Y03-TMDL-02a

Boulder River Watershed
Total Maximum Daily Loads

September 11, 2009

Montana Department of
ENVIRONMENTAL QUALITY

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Pete Schade, Project Manager

Cooperators:
Sweet Grass Conservation District
Big Timber, MT 59611

Boulder River Watershed Association
PO Box 749
Big Timber, MT, 59011

Stillwater Mining Company: East Boulder Mine
P.O. Box 1227
Big Timber, MT 59011-1227

Natural Resources Conservation Service
P.O. Box 749
Big Timber, MT 59011-0749

Northern Plains Resource Council
2401 Montana Avenue, Suite 200
Billings, Montana 59101

Cottonwood Resource Council
P.O. Box 1105
Big Timber, Montana 59011

Gallatin National Forest
P.O. Box 130
Bozeman, MT 59771

Significant Contributors:
Camp Dresser & McKee
Helena, MT 59601

ERRATA SHEET FOR THE BOULDER RIVER WATERSHED TOTAL MAXIMUM DAILY LOADS

This TMDL was approved by EPA on September 11, 2009. Several copies were printed and spiral bound for distribution, or sent electronically on compact disks. The original version had minor changes that are explained and corrected on this errata sheet. If you have a bound copy, please note the corrections listed below or simply print out the errata sheet and insert it in your copy of the TMDL. If you have a compact disk please add this errata sheet to your disk or download the updated version from our website.

Appropriate corrections have already been made in the downloadable version of the TMDL located on our website at: http://deq.mt.gov/wqinfo/TMDL/finalReports.mcpx

The following table contains corrections to the TMDL. The first column cites the page and paragraph where there is a text error. The second column contains the original text that was in error. The third column contains the new text that has been corrected for the Boulder River Watershed Total Maximum Daily Loads document. The text in error and the correct text are underlined.

Location in the TMDL	**Original Text**	**Corrected Text**
Page 74, Section 5.2.2.2.1, MPDES Permit MT-0026808 Stillwater Mining Company section, First paragraph, First sentence	The Stillwater Mining Company operates the East Boulder Mine and is permitted to discharge wastewater to the East Boulder River segment <u>MT43B004_132</u> through ground water and surface water outfalls.	The Stillwater Mining Company operates the East Boulder Mine and is permitted to discharge wastewater to the East Boulder River segment <u>MT43B004_142</u> through ground water and surface water outfalls.

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SECTION 1.0
EXECUTIVE SUMMARY

The Boulder River watershed is a forested drainage encompassing approximately 528 square miles. Half of the watershed's area lies within the Absaroka-Beartooth Wilderness. The Boulder River Watershed (also referred to in this document as the Boulder Total Maximum Daily Load Planning Area, or TPA) is one of more than 90 TMDL planning areas in the State of Montana in which water quality is currently or was previously listed as impaired. In each of these TMDL planning areas, the State of Montana is required to develop TMDLs to reduce pollutant loading and eliminate other negative impacts to water quality in impaired water bodies. This document focuses on metals related water quality impairments in the Boulder TMDL Planning Area (TPA) and presents a review of data on streams with verified metals impairments followed by all necessary metals TMDLs.

The primary objective is to develop an approach to restore and maintain the physical, chemical, and biological integrity of streams in the sub-basin so they will support all uses identified in state water quality standards. The uses include drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply. Clean Water Act objectives include restoration and maintenance of these watershed attributes for all of these uses. The Clean Water Act also requires the development of TMDLs that, when implemented, will result in conditions that support all beneficial uses. Fishery and associated aquatic life, recreation, or drinking water uses are usually the most sensitive uses in the Boulder watershed when developing TMDLs.

A TMDL is a pollutant budget identifying the maximum amount of a particular pollutant that a water body can assimilate without causing applicable water quality standards to be exceeded. Section 303 of the Federal Clean Water Act and the Montana Water Quality Act (Section 75-5-703) require development of TMDLs for impaired water bodies that do not meet Montana water quality standards. Section 303(d) also requires identification of impaired water bodies on a list, referred to as the 303(d) list. This 303(d) list is updated every two years and submitted to the U.S. Environmental Protection Agency (U.S. EPA) by the Montana Department of Environmental Quality (DEQ).

