Lake Helena Planning Area Metals Total Maximum Daily Load (TMDL) Addendum

September 2013

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Document Number M09-TMDL-02a-aF

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Suggested citation: US EPA. 2013 EPA Submittal - Lake Helena Planning Area Metals TMDL Addendum. Prepared for Montana Dept. of Environmental Quality Helena, MT.

ACKNOWLEDGEMENTS

DEQ and EPA would first like to thank the landowners who graciously provided permission to access water quality sampling sites via their land. DEQ and EPA would also like to acknowledge multiple consultants who provided significant contributions to the development of this addendum. Gary Ingman and Erich Weber, with ATKINS consulting (formally PBS&J), conducted water quality sampling in 2010 and 2012 which provided the majority of data used in this report. Tetra Tech, Inc. compiled data and drafted TMDLs following the 2010 data collection.

Numerous other individuals offered technical assistance vital to the success of this addendum. Robert Cronholm and Paul Skubinna, both with DEQ, helped navigate the complex world of abandoned mines, active mines and permits. David William of the BLM was an asset while investigating the history of mining and existing conditions in the Granite Creek Watershed. Gratitude is also in order for Carrie Greeley, an administrative assistant for the Watershed Management Section of DEQ, for her time and efforts formatting this addendum. Lastly, Jason Gildea with EPA reviewed the document and helped the project in many ways get to a final product.

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ACRONYM LIST

Acronym	Definition
AL	Aquatic Life
ARM	Administrative Rules of Montana
BLM	Bureau of Land Management (Federal)
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DEQ	Department of Environmental Quality (Montana)
DNRC	Department of Natural Resources & Conservation (Montana)
EPA	Environmental Protection Agency (U.S.)
GPM	Gallons Per Minute
HUC	Hydrologic Unit Code
LA	Load Allocation
LCWQPD	Lewis and Clark Water Quality Protection District
MBMG	Montana Bureau of Mines and Geology
MCA	Montana Code Annotated
MOS	Margin of Safety
MPDES	Montana Pollutant Discharge Elimination System
NOAA	National Oceanographic and Atmospheric Administration
PEL	Probable Effects Levels
SMCL	Secondary Maximum Contamination Level
TMDL	Total Maximum Daily Load
TPA	TMDL Planning Area
TSS	Total Suspended Solids
USGS	United States Geological Survey
WLA	Wasteload Allocation
WTP	Water Treatment Plant

DOCUMENT SUMMARY

This addendum presents total maximum daily loads (TMDLs) for impaired tributaries to Lake Helena, including Corbin Creek, Granite Creek, Jackson Creek and Silver Creek (see **Figure 9-1**).

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

The Lake Helena TMDL Planning Area (TPA) is located in the west-central Montana. The drainage area encompasses 620 square miles and includes the towns of Helena, East Helena and Montana City. The three major subbasins are Silver Creek and Tenmile Creek, in Lewis and Clark County, and Prickly Pear Creek originating in Jefferson County. All surface water flows into Lake Helena and eventually to the Missouri River. A more detailed description of the watershed's physical and socio-economic characteristics is included in the Lake Helena Volume I document (U.S. Environmental Protection Agency, 2004).

In 2006 EPA established TMDLs for multiple streams in the Lake Helena Watershed in the document titled *Framework Water Quality Restoration Plan and Total Maximum Daily Loads (TMDLs) for the Lake Helena Watershed Planning Area: Volume II Final Report* (U.S. Environmental Protection Agency, 2006). While that document addressed 109 waterbody-pollutant combinations, due to uncertainties for some pollutants such as a lack of data, multiple impairments remained unresolved at that time. The purpose of this addendum is to complete all remaining metals TMDLs in the Lake Helena Watershed. Although DEQ recognizes that other pollutant listings remain in this TPA, only metal-related causes are addressed in this addendum.

Data gaps and uncertainties were reduced following additional water quality monitoring funded by EPA in 2010 and 2012. With this improved dataset DEQ reevaluated the impairment status of all applicable stream segments using DEQ's standardized assessment methodology (Montana Department of Environmental Quality, Water Quality Planning Bureau, Montioring and Assessment Section, 2012) and determined that four streams do not meet water quality standards. TMDLs for these four streams are contained in this addendum. DEQ also determined that 18 pollutants on 12 waterbodies are no longer impaired (see **Table 2-3**) because recent data indicates that water quality standards are being met. These 18 pollutants will be removed or "delisted" from subsequent lists of impaired waterbodies.

1.0 Supporting Information

This addendum builds off the information presented in the Lake Helena Volume II TMDL Report (U.S. Environmental Protection Agency, 2006) and therefore contains only the fundamental information necessary to understand the TMDL process. To learn more about the process in detail please refer to the 2006 document. This addendum begins with a discussion on how metals affect beneficial uses and a general description of the applicable streams and pollutant sources; it then moves into a section on water quality targets and how impairment determinations are made; the next section explains how TMDLs are calculated and allocated; and finally the document provides sections devoted to identifying sources, evaluating data and establishing TMDLs. The addendum also contains documentation of and response to public comments.

1.1 Effects of Metals on Designated Beneficial Uses

Metal concentrations exceeding aquatic life and/or human health standards can impair support of numerous designated uses including: aquatic life, coldwater fisheries, 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 high metals concentrations can be toxic to plants and animals, impaired irrigation or stock water may affect agricultural uses. Although arsenic is a metalloid, it is treated as a metal for TMDL development due to the similarity in sources, environmental effects and restoration strategies.

1.2 Stream Segments of Concern

Following DEQ's 2013 reassessment, four waterbody segments in the Lake Helena TPA were confirmed to be impaired by metals. Two of these streams, Corbin and Silver Creek, had TMDLs developed for other pollutants in 2006 but required additional TMDLs that are included in this addendum. Iron on Corbin Creek is noted in **Table 1-1** as not being on Montana's 2012 303(d) List (within the Integrated Report) because the impairment was recently identified. It will be documented within DEQ assessment files and incorporated into the 2014 Integrated Report.

Table 1-1. Impairment causes addressed via TMDL development within this addendum

Waterbody & Location Description	Waterbody ID	Impairment Cause	TMDL Addendum Resolution	Included in 2012 Integrated Report
CORBIN CREEK, headwaters to mouth (Spring Creek)	MT41I006_090	Silver	TMDL Completed	Yes
		Iron	TMDL Completed	No
		pH	Addressed by Iron TMDL	Yes
GRANITE CREEK, headwaters to mouth (Sevenmile Creek)	MT41I006_230	Arsenic	TMDL Completed	Yes
		Cadmium	TMDL Completed	Yes
JACKSON CREEK, headwaters to mouth (McClellan Creek - Prickly Pear Creek)	MT41I006_190	Zinc	TMDL Completed	Yes
SILVER CREEK, headwaters to T11N R4W S30/S31 to Lake Helena	MT41I006_150	Mercury	TMDL Completed	Yes

1.3 Sources of Metals

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. Therefore identifying and characterizing the total loading contribution from each source category is an important step in the TMDL process.

Mining is a significant source of metals pollution to streams in the Lake Helena TPA. Helena began as a small mining town following the discovery of gold in 1864, and today there are hundreds of abandoned prospect, placer, gravel and lode mines in the region. Mining remains an active industry in the Lake Helena watershed with gold, silver, and copper being the primary commodities mined. Other common commodities mined within the watershed include lead, zinc, manganese, and uranium. Mining districts within the Lake Helena watershed applicable to this project include the Missouri River, Marysville, Scratch Gravel Hills, Austin, McClellan, Clancy, and Colorado.

There are no permitted point sources in the Corbin, Granite or Jackson Creek Watersheds; however there are three Montana Pollutant Discharge Elimination System (MPDES) permits for point sources in the Silver Creek Watershed. The Drumlummon Gold Mine holds a permit for minor construction stormwater activities (MTR104058) and a permit for dewatering flooded mineshafts (MT0031721). In April 2013, while this addendum was being written, operations at Drumlummon were halted and the future of the mine is uncertain. The third issued permit in the Silver Creek Basin is the Marysville Road Reconstruction Project Permit (MTR102884), which is a general permit for stormwater associated with road construction. A more detailed source assessment is provided individually for each stream segment later in this addendum.

Because the 2010 and 2012 monitoring did not include sites above historic mines, natural background concentrations of metals were statistically calculated from a larger dataset: all surface water data collected from 2002 through 2012 in the Upper Missouri Hydrologic Unit (HUC 10030101). The selected area encompasses the Lake Helena, Canyon Ferry, Deep Creek and Holter TMDL Planning Areas. This dataset was robust enough to have a sufficient number of samples from both flow conditions thereby incorporating any difference in seasonal loading pathways. High flow conditions are represented by samples collected between April 15 and June 30; samples collected outside this time period are considered low flow.

Naturally occurring background concentrations of metals were established in a manner consistent with national guidance EPA has published for other pollutants (Buck et al., 2000). EPA suggests selecting the 75th percentile of a reference dataset or the 25th percentile of a general population dataset. The Upper Missouri HUC dataset is not a reference dataset. In fact, most of the monitoring in the basin (e.g., EPA's 2010 and 2012 sampling effort) has focused on problem waterbodies with known or suspected metals impairments linked to abandoned mines. Because the Upper Missouri HUC dataset is biased towards degraded streams, the 25th percentile was chosen to represent naturally occurring background concentrations for TMDLs in this addendum. The 25th percentile column in **Tables 1-2** and **1-3** is emphasized for that reason. It is assumed that natural background concentrations alone do not exceed instream water quality standards, if future monitoring indicates otherwise; an adaptive management approach will be employed including the possibility of revising allocations to natural background. **Tables 1-2** and **1-3** display standard summary statistics for the Upper Missouri HUC dataset by flow condition.

