs on 10/2/12 all of which are obviously wrong. Again, these errors were identified through a very cursory review and raises the question of the validity of the tables and data in general and the findings reached using this data.

Response 16: DEQ has reviewed the data in question. The "-9999" code has been removed from the tables in **Appendix B**. This code is used to indicate non-detect samples when the detection limit is not provided with the data. As this does not apply to flow values, it was removed. A dash in now used in those locations were the "-9999" code was used.

Regarding JEFF-05, see the response to comment 10 with regard to how sampling locations are named.

With regard to the JEFS-01 on 8/30/201, 6/10/2011 and 9/8/2011; SLOU01 on 6/10/2011; JEFF-04 on 6/9/2011; JEFF-03 on 6/9/2011 and M08JRFFR40 on 10/2/2012, data points in **Table B-1** were updated to show the correct flow for these dates. **Table B-5** which contains data specific to the Jefferson Slough (JEFS-01, SLOU01) and **Table B-7** which contain data specific to the lower Jefferson River (JEFF-03, JEFF-04 and M08JRFFR40) were not updated, as they contained the correct data.

Comment 17: High water samples, which directly affect the high metals findings in the Slough were measured during very high flows. We are curious as to how those flow samples were made. During the high water events (especially in 2011), the Slough was significantly out of its banks and it would have been very difficult to measure or even approach. We would appreciate further information on flow monitoring methods used by DEQ to generate the flow data used in this report. This high flow data, as well as the flow data in general, could be helpful to projects we are currently working on in the Jefferson Slough, so verification of method and accuracy is important to us.

Response 17: Flow data in the TMDL document is a compilation of data measured by DEQ when sampling was conducted and data from the U.S. Geological Survey. Often during high flow events, DEQ will estimate flow. Flow from June 2011 was estimated using the float method, which is described in detail in the 2011 sampling and analysis plan for the Upper and Lower Jefferson River TMDL planning areas (on file at DEQ) and is part of our general sampling method, as described in our Field Procedures Manual (available online at: http://deq.mt.gov/wqinfo/qaprogram/sops.mcpx) for sites that cannot be waded during high flow sampling events. A description of the method is included below:

Float Method

The floating stick/ball method is a semi-quantitative method of determining flow. It is important to note this method tends to underestimate the flow due to slower velocity near the surface, but it is more accurate than a visual estimate.

Find a stream reach that is straight and uniform in width and depth; a glide is preferred. This will assure that laminar flow is achieved to the greatest extent possible. Measure a length at least twice the mean wetted width (≥ 50 feet is preferable) and mark each end by hanging flagging or driving a stake or rebar into the ground at the high water line.

Determine the mean width (from the water's edge) by measuring at least three cross-sections (if wadeable), using a rangefinder, or by making a visual estimate.

Determine the mean depth by measuring depth at multiple points throughout the reach (if wadeable) or by making a visual estimate.

Record the measured distance and a description of each stake's location on the Total Discharge Form for high flow. Note landmarks and make a sketch if necessary to help identify stake locations in the event that they are no longer in place during subsequent flow measurements. Photograph both stakes to record their location along the streambank and the water level.

Toss a small stick or other biodegradable floating object (i.e., an orange) heavy enough to stay in and move consistently with the main current into the middle of the stream above the upstream marker of the measured reach. Begin timing when the object passes the upstream marker. Count (with a watch or stopwatch) the seconds it takes the object to reach the downstream marker. The object must stay in the main current. If it does not, repeat the measurement. Complete three measurable floats. Remove the stakes upon completion unless subsequent site visits requiring flow measurement are anticipated.