The document structure provides specific sections that address TMDL components and watershed restoration. **Sections 1.0 through 3.0** provide background information about the Boulder River watershed, Montana's water quality standards, and Montana's 303(d) listings. **Section 4.0** provides a review of data for water body segments requiring TMDLs, and **Section 5.0** provides all necessary metals TMDLs for water bodies with verified impairments and provides a framework restoration strategy for addressing known impairments.

Table 1-1 provides a brief summary of how each of these waterbodies is addressed within the TMDL document.

Table 1-1. Summary of TMDL Elements for the Boulder River TMDL Planning Area

Waterbodies & Pollutants of Concern (2006 303(d) list)	East Boulder River MT43B004_141	Sedimentation/Siltation Chlorophyll-*a*
	East Boulder River MT43B004_142	Chlorophyll-*a*
	Boulder River MT43B004_131	Copper Iron Lead Silver
	Boulder River MT43B004_132	Chromium Nickel Nitrate/Nitrite Total Kjeldahl Nitrogen
	Boulder River MT43B004_133	Phosphorous (Total) Nitrate/Nitrite Total Kjeldahl Nitrogen Excess Algal Growth
	Boulder River MT43B004_134	Copper Lead
Impaired Beneficial Uses	East Boulder River MT43B004_141	Aquatic life Cold Water Fishery Contact Recreation
	East Boulder River MT43B004_142	Aquatic life Cold Water Fishery Contact Recreation
	Boulder River MT43B004_131	Aquatic life Cold Water Fishery Contact Recreation
	Boulder River MT43B004_132	Aquatic life Cold Water Fishery
	Boulder River MT43B004_133	Aquatic life Cold Water Fishery Contact Recreation
	Boulder River MT43B004_134	Aquatic life Cold Water Fishery Drinking Water
Pollutant Sources	• Irrigated crop production • Impacts from abandoned mine lands • Flow Alterations from water diversions • Unknown sources	

Table 1-1. Summary of TMDL Elements for the Boulder River TMDL Planning Area

Water Quality Targets	Metals Targets • Targets are the adopted State of Montana water quality criteria for metals as defined in Circular DEQ-7.
Required TMDLs	Metals TMDLs • TMDLs prepared include the following metals TMDLs for the Boulder River: o Boulder River MT43B004_131: Lead, Copper, Iron o Boulder River MT43B004_132: Lead, Copper, Iron o Boulder River MT43B004_133: Lead, Copper, Iron o Boulder River MT43B004_134: Lead, Copper, Iron o Basin Creek MT43B005_010: Lead, Copper, Iron • The TMDL is an equation based on water hardness and stream flow
Allocations	• Waste load allocations are provided for existing MPDES permitted discharges: MT-0026808 (Stillwater Mining Company) and MT-0020753 (City of Big Timber). • A composite waste load allocation is provided for the combined load from abandoned mining and other non-point sources.
Restoration Strategies	• Utilize state and federal programs in place to reclaim abandoned mines • Detailed surface water sampling plan to better quantify metals loading rates and mechanisms • Utilize an adaptive management approach in restoration activities
Margin of Safety	• The Margins of Safety for copper, lead, and iron are implicit because the analyses are conservative. • The chronic criteria were used in calculating allocations • 25 mg/L hardness value was used in the wasteload allocations • An adaptive management approach will be used to implement reductions that work towards attainment of in-stream standards.
Seasonal Considerations	• Metals targets and loads were calculated based on high flow, low hardness events, ensuring year-round attainment

SECTION 2.0
WATERSHED CHARACTERIZATION

2.1 Physical Characteristics

2.1.1 Location

The Boulder River watershed comprises approximately 528 square miles in Sweet Grass and Park counties in south-central Montana. Approximately one-half of the watershed lies within the Absaroka-Beartooth Wilderness Area (ABWA). The watershed drains the East Boulder, West Boulder, and Lake Plateaus, and drains headwater areas at an elevation of up to approximately 11,300 feet on Mount Douglas to the northeast down to the mouth at the Yellowstone at an elevation of approximately 4,000 feet.