Table 1-2. Water Quality Statistics for Natural Background From Non-reference Dataset – High Flow

Pollutant	# Samples	Max	Min	Median	Average	25th Percentile (Nat. Back)	10th Percentile
Arsenic	285	296	0.97	9	17.53	**3**	1.8
Cadmium	207	12.5	0.01	0.66	1.45	**0.11**	0.05
Iron	61	824	50	137	156	**87**	60
Mercury	55	0.018	0.005	0.0067	0.0089	**0.005**	0.005
Silver	35	1	0.04	0.5	0.34	**0.16**	0.07
Zinc	206	1850	2	96.45	197.31	**17.23**	6

All units in µg/L

Table 1-3. Water Quality Statistics for Natural Background From Non-reference Dataset – Low Flow

Pollutant	# Samples	Max	Min	Median	Average	25th Percentile (Nat. Back)	10th Percentile
Arsenic	626	8430	0.39	13.75	36.32	**3**	1.55
Cadmium	465	476	0.02	0.67	3.48	**0.1**	0.08
Iron	138	228,000	10	90	1858	**50**	30
Mercury	47	0.0903	0.0014	0.005	0.0087	**0.005**	0.005
Silver	96	3	0.04	1	1.22	**0.30**	0.16
Zinc	468	205,000	1	100	919.15	**10**	5.07

All units in µg/L

Only low level mercury samples with detection limits less than 0.05 µg/L (i.e., the human health criteria) were used in the analysis. If the pollutant was not detected in a sample, the detection limit was used for calculations, thereby incorporating a margin of safety into the TMDL process by potentially overestimating natural background loading. Margin of safety is more fully discussed in **Section 3.0.**

1.4 Data and Information Sources

Metals concentrations in the water column and streambed sediments are the primary data used in this addendum; the majority of which were collected through a partnership between the DEQ Water Quality Protection Bureau and the EPA Region 8 Montana Field Office from 2010 to 2012. That dataset was supplemented by data obtained from the Lewis and Clark Water Quality Protection District. In accordance with DEQ's data quality guidance, only data collected in the last 10 years is used for impairment assessment and target evaluation. Older data is considered descriptive and may be used for source characterization, loading analysis and trend evaluation. In order to characterize the existing conditions, for cases where there has been significant cleanup action, data predating the cleanup was not considered. All data used for analysis in this addendum is contained in **Tables 10-1** and **10-2**.

2.0 WATER QUALITY STANDARDS AND IMPAIRMENT DETERMINATIONS

Water quality standards provide the means to determine whether a waterbody is impaired or not and include three main parts: stream classifications and designated uses, water quality criteria, and nondegradation provisions. Streams are classified based on their designated uses. Water quality must be maintained suitable for a designated use regardless of whether or not the waterbody is currently being used for that particular use. All stream segments assessed as part of this project except one are classified as B-1, which specifies that the water must be maintained suitable to support drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming, and recreation; the growth and propagation of salmonids fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. The upper segment of Tenmile Creek (MT41I006_141) is given a higher water quality classification of A-1 which includes the same designated uses but states that conventional treatment should only be necessary to remove naturally present impurities. The upper Tenmile drainage is one of the main public water supply sources for the city of Helena. All waterbodies not fully supporting a designated use due to a pollutant are considered impaired and require a TMDL. More detailed descriptions of Montana's surface water classifications and are provided in Montana Administrative Rules ARM 17.30.622 and 17.30.623.

The second component of water quality standards is water quality criteria, which describe conditions necessary to protect designated uses. Criteria can be numeric and expressed as a pollutant specific maximum concentration, level or magnitude for a specified frequency and recurrence interval. Or they can be narrative descriptions of allowable or desired conditions. Nondegradation provisions are not applicable to the TMDLs developed within this addendum because of the impaired conditions of the streams. A more detailed description of Montana's water quality standards may be found in the Montana Water Quality Act (75-5-301,302 MCA) and Circular DEQ-7 (Montana Department of Environmental Quality, 2012). The process used to determine the impairment status of each stream segment and identify which waterbodies require TMDLs includes following two steps:

1. Develop targets that represent unimpaired water quality
   TMDLs must include targets that represent a condition that meets Montana's ambient water quality standards. For certain pollutant groups that do not have established numeric criteria, such as sediment, the TMDL must develop measureable targets (e.g., width to depth ratios, pools per mile, etc.) from which to compare the current condition to the desired condition. All metals in this addendum have established numeric water quality criteria. These numeric water quality criteria are used directly as the primary TMDL targets and presented in more detail below.

2. Compare water quality against targets
   DEQ determines whether a waterbody is impaired by a pollutant and thus requires a TMDL to be developed 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 that a previously identified impairment is no longer verified, the waterbody-pollutant combination is recommended for removal from the 303(d) list. The impairment determination process is presented below in further detail.

2.1 METALS TARGETS

Targets for metals-related impairments in the Lake Helena TPA include both water chemistry targets and streambed sediment targets. The water chemistry targets are based on numeric human health standards and both chronic and acute aquatic life criteria as defined in DEQ Circular DEQ-7 (Montana Department of Environmental Quality, 2012). Sediment chemistry targets are adopted from numeric screening values for metals in freshwater sediment established by the National Oceanographic and Atmospheric Administration (Buchman, 2008).

The numeric pH standard for B-1 classified waters is adopted as the pH target. The standard, found in the Administrative Rules of Montana ARM 17.30.623, allows for a pH variation of 0.5 standard units within the range of 6.5 to 8.5. Additionally, waterbodies that have a pH naturally above 7.0 are required to maintain that level.

Water Chemistry Targets
All metals pollutants applicable to the project have numeric water quality criteria defined in Circular DEQ-7 (Montana Department of Environmental Quality, 2012). These criteria include values for protecting both human health and aquatic life. Aquatic life criteria are split into acute and chronic categories. Chronic criteria prevent long-term, low level exposure to pollutants while acute criteria protect against short-term exposure. Acute and chronic aquatic life criteria are intended to protect aquatic life uses; human health criteria are intended to protect drinking water uses. For any given pollutant, the most stringent of these criteria is adopted as the water quality target in order to protect all designated uses.

The aquatic life criteria for cadmium, silver and zinc are dependent upon water hardness values: the criteria increases (i.e., becomes less stringent) as the hardness increases. Water quality criteria for each parameter of concern at water hardness values of 25 mg/L and 400 mg/L are shown in **Table 2-1**. The targets are expressed in micrograms per liter, equivalent to parts per billion. Note that there is no acute aquatic life criterion for iron or chronic aquatic life criterion for silver; and the chronic and acute aquatic life criteria for zinc are identical. Additionally, the human health criteria for iron (300 µg/L) is based on a secondary maximum contaminant level (SMCL) established by EPA to prevent unwanted tastes, odors, or staining. This value provides a guide for determining interference with the specified uses after conventional water treatment. Therefore, the chronic aquatic life criterion of 1,000 µg/L is used as the iron target instead of the human health criteria.

Table 2-1. Numeric water quality targets for metals

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
	Acute	Chronic	Acute	Chronic	
Arsenic, TR	340	150	340	150	10
Cadmium, TR	0.52	0.10	8.73	0.76	5
Iron, TR	---	1,000	---	1,000	300†
Mercury, TR	1.70	0.91	1.70	0.91	0.05
Silver, TR	0.37	--	44.05	--	100
Zinc, TR	37.02	37.02	387.83	387.83	2,000

TR = total recoverable
†The iron human health criteria is a secondary aesthetic standard, therefore the chronic aquatic life criteria is used as the iron target.

Sediment Chemistry Targets
Montana does not currently have numeric criteria for metals in stream sediment, although general water quality prohibitions found in the ARM 17.30.637 state that *"surface waters must be free from substances…that will…create concentrations or combinations of materials that are toxic or harmful to aquatic life."* Therefore, 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 the water column during high flow conditions when the sediment is re-suspended. Where instream water quality data exceeds water quality targets, sediment data provide supporting information, but are not necessary to verify impairment.

In the absence of numeric criteria for metals in stream sediment, DEQ bases sediment quality targets on values established by the National Oceanic and Atmospheric Administration (NOAA). NOAA has developed concentration guidelines for metals in freshwater sediments. These criteria come from numerous toxicity studies and investigations, and are expressed in Probable Effects Levels (PEL). PELs represent the sediment concentration above which toxic effects to aquatic life frequently occur, and are calculated as the geometric mean of the 50th percentile concentration of the toxic effects dataset and the 85th percentile of the no-effect dataset (Buchman, 2008). **Table 2-2** contains the PEL values (in parts per million) for parameters of concern in the Lake Helena TPA. Note that iron and silver do not have established PEL values.

Table 2-2. Secondary targets for metals in stream sediments

Metal of Concern	PEL (mg/kg)
Arsenic	17.0
Cadmium	3.53
Mercury	0.486
Zinc	315

These PEL values are used as supplemental targets to evaluate whether streams are meeting Montana's narrative criteria outlined in ARM 17.30.637. If water quality targets are met but sediment concentrations are more than double the PEL (100% exceedance magnitude), then this result can be used as an indication of a water quality problem and while a TMDL is not usually developed at that time, additional sampling may be necessary to fully evaluate target compliance.

2.2 Impairment Determination

The evaluation process used to determine the impairment status of each stream is derived from DEQ's guidance for metals assessment methods (Montana Department of Environmental Quality, Water Quality Planning Bureau, Montioring and Assessment Section, 2012). A waterbody is considered impaired by a pollutant if at least one of the following scenarios is met:

- a single sample exceeds the human health target
- a single sample exceeds the acute aquatic life standard by a factor of two or more
- more than 10% of the samples exceed the chronic or acute aquatic life target

Eight independent samples are regarded as the minimum dataset, although either of the first two bullets can be met with less than eight samples. Additionally for the third bullet, if a dataset with less than eight samples has at least two chronic aquatic life target exceedances it is deemed impaired. For a pollutant currently listed as impaired with a dataset not falling into any of the three scenarios listed above but having less than eight samples, the status will remain impaired because the dataset is insufficient to prove water quality standards are met. All other scenarios result in a non-impaired status determination. Many datasets in this addendum contain less than eight samples because some attempted monitoring events encountered no streamflow during the late summer visits.

Following these steps, DEQ determined that 18 pollutants on 12 waterbodies are no longer impaired (see **Table 2-3**). These 18 pollutants will be delisted and will no longer appear on the list of impaired waters and subsequent 303(d) lists. DEQ also determined that seven pollutants on four streams are impaired and require TMDLs. Impairment determination summaries for these four impaired streams are documented in **Tables 4-1, 5-1, 6-1**, and **7-1**.

Table 2-3. Pollutants on the 2012 303(d) List no longer causing impairment

Waterbody & Location Description	Waterbody ID	Pollutant to be Delisted
CLANCY CREEK, headwaters to mouth (Prickly Pear Creek)	MT41I006_120	Mercury
GOLCONDA CREEK, headwaters to mouth (Prickly Pear Creek) T7N R3W S8	MT41I006_070	Copper
		Zinc
LUMP GULCH, headwaters to mouth (Prickly Pear Creek)	MT41I006_130	Mercury
MIDDLE FORK WARM SPRINGS CREEK, headwaters to mouth (Warm Springs Creek-Prickly Pear Creek)	MT41I006_100	Copper
		Mercury
PRICKLY PEAR CREEK, Lump Gulch to Wylie Drive	MT41I006_040	Aluminum
		Antimony
PRICKLY PEAR CREEK, Spring Creek to Lump Gulch	MT41I006_050	Arsenic
		Copper
PRICKLY PEAR CREEK, headwaters to Spring Creek	MT41I006_060	Cadmium
SEVENMILE CREEK, headwaters to mouth (Tenmile Creek)	MT41I006_160	Zinc
SKELLY GULCH, headwaters to mouth (Greenhorn Creek-Sevenmile Creek)	MT41I006_0220	Arsenic
SPRING CREEK, Corbin Creek to mouth (Prickly Pear Creek)	MT41I006_080	Aluminum
		Mercury
		Silver
TENMILE CREEK, headwaters to confluence of Spring Creek	MT41I006_141	Mercury
TENMILE CREEK, Helena WTP to mouth (Prickly Pear Creek)	MT41I006_143	Mercury

3.0 CALCULATING TMDLS AND ALLOCATIONS

Total maximum daily loads are provided in this addendum for all waterbody-pollutant combinations indicated in **Table 1-3**. TMDLs are based on the most stringent water quality target, the water hardness (if applicable), and the streamflow. These TMDLs apply to any point along the waterbody and therefore protect uses along the entire stream.