Record the following information on the Total Discharge Form for high flow:

- Reach length (ft or m)
- Mean depth (ft or m)
- Mean width (ft or m)
- Float times (sec)

Complete the following calculations on the Total Discharge Form for high flow:

- Cross-sectional area (m_2 or ft_2) = Mean width **x** Mean depth
- Average float time (sec) = (Float time 1 **+** Float time 2 **+** Float time 3) **/** 3
- Float velocity (ft/sec or m/s) = Reach Length **/** Average float time
- Discharge (ft_3/sec or m_3/sec) = Cross-sectional area **x** Float velocity

Comment 18: We would also like to know the rationale of using high and low flow numbers from different locations (i.e., the Jefferson Slough low flow taken just below Whitetail Creek and high flow at the mouth) when averaging to come up with the TMDLs, rather than using numbers from the same location.

Response 18: As defined in **Section 5.5,** the TMDL for each metal is a function of flow (see **Tables 5-7** through **5-13**). To help understand the potential range of TMDL values for a stream, this document provides example TMDLs using the highest and lowest flow conditions. Since the Boulder River provides significant flow to the Jefferson Slough, it follows that the highest flow would be below the Boulder River and the lowest flow would be from above the Boulder River. **Table 5-21** identifies the flow data that were used to calculate both the high and low flow example TMDLs for the Jefferson Slough. A high flow value of 1,276 cfs from M08JEFFS03 on 6/1/2010 and a low flow value of 21.75 cfs from M08JEFFS05 on 5/9/2013 were used to calculate the TMDL. The fact that these values are from different locations does not matter since they are used for example purposes only.

Table I-1. Site Names and GPS Coordinates for Sample Sites in the Jefferson River TMDL Project Area

Station (Site) Name	Site ID	Latitude	Longitude
Little Whitetail Creek (upper)	WWHI-03	46.037692	-112.210176
Little Whitetail Creek downstream Whitetail Reservoir	M08LWHTC02	46.02728	-112.20967
Little Whitetail Creek (upper) at Whitetail Road crossing	WWHI-02	46.023993	-112.208143
Little Whitetail Creek 4 miles below Whitetail Reservoir	M08LWHTC01	46.023611	-112.207778
Little Whitetail Creek (lower) about 300 ft downstream railroad crossing	WWHI-01	45.947604	-112.128393
Little Whitetail Creek above confluence with Whitetail Deer Creek	JWCLWHTL01	45.941201	-112.117409
Little Whitetail Creek upstream Whitetail Deer Creek confluence	M08LWHTC03	45.94085	-112.11772
Whitetail Deer Creek (East Fork Whitetail) upstream of Keogh Reservoir	EWHI-03	46.080992	-112.125826
Whitetail Deer Creek (East Fork Whitetail) downstream of Keogh Reservoir	EWHI-02	46.075319	-112.122838
Whitetail Deer Creek at Hay Canyon Road crossing	M08WHTDC01	46.0716	-112.11965
Whitetail Deer Creek (East Fork Whitetail) u/s of fence and road crossing	EWHI-01	45.945549	-112.11483
Whitetail Deer Creek ab Ltl Whitetail Deer Cr	WHTL05	45.94524	-112.11175
Whitetail Deer Creek at Whitetail Road Crossing	JWCWHTL04	45.9013	-112.1112
Whitetail Deer Creek upstream of I-90	WHIT-02	45.878467	-112.097001
Whitetail Deer Creek abt 1/4 mile upstream of Whitehall	M08WHTDC04	45.878889	-112.098333
Whitetail Deer Creek at Hwy 2 crossing	JWCWHTL03	45.868499	-112.08541
Whitetail Deer Creek about 100 ft downstream Hwy 69 crossing	M08WHTDC03	45.86727	-112.0849
Whitetail Deer Creek about 500 ft downstream of railroad crossing	WHIT-01	45.867254	-112.084906
Whitetail Deer Creek downstream of Hwy 69 about 3/4 mile	M08WHTDC05	45.8653	-112.0783
Whitetail Deer Creek above confluence with Jefferson Slough	JWCWHTL02	45.862281	-112.068464
Whitetail Deer Creek 200 yards upstream center-pivot	M08WHTDC02	45.8646	-112.0717
Big Pipestone Creek downstream of Delmoe Lake	PIPE-07	45.982879	-112.339253
Big Pipestone Creek below Delmoe Lake	JWCBPST04	45.967331	-112.319609
Big Pipestone Creek near Spire Rock	JWCBPST01	45.918655	-112.286928
Big Pipestone Creek upstream of I-90	PIPE-06	45.917208	-112.284387
Big Pipestone Creek downstream Pipestone Hot Springs	PIPE-05	45.891494	-112.226498
Big Pipestone Creek bl I-90 (Spackman Rd)	BPST06	45.88902	112.22191
Big Pipestone Creek at Hwy 2 crossing	JWCBPST02	45.876972	-112.188539
Big Pipestone Creek at Hwy 55 crossing	M08BGPSC01	45.8697	-112.1118
Big Pipestone Creek just upstream of Hwy 55	PIPE-03	45.869748	-112.111825
Big Pipestone Creek at Division Street crossing	M08BGPSC04	45.86353	-112.09732
Big Pipestone Creek ab Sewage Lagoons	BPST05	45.85921	112.08492
Big Pipestone Creek about 70 yards downstream of WWTP	M08BGPSC03	45.8591	-112.0755
Big Pipestone Creek downstream of WWT ponds	M08BGPSC02	45.8605	-112.0741
Big Pipestone Creek below Whitehall sewage lagoons	JWCBPST03	45.860947	-112.07353
Jefferson Slough ab mouth	SLOU01	45.86024	-112.06573
Jefferson Slough downstream from Whitetail Deer Creek	M08JEFFS05	45.86261	-112.06063
Jefferson Slough at Tebay Lane crossing	M08JEFFS06	45.8708	-112.013