Because streamflow and hardness vary seasonally, TMDLs within this addendum are not expressed as a static value, but as an equation of the appropriate target multiplied by flow using the following formula:

Equation 1:

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 cfs
k = conversion factor of 0.0054

Example TMDLs are developed for high and low flow conditions in order to address seasonality. Seasonality is important because metals loading pathways and water hardness change as flow conditions change. During high flows, loading associated with overland flow and erosion of metals-contaminated soils and mine wastes tend to be the major cause of elevated metal concentrations. During low flow, groundwater transport and/or adit discharges tend to be the major source of elevated metals concentrations. Hardness tends to be lower during high flow conditions, which leads to more stringent water quality standards for hardness-dependent metals during the runoff season. Adaptive management policies and conceptual implementation strategies for TMDLs developed within this addendum will follow those contained in the Lake Helena Volume II Report (U.S. Environmental Protection Agency, 2006).

Table 3-1 provides example TMDLs and the total load reductions necessary to meet each TMDL in the Lake Helena TPA. Example TMDLs are calculated by replacing the “X” and “Y” variables in **Equation 1** with the flow observed at the identified monitoring stations and the appropriate target value based upon measured water hardness. If available, stations that had data collected under both flow conditions were selected to represent example TMDLs. If multiple data points met that stipulation, sites and dates with the highest measured metal concentration were used. Existing loads are calculated using the same flow values but changing the “X” variable to the observed metal concentration at the same site. Existing loads are shown in **Tables 4-2**, **5-2**, **6-2**, and **7-2**.The required percent reduction in total load is calculated by subtracting the TMDL from the existing load, and dividing the difference by the existing load. In cases where streams appear to be meeting the TMDL based on the current dataset, the percent reduction is reported as 0%.

Table 3-1. Inputs for example TMDLs in the Lake Helena TPA

Stream Segment	Station	Discharge (cfs)		Hardness (mg/L)		Metal	Target Conc. (µg/L)		TMDL (lbs/day)		% Total Reduction	
		High Flow	Low Flow	High Flow	Low Flow		High Flow	Low Flow	High Flow	Low Flow	High Flow	Low Flow
Corbin Creek	M09CRBNC02	0.011	0.004	366	377	Silver	37.81	39.78	0.0023	0.0009	0%	0%
	CRBNC-2.5	0.007	0.13	394	1420	Iron	1000	1000	0.0378	0.702	0%	99%
Granite Creek	M09GRNTC03	0.01	0.002	277	264	Arsenic	10	10	0.00054	0.0001	74%	83%
						Cadmium	0.58	0.56	0.00003	0.000006	0%	0%
Jackson Creek	M09JCKSC02	1.42	1.06	30	33.6	Zinc	43.2	47.55	0.331	0.272	0%	31%
Silver Creek*	S-26	NA	0.65	NA	312	Mercury	NA	0.05	NA	0.0002	NA	67%

*No low-level mercury data is available during high flow conditions

Once a TMDL is calculated, the total load must be allocated to all contributing sources. A TMDL is generally broken into a wasteload allocation (WLA), a load allocation (LA), and a margin of safety (MOS). WLAs are allowable pollutant loads that are assigned to permitted and non-permitted point sources. Mining-related waste sources (e.g. adit discharges, tailings accumulations, and waste rock deposits) are considered non-permitted point sources subject to WLAs. LAs are allowable pollutant loads assigned to nonpoint sources and may include the pollutant load from naturally occurring sources, as well as human-caused nonpoint loading. TMDLs must also take into account uncertainties which are inherent to environmental analyses such as these in a margin of safety. These elements are combined in the following equation:

Equation 2:

TMDL = ∑WLA + ∑LA + MOS

WLA = Wasteload allocation or the portion of the TMDL allocated to point sources

LA = Load allocation or the portion of the TMDL allocated to nonpoint 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 this addendum are provided for abandoned/unpermitted mining sources (WLA_{Mines}), naturally occurring metals sources ($LA_{NatBack}$), and permitted point sources (only applicable for Silver Creek). Due to uncertainties involved with allocating loads to specific mines, mining sources are given a composite WLA. Future targeted monitoring could help refine this composite WLA. An implicit margin of safety is applied to all TMDLs in this addendum through use of conservative assumptions throughout the TMDL development process as summarized below:

- Although a 10% exceedance rate is allowed for chronic and acute aquatic life targets, the TMDLs are set so the lowest applicable target is satisfied 100% of the time. This focuses remediation and restoration efforts toward 100% compliance with all targets, thereby providing a margin of safety for the majority of conditions where the most protective (lowest) target value is linked to the numeric aquatic life criteria.
- The monitoring results used to estimate existing water quality conditions and daily loads are instantaneous measurements, whereas chronic aquatic life criteria are based on average

conditions over a 96-hour period. This provides a margin of safety since a four-day loading limit could potentially allow higher daily loads in practice.

- The lowest or most stringent numeric water quality criterion 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 criteria developed at the national level via EPA and incorporate a margin of safety necessary for the protection of human health and aquatic life.
- Target attainment, allocations refinement, impairment determinations 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.

As an example, the steps taken to establish the low flow iron TMDL and allocation scheme on Corbin Creek is provided below.

1.) Establish example TMDL (see **Equation 1**)
(1,000 µg/L) x (0.13 cfs) x (0.0054) = 0.702 lbs/day

2.) Calculate existing load
(228,000 µg/L) x (0.13 cfs) x (0.0054) = 160.056 lbs/day

3.) Calculate total percent reduction required to meet TMDL
(160.056 lbs/day – 0.702 lbs/day) ÷ 160.056 lbs/day = 0.99 = 99%

4.) Allocate TMDL to sources (see **Equation 2**)
$LA_{NatBack}$ = (50 µg/L) x (0.13 cfs) x (0.0054) = 0.035 lbs/day
WLA_{Mines} = TMDL - $LA_{NatBack}$ = 0.702 lbs/day – 0.035 lbs/day = 0.667 lbs/day

The following four sections are organized by waterbody and provide a stream-specific description of metals sources, target evaluations, TMDL calculations and allocations. Loading estimates are based on limited datasets and are assumed to approximate metals loading during high and low flow conditions.

4.0 CORBIN CREEK (MT41I006_090)

Corbin Creek from the headwaters to the mouth at Spring Creek (2.8 miles) was listed as impaired on the Montana 2012 303(d) List because of pH, silver and temperature. These impairments caused the beneficial uses of aquatic life and agriculture to not be fully supported. In 2006 TMDLs were developed for arsenic, cadmium, zinc, lead, solids (sediment), and copper, but data were insufficient to develop a silver TMDL. Following additional data collection by EPA in 2010 and 2012, Corbin Creek's listing status was reassessed and iron was added to the list of impairments.

This addendum contains a silver and an iron TMDL for Corbin Creek. Additionally, because setting loads for pH is not practical, the iron TMDL will act as a surrogate for a pH TMDL. Because the pH issues are a consequence of acid mine drainage, it is assumed any reclamation activities needed to meet the iron TMDL will also address sources causing the pH impairment.

4.1 SOURCES OF SILVER AND IRON

Historic mining activities in the Corbin Creek watershed are significant contributors of silver and iron to Corbin Creek. Most of the drainage falls within the Colorado Mining District, with a small portion of the headwaters in the Clancy District. According to the Montana Bureau of Mines and Geology's (MBMG) abandoned and inactive mines database, there are an estimated 14 abandoned lode mines in the basin (see **Figure 9-2**). DEQ's abandoned mine inventory identifies no additional sites. Mines in the Corbin Creek drainage produced commodities such as copper, silver, lead, zinc, uranium and gold. Two abandoned mines, listed by the state of Montana as high priority, have been reclaimed to various degrees: the Bertha Mine and the Alta Mine.

The Bertha Mine was one of the first hardrock mines reclaimed in Montana. In 1987 the state sealed mine shafts and placed toxic materials associated with the mine into an onsite repository. The site was subject to additional reclamation work in 2002 because contaminated water was leaking from the repository and significant erosion was occurring due to sterile soils and a general lack of vegetation on the repository's surface. During this second phase, a clean layer of top soil and vegetation was applied to the repository and a collection pond was constructed below the structure. At the Alta Mine in 1999, DEQ sealed mine shafts, re-contoured the drainage and transported 154,000 cubic yards of contaminated soil to an imperviously lined, eight acre repository on a ridge adjacent to the site. Inspections of the Alta Mine during subsequent years have revealed continued discharge of toxic water and moderate revegetation success (Office of Surface Mining Reclamation and Enforcement (OSM), 2003). Despite restoration efforts at these two sites, abandoned mines are the single largest contributor of silver and iron pollution. There are no permitted point sources in the drainage.

4.2 EXISTING DATA AND COMPARISON TO WATER QUALITY TARGETS

The DEQ assessment record for Corbin Creek cites a sample collected in April 1997 by DEQ part of an investigation into a mine site along Spring Creek (Corbin Flats) as the basis for listing Corbin Creek as not supporting aquatic life and agriculture beneficial uses. Additionally, an attempt by DEQ to catalog macroinvertebrate populations prior to 1997 was unsuccessful because no macroinvertebrates were found in the creek.

The silver dataset representative of present day conditions (within the last ten years; post-reclamation work at the Bertha and Alta Mines) includes one sample collected by EPA in 2010, another two EPA samples from 2012, a fourth sample collected by the Lewis and Clark Water Quality Protection District (LCWQPD) in 2010 and a fifth LCWQPD sample from 2012. **Table 10-1** in **Section 10.0** below, contains six silver samples but two samples collected on 5/11/12 were less than one mile apart (as required by DEQ's assessment methodology to meet geographical independence) so only one of these samples was included in this analysis. Both 5/11/12 samples were below detection (< 0.5 µg/L). EPA attempted to collected additional data in 2012, but Corbin Creek was dry when visited in September and October. All water chemistry samples of silver were below human health and aquatic life criteria, however, since minimum dataset requirements are not met (i.e., there are less than eight samples) and human sources are present in the watershed, the pollutant remains impaired and a TMDL was developed.

Of the two iron samples, one met water quality criteria and the other did not. The iron concentration in the sample collected by EPA in October 2010 at the Alta Ore Mine Road crossing (below the mine) was 228 times greater than the target value (228,000 µg/L vs. 1,000 µg/L). A picture taken during that site visit is provided in **Figure 9-3** and clearly illustrates an overabundance of iron. Orange stained substrate is commonly seen in streams effected by acid mine drainage where the mineral pyrite (FeS_2) is exposed to oxygen and water to produce highly acidic water and ferrous hydroxide ($Fe(OH)_3$). Ferrous hydroxide then precipitates out of the water column and colors the streambed orange. To further illustrate the fact that Corbin Creek experiences acid mine drainage, the pH of the water that day measured an extremely acidic 3.1 standard units. At the same site during high flow conditions in April 2012 the iron concentration reduced to 188 µg/L and pH was a more neutral 6.26 standard units. Even though the iron dataset only contains one exceedance and less than eight samples, the magnitude of the 2010 exceedance is considered overwhelming evidence to warrant listing and require an iron TMDL. PELs for silver and iron have not been established; additionally, no metals sediment data exists on Corbin Creek. **Table 4-1** compares existing silver and iron data to the targets described in **Section 2.1**.

Table 4-1. Corbin Creek data summary and target exceedances

Parameter	Silver	Iron	pH
Number of samples	5	2	5
Date of samples	2010-2012	2010-2012	2010-2012
% of samples considered high flow	40%	50%	40%
Chronic AL criteria exceedance rate > 10%?	No	Yes	NA
> 2x acute AL criteria exceeded?	No	NA	NA
Human health criteria exceeded?	No	NA	NA
NOAA PEL exceeded?	NA	NA	NA
Human caused sources present?	Yes	Yes	Yes
Impairment Determination	**Impaired**	**Impaired**	**Impaired**

4.3 Corbin Creek TMDLs

The silver and iron TMDLs for Corbin Creek are broken into a load allocation to natural background and a composite wasteload allocation to abandoned mines, as expressed by the following formula:

$TMDL_{Corbin} = LA_{NatBack} + WLA_{Mines}$

The silver TMDLs and existing loads were calculated using silver concentrations and field parameters observed at site M09CRBNC02, located below the Alta Mine. Silver loads are extremely low in terms of pounds per day because streamflow in May 2012 was estimated to be five gallons per minute (GPM) and only two GPM in July 2012. The high flow iron TMDL and existing load were calculated using iron concentrations and field parameters observed at sit CRBNC-2.5 on April 21, 2012. At that time, flow was visually estimated to be three GPM. Low flow values for iron were calculated using observed values at the same site from October 2010. **Table 4-2** provides example TMDLs and allocations based on conditions observed at the previously mentioned sample sites. Note the high flow discharge value used to calculate the iron TMDL is actually smaller than the low flow discharge value. Flow conditions are classified by monitoring date. A dataset with more than two samples would likely show a different, more expected flow pattern. Because TMDLs are flow and hardness dependent, actual TMDLs will not always match **Table 4-2**.

Table 4-2. Corbin Creek Example TMDLs and Allocations

Metal	Flow	$TMDL_{Corbin}$	$LA_{NatBack}$	WLA_{Mines}	Existing Load	% Reduction
Silver	High flow	0.0023	0.00001	0.00229	0.00003	0%
	Low flow	0.0009	0.0000065	0.00089	0.000004	0%
Iron	High flow	0.0378	0.0033	0.0345	0.0068	0%
	Low flow	0.702	0.035	0.667	160.056	99%

All units are lbs/day

Even though **Table 4-2** appears to indicate that silver is currently meeting the TMDL with an overall reduction of 0% call for, it is possible Corbin Creek requires a reduction in silver loading at times not represented in the current sampling data. Because of the small dataset and the fact that exceedances have occurred in the past, a silver TMDL has been established. A limited dataset of two samples suggests that the iron TMDL is met during high flow conditions but a large reduction in iron loading is required during low flow time periods. The iron TMDL will act as a surrogate for a pH TMDL on Corbin. **Table 3-1** lists the inputs used to calculate Corbin Creek's example TMDLs.

5.0 Granite Creek (MT41I006_230)

Granite Creek from the headwaters to the mouth at Sevenmile Creek (2.5 miles) was listed as impaired on the Montana 2012 303(d) List because of arsenic and cadmium. These impairments caused the drinking water beneficial use to not be fully supported. No previous TMDLs have been developed for this waterbody. This addendum contains an arsenic and a cadmium TMDL for Granite Creek.

5.1 Sources of Arsenic and Cadmium

Historic mining activities in the Granite Creek watershed are significant contributors of arsenic and cadmium to Granite Creek. The entire drainage falls within the Austin Mining District. According to MBMG's abandoned and inactive mines database, there is one abandoned mine in the basin and DEQ's abandoned mine inventory shows three additional abandoned mines; all clustered together roughly 1.4 miles above the confluence (See **Figure 9-4**). There is no information in the abandoned mine records on the type of mine or commodities produced from these sites, but other operations in Austin Mining District (mostly in the Sevenmile Creek drainage) produced copper, silver, lead and gold from placer and lode mines. A cyanide heap leach operation named the Golden Flagg was built on BLM land in the early 1980s. Since that time the building has been removed but the foundation is still clearly visible from aerial photography (see **Figure 9-4**). The plant's processing facilities were never completed and if any ore processing was attempted it was very minimal (Brumm, Peter and David Williams, personal communication 2013). The United States Geological Survey (USGS) 7.5' x 7.5' topographic map of the area shows additional prospects and unnamed mines on both hillslopes above Granite Creek. No mines in the Granite Creek watershed are listed by the state of Montana as high priority and no reclamation work has occurred. There are no permitted point sources in the drainage.

5.2 Existing Data and Comparison to Water Quality Targets

The DEQ assessment record for Granite Creek cites a single sample from 1983 as the basis for listing the stream as not supporting drinking water beneficial uses. Five samples have been collected since then, and all were collected by EPA in 2012. Additional data collection was attempted but Granite Creek lost continuous flow and became isolated semi-stagnant pools as the summer progressed. Note the Granite Creek of interest here should not be confused with a stream by the same name also located in the Sevenmile Creek Watershed but found five miles to the east. That Granite Creek (MT41I006_179) was sampled by DEQ in 2002 and 2003 and found to be fully supporting all beneficial uses.

All five arsenic samples exceeded the human health target during both flow conditions. Concentrations increased by 1.5 times at the monitoring station below the four mines identified in DEQ and MBMG records, however, the station above the mines also exceeded targets. These results suggest that upstream sources, in addition to the four identified mines, contribute arsenic to Granite Creek. Future sampling in the watershed could help refine and characterize arsenic sources upstream of EPA's site M09GRNTC04. Concentrations of arsenic were slightly higher during August compared to May, although that could be more a consequence of semi-isolated pools evaporating and concentrating pollutants rather than actual changes in the amount of arsenic input to the system.

Unlike arsenic, all five cadmium samples were below the detection limit (< 0.08 µg/L) and met both human health and aquatic life criteria. However, since minimum dataset requirements are not met (i.e., there are less than eight samples) and human sources are present in the watershed, the pollutant remains impaired and a TMDL was developed. No metals sediment data exists on Granite Creek. **Table 5-1** compares existing arsenic and cadmium data to the targets described in **Section 2.1**.

Table 5-1. Granite Creek data summary and target exceedances

Parameter	Arsenic	Cadmium
Number of samples	5	5
Date of samples	2012	2012
% of samples considered high flow	20%	20%
Chronic AL criteria exceedance rate > 10%?	No	No
> 2x acute AL criteria exceeded?	No	No
Human health criteria exceeded?	Yes	No
NOAA PEL exceeded?	NA	NA
Human caused sources present?	Yes	Yes
Impairment Determination	**Impaired**	**Impaired**

5.3 Granite Creek TMDLs

The arsenic and cadmium TMDLs for Granite Creek are broken into a load allocation to natural background and a composite wasteload allocation to abandoned mines, as expressed by the following formula:

$$TMDL_{Granite} = LA_{NatBack} + WLA_{Mines}$$

The TMDLs and existing loads were calculated using metal concentrations and field parameters observed at site M09GRNTC03, located below the four abandoned mines in the drainage. Loads are extremely low in terms of pounds per day because streamflow in May 2012 was estimated to be 4.5 gallons per minute (GPM) and only one GPM in August 2012. **Table 5-2** provides example TMDLs and allocations based on conditions observed at the previously mentioned sample site. Because TMDLs are flow and hardness dependent, actual TMDLs will not always match **Table 5-2**.

Table 5-2. Granite Creek Example TMDLs and Allocations

Metal	Flow	$TMDL_{Granite}$	$LA_{NatBack}$	WLA_{Mines}	Existing Load	% Reduction
Arsenic	High flow	0.00054	0.00016	0.00038	0.0021	74%
	Low flow	0.0001	0.00003	0.00007	0.0006	83%
Cadmium	High flow	0.00003	0.000006	0.000024	0.000004	0%
	Low flow	0.000006	0.000001	0.000005	0.0000009	0%

All units are lbs/day

A large reduction in arsenic loading is required during both flow conditions. Even though **Table 5-2** appears to indicate that cadmium is currently meeting the TMDL with an overall reduction of 0% call for, it is possible Granite Creek requires a reduction in cadmium loading at times not represented in the current sampling data. Because of the small dataset and the fact that exceedances have occurred in the past, a cadmium TMDL has been established. **Table 3-1** lists the inputs used to calculate Granite Creek's example TMDLs.

6.0 Jackson Creek (MT41I006_190)

Jackson Creek from the headwaters to the mouth at McClellan Creek (2.3 miles) was listed as impaired on the Montana 2012 303(d) List because of zinc which caused the beneficial use of aquatic life to not be fully supported. No previous TMDLs have been developed for this waterbody. This addendum contains a zinc TMDL for Jackson Creek.

6.1 Sources of Zinc

Historic mining activities in the Jackson Creek watershed are significant contributors of zinc to Jackson Creek. The entire drainage falls within the McClellan Mining District. According to MBMG's abandoned and inactive mines database, there are two abandoned mines in the basin: the Pilot Mine and the Thomas Cruse Mine (See **Figure 9-5**). These sites are not included in DEQ's abandoned mine inventory. Jackson Creek is the only stream in this addendum to fall within Helena National Forest, however no mention of these two mines is contained in the MBMG report inventorying abandoned and inactive mines on the Helena National Forest (Metesh et al., 1998).

According to DEQ Historical Narratives, the Pilot Mine workings included a 330 foot shaft and a 1,200 foot tunnel which produced an unknown quantity of gold (Montana Department of Environmental Quality, 2009). The Thomas Cruse Mine was also a lode mine but no further description of the operation was found. No mines in the Jackson Creek watershed are listed by the state of Montana as high priority and no reclamation work has occurred. There are no permitted point sources in the drainage.