Table I-1. Site Names and GPS Coordinates for Sample Sites in the Jefferson River TMDL Project Area

Station (Site) Name	Site ID	Latitude	Longitude
Jefferson Slough upstream Boulder River, upstream Hwy 2	JEFS-01	45.868227	-111.954342
Jefferson Slough upstream Boulder River at Hwy 359 crossing	M08JEFFS04	45.86832	-111.95435
Jefferson Slough at mouth (Jefferson River)	M08JEFFS03	45.8591	-111.9347
USGS Gage 06026500 - Jefferson River near Twin Bridges	JEFF-08	45.613376	-112.329421
Jefferson River about 100 yds downstream from USGS gaging station	M08JEFFR30	45.6134	-112.3295
Jefferson River downstream of Twin Bridges USGS gage	JWCJEFF04	45.616898	-112.327078
Jefferson River between USGS gage and Hells Canyon fishing access	JEFF-07	45.623981	-112.324259
Jefferson River downstream Parson's Bridge fishing access, at USGS gage	JEFF-06	45.747346	-112.186765
Jefferson River at Mayflower fishing access	JWCJEFF03	45.857928	-112.01643
Jefferson River below Pipestone Creek	JEFF-05	45.856816	-112.014484
Jefferson River just upstream South Boulder River	M08JEFFR41	45.84426	-111.91944
Jefferson River just upstream of SF Boulder River confluence	JEFF-04	45.843687	-111.918741
Jefferson River at Sheep Gulch, downstream South Boulder River	JEFF-03	45.829367	-111.898781
Jefferson River about 2 miles below South Boulder River	M08JEFFR40	45.82962	-111.89674
Jefferson River at Sappington fishing access	JWCJEFF02	45.803887	-111.752364
Jefferson River downstream Willow Creek	M08JEFFR39	45.83368	-111.66269
Jefferson River downstream Willow Creek	JEFF-02	45.83338	-111.658866
Jefferson River near Three Forks, 400 yards above bridge	M08JEFFR01	45.894722	-111.598889
Jefferson River at Three Forks USGS gage	JWCJEFF01	45.896271	-111.59763
Jefferson River downstream of Hwy 2 and at USGS gage	JEFF-01	45.897233	-111.596354
Jefferson River near Three Forks MT	6036650	45.8971361	-111.5956722