6.2 Existing Data and Comparison to Water Quality Targets

The DEQ assessment record for Jackson Creek cites a single sample from September 2002 as the basis for listing the stream as not supporting aquatic life beneficial uses. Results from that DEQ monitoring event included a zinc water sample that exceeded the aquatic life target (69 µg/L vs. 47.55 µg/L), a zinc sediment sample that exceeded the sediment target (433 mg/kg vs. 315 mg/kg) and a diatom population that indicated evidence of chronic toxicity from heavy metals. Seven additional zinc samples have been collected since 2002, all of which were at or below the detection limit of 10 µg/L. **Table 6-1** compares existing zinc data to the targets described in **Section 2.1**.

Table 6-1. Jackson Creek data summary and target exceedances

Parameter	Zinc
Number of samples	8
Date of samples	2002-2012
% of samples considered high flow	25%
Chronic AL criteria exceedance rate > 10%?	Yes
> 2x acute AL criteria exceeded?	No
Human health criteria exceeded?	No
NOAA PEL exceeded?	Yes
Human caused sources present?	Yes
Impairment Determination	**Impaired**

6.3 JACKSON CREEK TMDLS

The zinc TMDL for Jackson Creek is broken into a load allocation to natural background and a composite wasteload allocation to abandoned mines, as expressed by the following formula:

$TMDL_{Jackson} = LA_{NatBack} + WLA_{Mines}$

The TMDLs and existing loads were calculated using metal concentrations and field parameters observed at site M09JCKSC02 in September 2010 and May 2012. **Table 6-2** provides example TMDLs and allocations based on conditions observed at the previously mentioned sample site. Because TMDLs are flow and hardness dependent, actual TMDLs will not always match **Table 6-2**.

Table 6-2. Jackson Creek Example TMDLs and Allocations

Metal	Flow	$TMDL_{Jackson}$	$LA_{NatBack}$	WLA_{Mines}	Existing Load	% Reduction
Zinc	High flow	0.331	0.132	0.199	0.077	0%
	Low flow	0.272	0.057	0.215	0.395	31%

All units are lbs/day

The current dataset suggests that the zinc TMDL is met during high flow conditions but a reduction in zinc loading is required during some low flow time periods. **Table 3-1** lists the inputs used to calculate Jackson Creek's example TMDLs.

7.0 Silver Creek (MT41I006_150)

Silver Creek from the headwaters to T11N R4W S30 to Lake Helena (22.1 miles) was listed as impaired on the Montana 2012 303(d) List because of mercury and Dichlorodiphenyldichloroethylene (DDE), a metabolite of the pesticide Dichlorodiphenyltrichloroethane (DDT). These impairments caused the beneficial uses of aquatic life and drinking water to not be fully supported. In 2006 an arsenic TMDL was developed, but data were insufficient to develop a mercury TMDL. This addendum contains a mercury TMDL for Silver Creek.

7.1 Sources of Mercury

Mining activities in the Silver Creek watershed are significant contributors of mercury to Silver Creek. The drainage covers part of the Austin, Marysville, Scratchgravel Hills and Missouri River Mining Districts. According to MBMG's abandoned and inactive mines database, there are roughly 33 abandoned mines in the basin including placer, lode and mill operations (See **Figure 9-6**). DEQ's abandoned mine inventory estimates a higher number of abandoned mines in the region at around 53.

Silver Creek has been extensively placer mined. From Marysville Road one can observe major channel and floodplain disturbance, waste rock dumps, settling ponds and numerous tailings dams spanning the stream channel. The historic use of mercury during the amalgamation process at these placer sites is considered a significant source of mercury impairment today. Mines in the Silver Creek drainage produced commodities such as gold, silver, lead, copper and tungsten. Five sites are listed by the state of Montana as high priority: Belmont Mine, Bald Mountain Mine, Argo Millsite, Goldsil Millsite and Drumlummon Mine/Millsite. Although DEQ has studied and proposed reclamation activities in the Silver Creek drainage, no action has taken place (Olympus Technical Services, Inc., 2004).

The Belmont Mine started producing silver and gold in the 1870s and experience periodic activity up until 1948. In the end, workings included 2,000 feet of tunnels, a mill and three adits. An estimated 336,000 cubic yards of mine tailings currently exist at the site and a 1993 investigation found levels of mercury in tailing piles to be nearly 4 times the NOAA PEL and levels in waste rock nearly 1.5 times the NOAA PEL (Pioneer Technical Services, Inc., 1995). The Bald Mountain Mine was operated in close relationship with the Belmont Mine as part of the Cruse-Belmont-Bald Mountain Group and production records were sometimes combined. Roughly 65,000 cubic yards of tailings remain at the Bald Mountain Mine and one sample of the tailings tested nearly two time the NOAA PEL for mercury (Pioneer Technical Services, Inc., 1995). No production records or present day description of the Argo Millsite is available although it is only 1/3 mile west of the Goldsil Millsite.

The Goldsil Millsite was built in the 1970s for the purpose of reprocessing historic mill tailings. The Mill has had tumultuous operational history. Production shut down briefly in 1976 after a fish kill occurred on Silver Creek and high concentrations of cyanide and heavy metals were observed in the mill pond; lower but still detectible concentrations of these pollutants were found in Silver Creek (Olympus Technical Service, Inc., 2003). Shortly thereafter the Mill was purchased and ran by a new owner until a fire and additional tailing pond breaches and fish kills occurred in the early 1980s. The mill last operated in 1987 (CDM, 2011). Sediment samples collected at the site in 1993 revealed numerous exceedances of the NOAA PEL for mercury, including a tailings sample that was over 450 times the target (Pioneer Technical Services, Inc., 1995).

The Drumlummon Mine and Millsite has been active intermittently since 1876. Most recently RX Gold and Silver, Inc. began conducting surface and underground exploration work in 2008 under DEQ Exploration License # 00674. Working under the Small Miner Exclusion Statement, which limits the size of surface disturbance to five acres but does not cap the amount of material mined, the company installed a dewatering system in 2009 to pump up to 300 gallons per day of treated water out of the flooded historic mine workings (CDM, 2011). The water is treated for arsenic and antimony in an underground treatment facility before being discharged to a surface drain field. Conditional to the issuance of the exploration license, the mine has monitored Silver Creek above, adjacent and below the drain field to insure no surface water connection exists. While monitoring has shown metal concentrations have not increased, nitrate levels have risen in Silver Creek providing evidence that the infiltrated groundwater is indeed hydraulically connected to Silver Creek (Cronholm, Robert and Peter Brumm, personal communication 2013). In June 2013 DEQ issued the Drumlummon Mine a MPDES permit (MT0031721) to address the discharge of the pumped mineshaft water to Silver Creek through the drain field. The permit caps the discharge at 0.34 cfs per day and limits the concentrations of numerous pollutants including mercury, which is set at a daily maximum concentration equal to the human health criteria of 0.05 µg/L. The mine also holds a MPDES permit (MTR104058) for stormwater associated with minor construction activities.

Based upon successful exploration findings the company applied for a general operating permit through DEQ's Hard Rock Mining Section in 2011. The general operating permit proposed expanding mining activities, building a gravity-floatation mill and using the historic Goldsil Millsite as a tailings impoundment. DEQ deemed the general operating permit incomplete shortly after receiving the application and the permit has not been resubmitted or approved at this time. Reports indicate the mine was profitable until 2012. In April 2013 RX Gold and Silver, Inc. announced plans to halt work and close the Drumlummon Mine indefinitely (Byron, 2013).

Another surface water permit that discharges into Silver Creek is a stormwater permit associated with road construction. Lewis and Clark County holds the permit (MTR102884) for periodic reconstruction of the Marysville Road. Due to the nature of this activity, no metals loading are expected from this source and thus no wasteload is provided in the TMDL. Atmospheric deposition from coal fired power plants, industrial activities, and improper disposal of wastes that contain mercury are additional potential sources of mercury in the Silver Creek watershed. However due to the extent of mining in the basin, these sources will be considered insignificant and no portion of the TMDL is will be allocated to them until evidence exists to prove otherwise.

7.2 Existing Data and Comparison to Water Quality Targets

In 1976 a pond at the Goldsil Millsite discharged water into Silver Creek and caused a fish kill (Olympus Technical Service, Inc., 2003). High levels of metals, including mercury, were discovered in fish tissue the following year. The DEQ assessment record for Silver Creek cites this information as basis for listing the stream as not supporting aquatic life and drinking water beneficial uses. Since that time, Montana Fish, Wildlife and Parks has maintained a fish consumption advisory for Silver Creek. Investigations in 1995, 1996, 1998 and 2002 also revealed elevated mercury in the streambed sediments and water column (Olympus Technical Service, Inc., 2003; Pioneer Technical Services, Inc., 1995; Maximum Technology, Inc., 1996; Kendy et al., 1998). More recently, RX Gold and Silver, Inc. has monitored Silver Creek, groundwater and mineshaft water from 2007 to 2011 and observed exceedances of the mercury human health standard (CDM, 2011).

The mercury dataset representative of present day conditions collected within the last ten years contains two samples collected on the same day by EPA in 2010. One of those samples collected below the town of Marysville tested just below the human health target (0.04 µg/L vs. 0.05 µg/L). The sample taken lower in the basin exceeded the target (0.09 µg/L). **Table 7-1** compares existing mercury data to the targets described in **Section 2.1**.

Table 7-1. Silver Creek data summary and target exceedances

Parameter	Mercury
Number of samples	2
Date of samples	2010
% of samples considered high flow	0%
Chronic AL criteria exceedance rate > 10%?	No
> 2x acute AL criteria exceeded?	No
Human health criteria exceeded?	Yes
NOAA PEL exceeded?	NA
Human caused sources present?	Yes
Impairment Determination	**Impaired**

7.3 Silver Creek TMDLs

The mercury TMDL for Silver Creek is broken into a load allocation to natural background, a composite wasteload allocation to abandoned mines, a wasteload allocation to the Drumlummon Mine construction stormwater permit (MTR104058) and a wasteload allocation to the Drumlummon Mine (MT0031721) for mineshaft water pumped to the infiltration basin as expressed by the following formula:

$TMDL_{Silver} = LA_{NatBack} + WLA_{Mines} + WLA_{DrumSW} + WLA_{DrumPump}$

The wasteload allocated to pumped mineshaft water was calculated using the limits for flow and mercury contained in the MPDES permit (MT0031721). The TMDL and existing load were calculated using metal concentrations and field parameters observed at site S-26, located near the mouth. Only a low flow TMDL is provided because there is no recent high flow data. **Table 7-2** provides an example TMDL and allocations based on conditions observed at the previously mentioned sample site. Because TMDLs are flow and hardness dependent, actual TMDLs will not always match **Table 7-2**.

Table 7-2. Silver Creek Example TMDLs and Allocations

Metal	Flow	$TMDL_{Silver}$	$LA_{NatBack}$	WLA_{Mines}	WLA_{DrumSW}	$WLA_{DrumPump}$	Existing Load	% Reduction
Mercury	Low flow	0.0002	0.00002	0.00009	0	0.00009	0.0003	33%

All units are lbs/day

The current dataset suggests a 33% reduction in total mercury loading is required during low flow time periods. **Table 3-1** lists the inputs used to calculate Silver Creek's example TMDL.

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 watershed advisory groups and local conservation districts during the TMDL development process. Public participation for the TMDLs contained within this document was largely conducted as part of the Lake Helena TMDL planning process in 2006. Since that time period, DEQ has worked with the Lewis and Clark County Watershed Protection District, the Lake Helena Watershed Group, and EPA to collect additional data and complete TMDLs for the remaining impairments.

8.1 Response to Public Comments

Upon completion of the draft TMDL document, and prior to submittal to EPA, 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, and DEQ addresses and responds to all formal public comments.

A 30-day public review period for this addendum was initiated on August 14th and ended on September 12th, 2013. Public notices for the comment period were displayed in the Jefferson City Post Office and the Clancy Post Office. The document was made available to the public at the Lewis and Clark Public Library, the Clancy Public Library, and on DEQ's website. At a public meeting in Helena on August 28th, 2013, EPA provided an overview of the TMDLs and solicited public input and comment on the plan. The announcement for that meeting was distributed among the Stakeholder Group and advertised in the following newspapers: The Independent Record in Helena and the Boulder Monitor. This section includes DEQ's response to all public comments received during the public comment period.

Formal comments were submitted by the City of Helena's Water/Wastewater Treatment Facility and the Lake Helena Watershed Group. Comments are paraphrased below followed by responses from DEQ. The original comment letters are held on file at the DEQ and may be viewed upon request.

Comment #1 (City of Helena)
Based on a review of the dataset presented in DEQ's Factsheet for the City of Helena's Permit (MT0022641) and the impairment determination process described in **Section 2.2** of this addendum, Prickly Pear Creek may not be impaired by copper or zinc.

> **Response to Comment #1**
> Prickly Pear Creek is divided into five assessment units (stream segments) for Clean Water Act program purposes. Each segment of Prickly Pear Creek is evaluated independently for metals impairment. The City of Helena discharges treated wastewater effluent into the lower-most segment (MT41I006_020) of Prickly Pear Creek. This segment, as well as the segment of Prickly Pear Creek immediately above the City's discharge location (MT41I006_030), are not associated with nor were they investigated as part of this addendum. These segments were addressed in the *Volume II Report* (U.S. Environmental Protection Agency, 2006). As stated in the public notice, comments were only solicited at this time for subject matter contained in the new addendum.

The two closest upstream segments of Prickly Pear Creek sampled and subsequently evaluated as part of this addendum include Prickly Pear Creek from Spring Creek to Lump Gulch (MT41006_050) and Prickly Pear Creek from Lump Gulch to Wylie Drive (MT41006_040). As noted in **Table 2-3** of this addendum, it was concluded that the segment from Spring Creek to Lump Gulch was not impaired for copper and arsenic; and the segment from Lump Gulch to Wylie Drive was not impaired for aluminum and antimony. Recent data confirms that these specific upstream segments are still impaired by several metals for which TMDLs have been previously written, including zinc.

Comment #2 (City of Helena)
The natural background concentrations for zinc listed in **Tables 1-2** and **1-3** of this addendum indicate that the majority of zinc present in Prickly Pear Creek is a result of natural background sources. Montana Code Annotated (MCA) 75-5-306 states that “It is not necessary that wastes be treated to purer condition than the natural condition of the receiving stream.” The City would like to discuss the possibility of reopening the wastewater treatment plant’s (WWTP) discharge permit, specifically the copper and zinc limits, to consider these higher natural background concentrations.

Response to Comment #2
Background concentrations of zinc were estimated in this addendum to be between 10.00 and 17.23 µg/L (**Tables 1-2** and **1-3)** depending on seasonal flow conditions. DEQ arrived at these numbers using a manner consistent with national guidance where the 25th percentile of a non-reference dataset is selected (Buck et al., 2000). Metal concentrations above the 25th percentile are not representative of natural background conditions because a majority of the data collected in the Upper Missouri HUC was done on waterbodies with known or suspected metals impairments linked to abandoned mines. Text was added to **Section 1.3** to clarify this distinction. Note that background values for all metals, when using the 25th percentile of the Upper Missouri HUC dataset, are well below the applicable water quality standards.

Furthermore, background zinc concentrations estimated in this addendum represent a mere 9-15% of the daily maximum discharge limit of 110 µg/L in the City’s permit (determined using a representative Prickly Pear Creek hardness value of 91 mg/l $CaCO_3$). The discharge permit is not requiring treatment to purer than natural conditions; therefore MCA 75-5-306 does not apply. The City’s request to reopen permit limits is outside the scope of this TMDL addendum. However the City is welcome to contact DEQ’s Permitting and Compliance Division to further discuss this matter.

Comment #3 (Lake Helena Watershed Group)
The Lake Helena Watershed Group is concerned with setting TMDLs based on limited sampling data. For example the iron TMDL on Corbin Creek was established even though the minimum dataset requirement of eight samples was not met. Additional sampling would further support the rationale behind TMDLs in this addendum with small datasets.

Response to Comment #3
The original intent of this addendum was to revisit listed pollutants that were not addressed through TMDL development in 2006 because of various uncertainties and data gaps. With those objectives in mind, EPA funded targeted monitoring in 2010 and 2012. An attempt was made to collect a minimum of eight samples on each stream segment; however monitoring crews met situations where streamflow went subsurface or ceased completely in the summer. While eight

samples is the minimum dataset required to remove an existing pollutant from the list of impaired waters, a new pollutant can be listed with less samples under the scenarios described in **Section 2.2** or if supplemental information overwhelmingly indicates an impairment.

In the case of Corbin Creek, the commenter is correct in noting that less than eight iron samples were available for TMDL analysis. EPA attempted additional monitoring in 2012 but encountered a dry streambed. This iron impairment decision was made by employing narrative standards found in the Administrative Rules of Montana (ARM) 17.30.637. The rationale behind listing iron was twofold: First, although the dataset is limited, one water sample was 228 times greater than the chronic aquatic life criteria. This is significant because the chronic aquatic life criteria is the only iron target to judge waterbodies against since iron does not have an established criteria for acute aquatic life criteria, and the human health. The magnitude of this single iron exceedance provides sufficient evidence that a harm to aquatic life beneficial uses has been demonstrated. Secondly, Corbin Creek exhibits clear visual evidence that iron concentrations are elevated above acceptable levels (see **Figure 9-3**). These conditions have been documented on numerous occasions and the orange-colored streambed is a result of ferrous hydroxide [$Fe(OH)_2$] precipitating out of the water column.

DEQ agrees that additional sampling data would enhance the technical analyses provided in this addendum. As is the case for all TMDL projects, a balance must be struck between collecting more data and moving forward with the data currently available. DEQ addresses this conflict by emphasizing an adaptive management approach which allows for target attainment decisions to be revisited and TMDLs and allocations to be refined as additional data becomes available. This approach is detailed further in the *Volume II Report* (U.S. Environmental Protection Agency, 2006).

9.0 Additional Figures

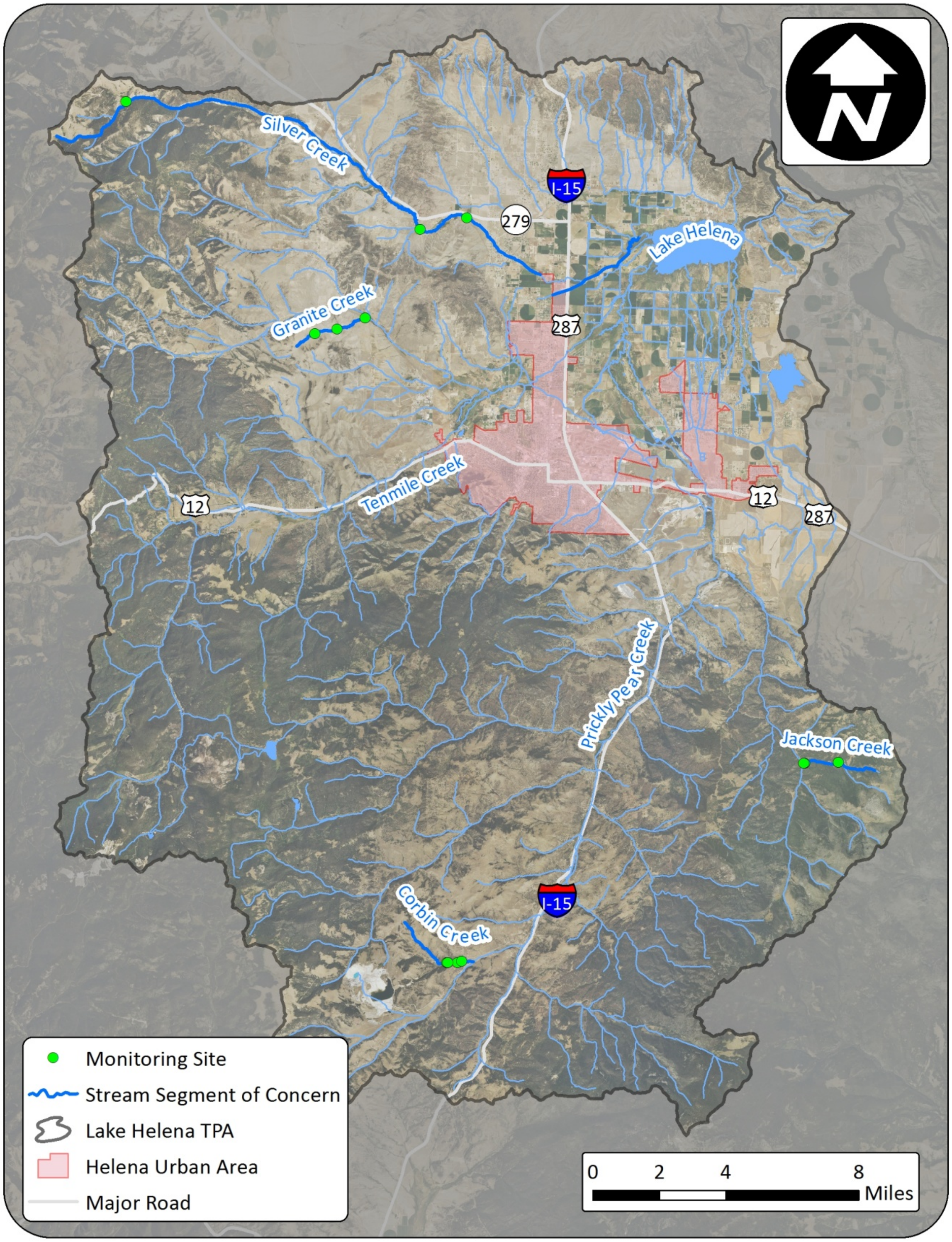

Figure 9-1. Lake Helena TMDL Planning Area

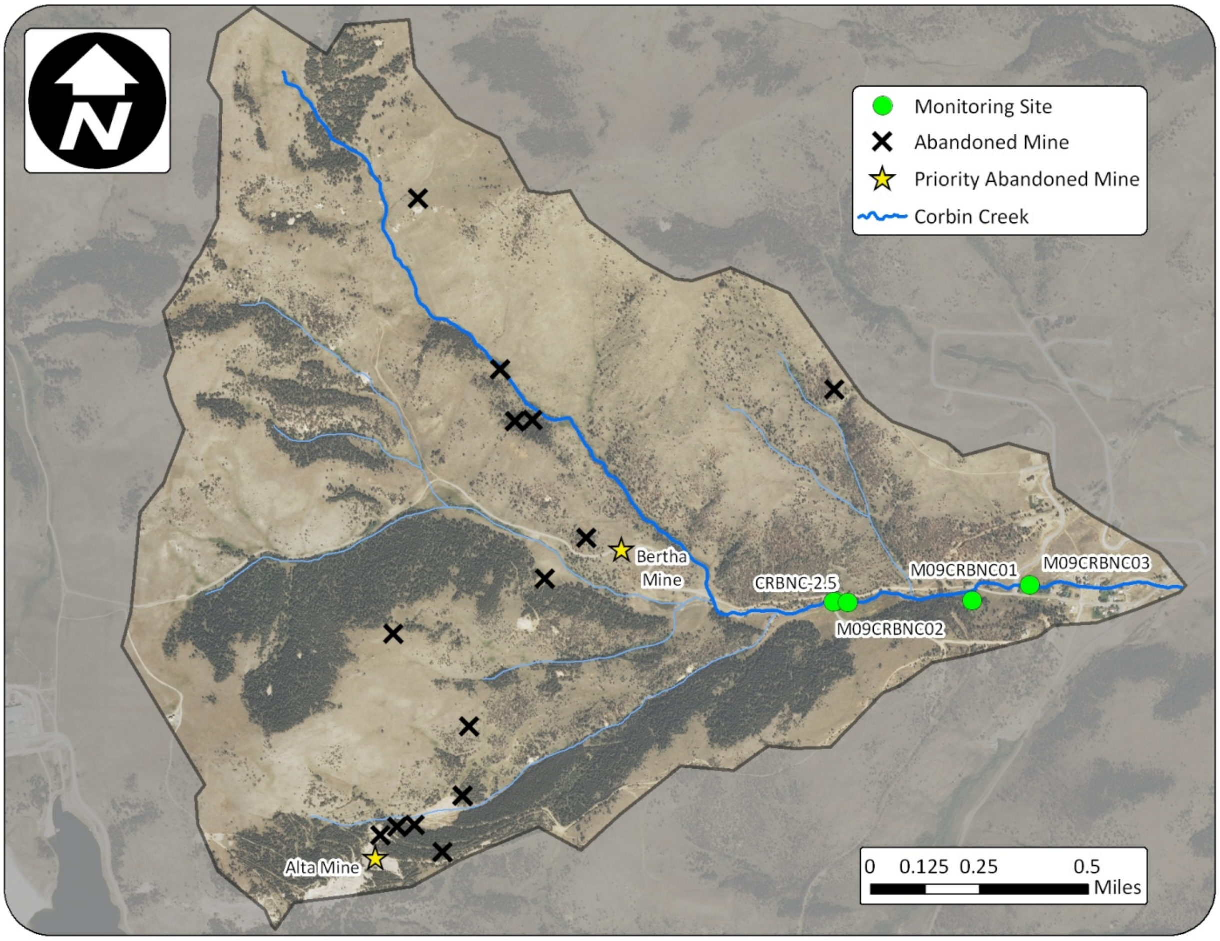

Figure 9-2. Corbin Creek Watershed

Figure 9-3. Ferric Hydroxide (Iron) Precipitate in Corbin Creek

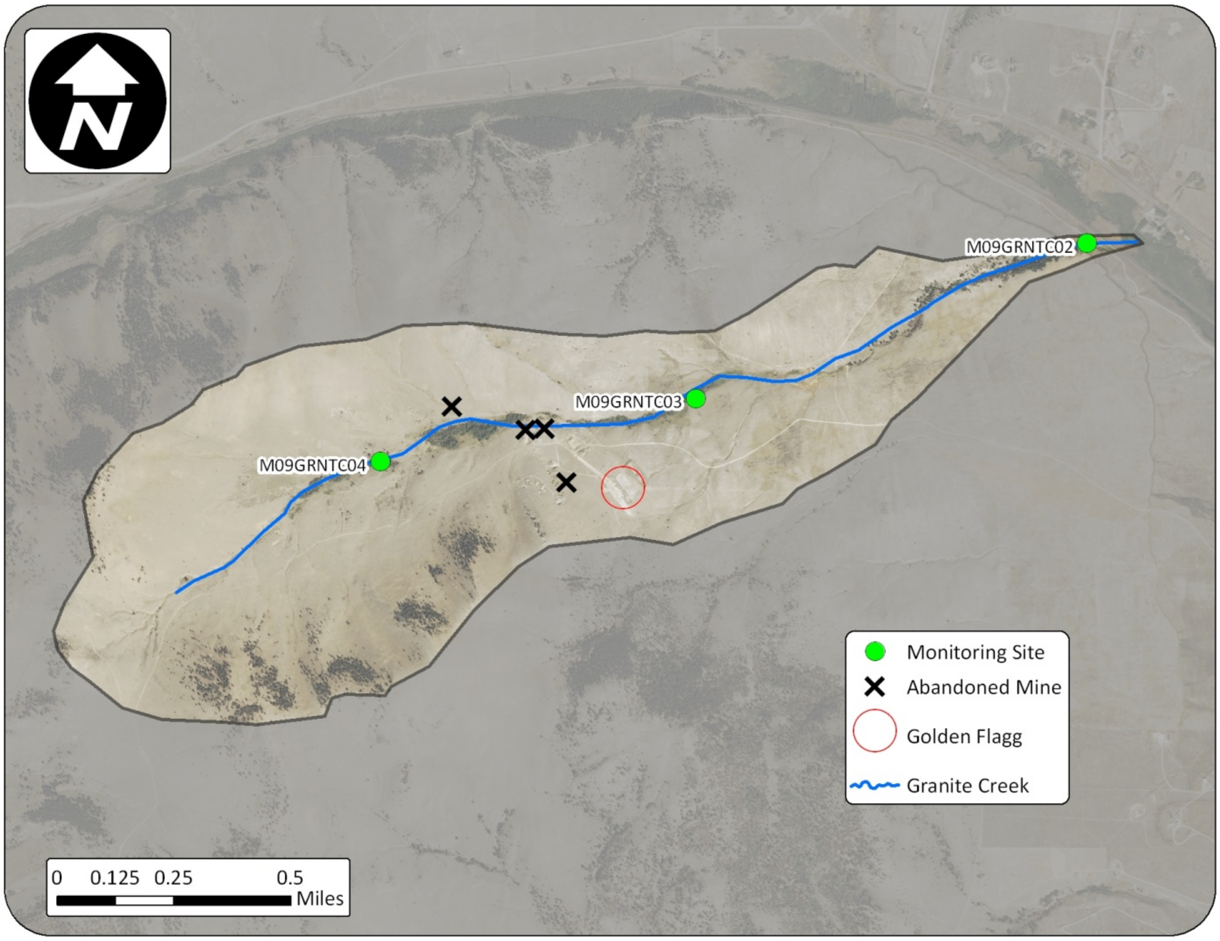

Figure 9-4. Granite Creek Watershed

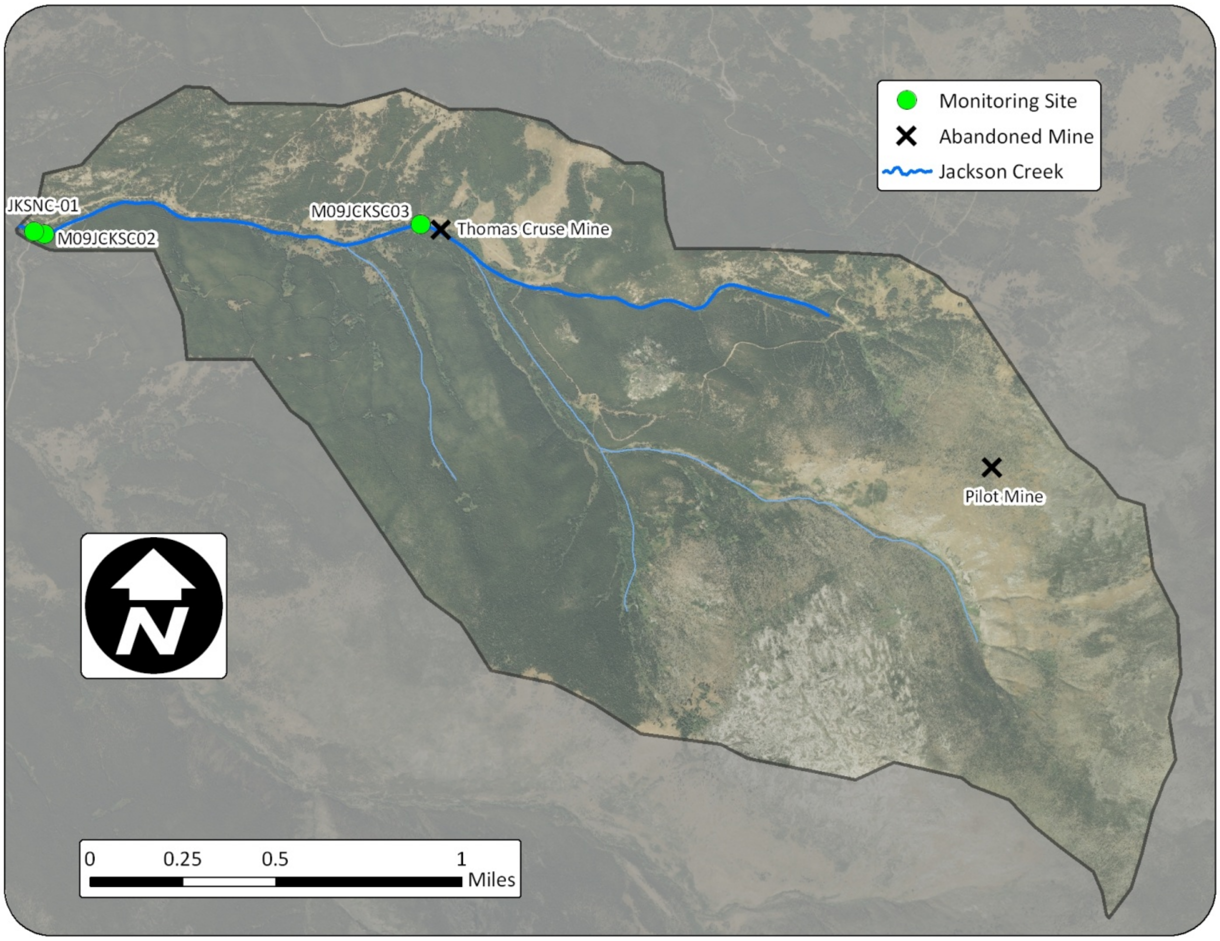

Figure 9-5. Jackson Creek Watershed

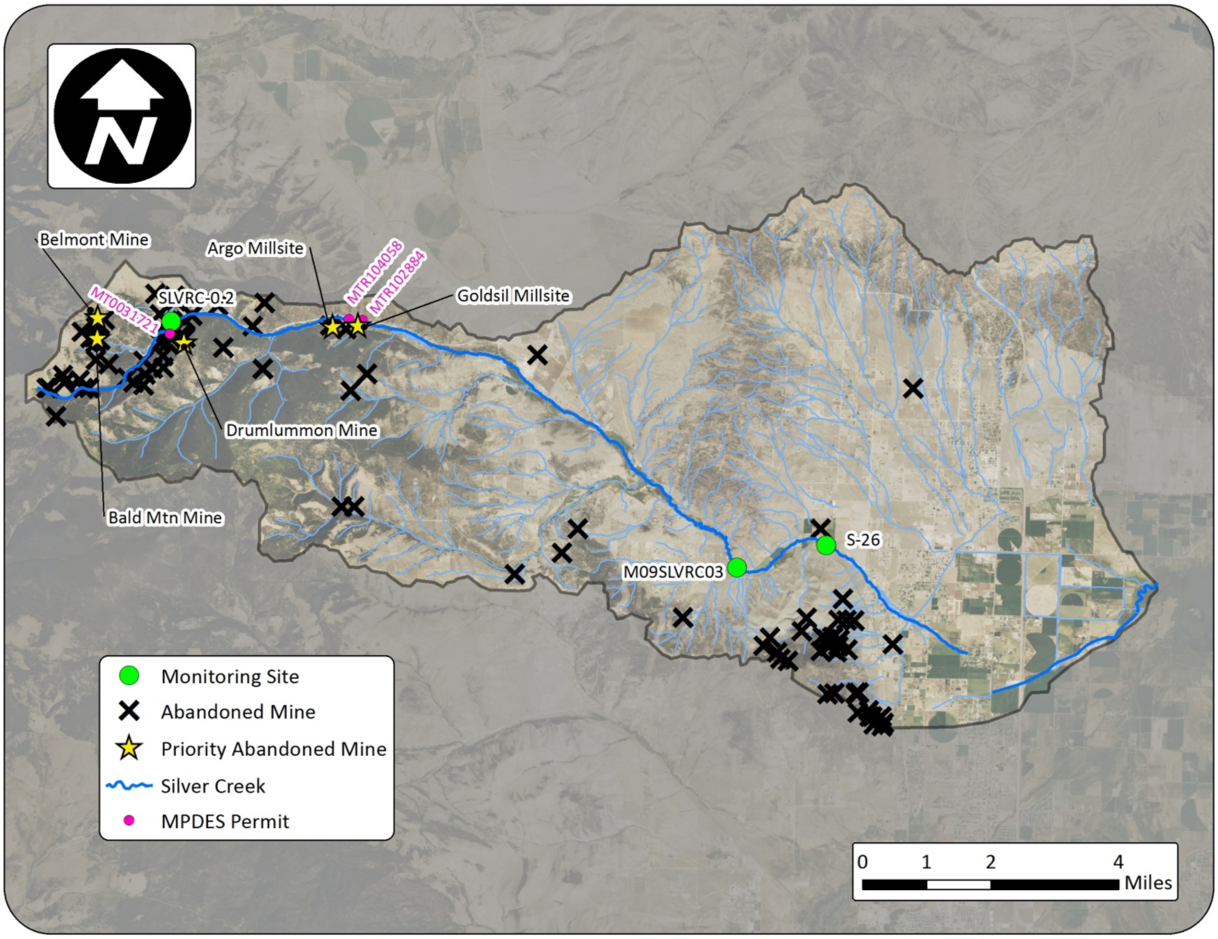

Figure 9-6. Silver Creek Watershed

10.0 METALS DATA

Table 10-1. Surface water data used during TMDL analysis

Organization	Site ID	Site Name	Activity Date	Latitude	Longitude	Hardness (mg/L)	Flow (cfs)	pH	As µg/L)	Ag (µg/L)	Cd (µg/L)	Fe (µg/L)	Hg (µg/L)	Zn (µg/L)	TSS (µg/L)
DEQ	M09CRBNC01	Corbin Creek at mouth	7/14/2003	46.38028	-112.0675	778.05			< 1		59			42700	
DEQ	M09CRBNC01	Corbin Creek at mouth	8/18/2003	46.38028	-112.0675	615.6			13		17			6770	
LCWQPD	CRBNC-2.5*	Corbin Creek downstream of Alta Ore Mine Road crossing	9/16/2010	46.3801	-112.074	1010	2.5	2.87	221	0.79	152			212000	
EPA	CRBNC-2.5	Corbin Creek at Alta Ore Mine Road crossing	10/18/2010	46.38008	-112.0742	1420	0.13	3.1	398	< 1	168	228000		205000	27000
LCWQPD	CRBNC-2.5*	Corbin Creek downstream of Alta Ore Mine Road crossing	4/21/2012	46.3801	-112.074	394	0.006684	6.26	< 3	< .5	7.24	180	< 0.1	4960	
EPA	M09CRBNC02	Corbin Creek at Alta Mine Road	5/11/2012	46.38007	-112.0735	366	0.01114	6.63		< .5					< 10000
EPA	M09CRBNC03	Corbin Creek above mouth	5/11/2012	46.38084	-112.0648	411	0.00891	5.07		< .5					< 10000
EPA	M09CRBNC02	Corbin Creek at Alta Mine Road	7/31/2012	46.38007	-112.0735	377	0.00446	6.89		< .2					< 4000
EPA	M09CRBNC02	Corbin Creek at Alta Mine Road	9/6/2012	46.38007	-112.0735		0								
EPA	M09CRBNC03	Corbin Creek above mouth	10/2/2012	46.38084	-112.0648		0								
EPA	M09CRBNC02	Corbin Creek at Alta Mine Road	10/2/2012	46.38007	-112.0735		0								
EPA	M09GRNTC04	Granite Creek above Granite Mine	10/2/2012	46.6521	-112.1707		0								
EPA	M09GRNTC04	Granite Creek above Granite Mine	8/1/2012	46.6521	-112.1707	150	0.00223	8.06	39		< .08				< 4000
EPA	M09GRNTC04	Granite Creek above Granite Mine	5/4/2012	46.6521	-112.1707	118	0.02	7.23	25		< .08				< 10000
EPA	M09GRNTC03	Granite Creek below Granite Mine	10/2/2012	46.65439	-112.1566	277	0.002228	8.06	50		< .08				< 4000
EPA	M09GRNTC03	Granite Creek below Granite Mine	9/5/2012	46.65439	-112.1566		0								
EPA	M09GRNTC03	Granite Creek below Granite Mine	8/1/2012	46.65439	-112.1566	264	0.00223	8.2	56		< .08				6000
EPA	M09GRNTC03	Granite Creek below Granite Mine	5/4/2012	46.65439	-112.1566	277	0.01	7.99	39		< .08				10000
EPA	M09GRNTC02	Granite Creek near mouth	5/4/2012	46.65987	-112.1393		0								
EPA	M09JCKSC02	Jackson Creek	9/7/2012	46.47181	-111.8529	33	0.98	7.34						< 10	< 10000
EPA	M09JCKSC02	Jackson Creek	7/31/2012	46.47181	-111.8529	32	1.27	7.76						< 10	< 4000
EPA	M09JCKSC02	Jackson Creek	5/10/2012	46.47181	-111.8529	30	1.42	7.73						< 10	< 10000
EPA	M09JCKSC03	Jackson Creek about 1 mile above mouth	9/7/2012	46.47262	-111.8317	33	0.89	7.4						10	< 10000
EPA	M09JCKSC03	Jackson Creek about 1 mile above mouth	7/31/2012	46.47262	-111.8317	31	1.16	7.41						10	12000
EPA	M09JCKSC03	Jackson Creek about 1 mile above mouth	5/10/2012	46.47262	-111.8317	28	1.41	7.71						< 10	< 10000
EPA	JKSNC-01	Jackson Creek near mouth	10/19/2010	46.47188	-111.8535	34	0.92	7.84	< 1	< 1	< .08	140		< 10	< 4000
DEQ	M09JCKSC02	Jackson Creek	9/11/2002	46.47181	-111.8529	33.6	1.06	7.67	1	< 1	< 0.1	130		69	5400
EPA	SLVRC-0.2	Silver Creek 0.25 mile below Marysville	10/21/2010	46.7502	-112.2952	130	0.49	8.39	2	< 1	< .08	210	0.0403	< 10	6000
DEQ	M09SLVRC03	Silver Creek at S. CK Estates Rd	8/21/2003	46.69897	-112.1062	444.6	0.66	8.6	12		< 0.1			< 1	
DEQ	M09SLVRC03	Silver Creek at S. CK Estates Rd	7/18/2003	46.69897	-112.1062	415.53	0.93	8.42	19		< 0.1			< 1	
EPA	S-26	Silver Creek at Smelko's (DNRC site)	10/21/2010	46.70466	-112.077	312	0.65	8.66	7	< 1	< .08	140	0.0903	< 10	< 4000

*LCWQPD identifies this site as CORBINCREEK5
All metal concentrations analyzed as Total Recoverable

Table 10-2. Stream sediment data used during TMDL analysis

Org ID	Site ID	Site Name	Activity Date	Latitude	Longitude	Al	Sb	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Ni	Se	Ag	Zn	Tl
DEQ	M09JCKSC01	Jackson Creek S/E of Montana City 2 edge of posted land	8/8/2001	46.508333	-112.019722	10300	< 5	11	170	< 5	< 1	19	43	23800	21	1860	15		< 5	< 5	70	< 5
DEQ	M09JCKSC02	Jackson Creek	9/11/2002	46.471806	-111.852889	11500	8.4	34.9	175	< 2	2.54	13.4	74.4	27200	99.2	1340	11.7	11.7	< 2.5	< 3	433	< 1
DEQ	M09SLVRC01	Silver Creek d/s of Frontage Rd. West of Hwy 15 N	8/1/2001	46.676389	-112.010556	8970	< 5	13	144	< 5	< 1	9	53	10700	28	128	8		< 5	< 5	86	< 20
DEQ	M09SLVRC02	Silver Creek 1/2 mile below Marysville	8/1/2001	46.748889	-112.296389	13700	< 5	20	222	< 5	< 1	11	56	15300	107	985	10		5	5	155	< 20

All metal concentrations analyzed as Total Recoverable and presented in units of mg/kg

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