The Boulder River Watershed comprises a portion of the Upper Yellowstone 4th field Hydrologic Unit Code sub-basin (HUC No. 10070002) and contains two 5th field watersheds (**Figure 2-1**):

- HUC 10070002090 Includes the West Boulder and Main Boulder below the mouth of the West Boulder River and associated tributaries, including:
    - Davis Creek
    - Falls Creek

- HUC 10070002080 Includes the East Boulder and the Main Boulder above its confluence with the West Boulder and associated tributaries, including:
    - Elk Creek
    - Dry Fork Creek
    - Brownlee Creek
    - Graham Creek
    - Great Falls Creek
    - Speculator Creek
    - Hawley Creek
    - Fourmile Creek
    - Meat Rack Creek
    - Bridge Creek
    - East Fork Boulder River
    - Rainbow Creek

2.1.2 Topography

Figure 2-1 shows the general topography of the Boulder River Watershed. The southern portion of the watershed is typically steep mountainous and heavily forested terrain, and lies within the ABWA at elevations above 5,000 feet. The northern portion of the watershed, below the National Forest Boundaries is primarily wider, flatter alluvial valleys and foothills.

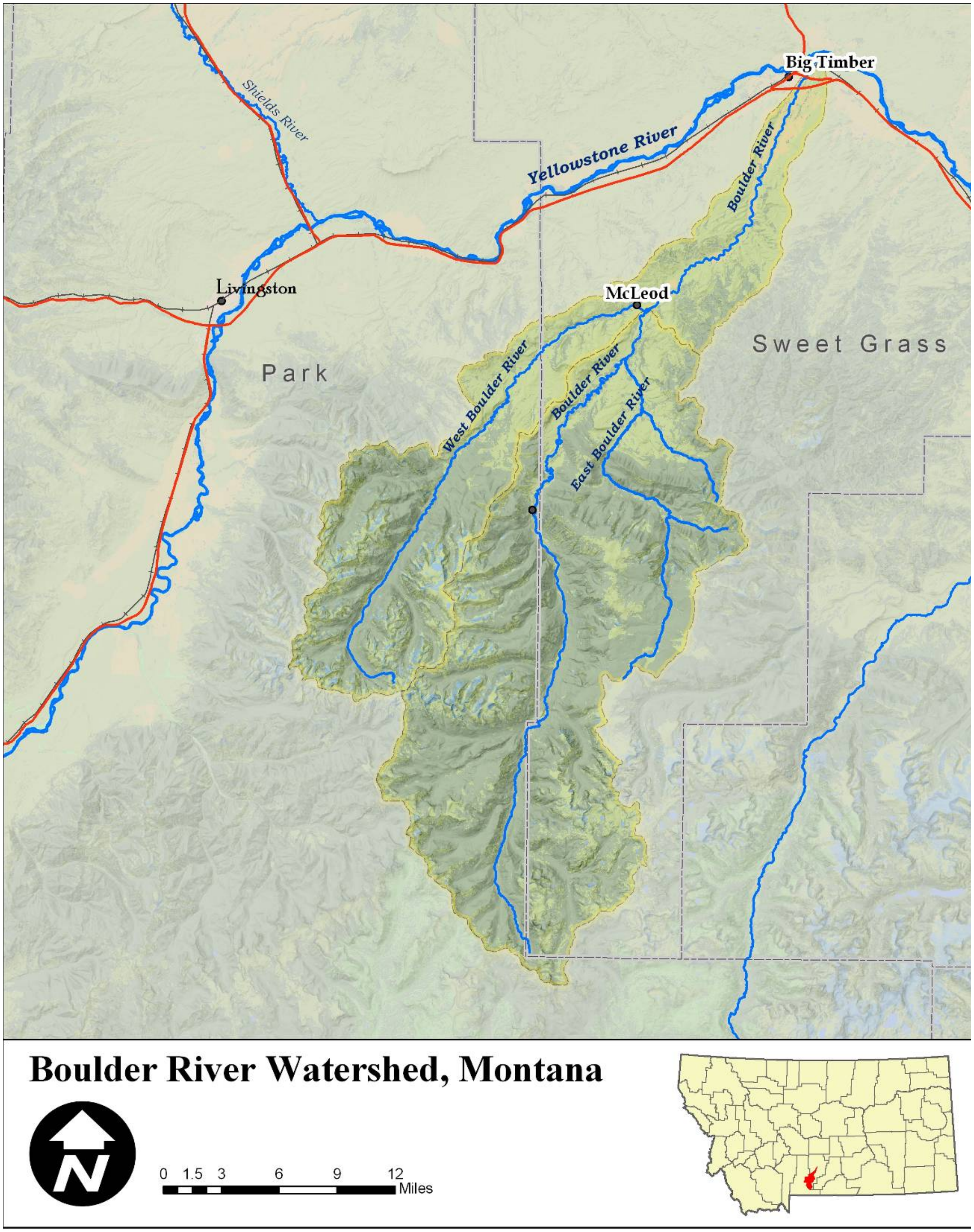

Figure 2-1. Boulder River watershed overview map

2.1.3 Climate

The Western Regional Climate Center provides data for several weather stations in Montana, including data collected from 1894 to 2003 in Big Timber, Montana. **Figure 2-2**, shows average minimum and maximum air temperatures and temperature extremes for Big Timber. In general, average daytime high temperatures range from the lower 30s in January and February to the 80s in late July. Average low temperatures range from the teens in the winter to the 50s in July.

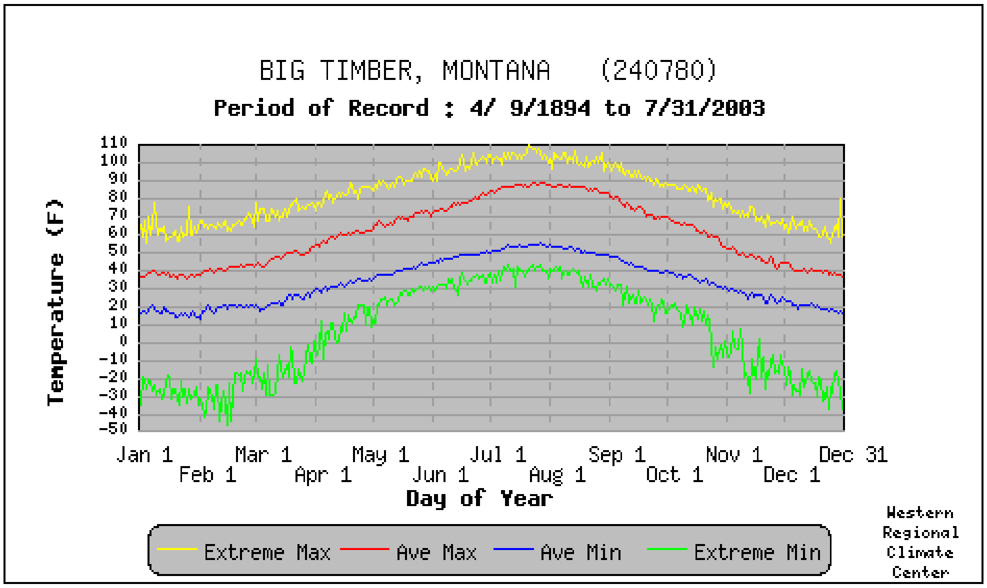

Figure 2-2. Minimum and maximum temperatures, Big Timber, Montana

Precipitation data is also summarized by the Western Regional Climate Center for Big Timber. **Figure 2-3** shows average monthly precipitation (in inches) for Big Timber from 1961-1990. The lower elevation Boulder River corridor receives approximately 15 inches of precipitation per year, while the headwaters for the Boulder River watershed generally receive 40 to 55 inches of annual precipitation.

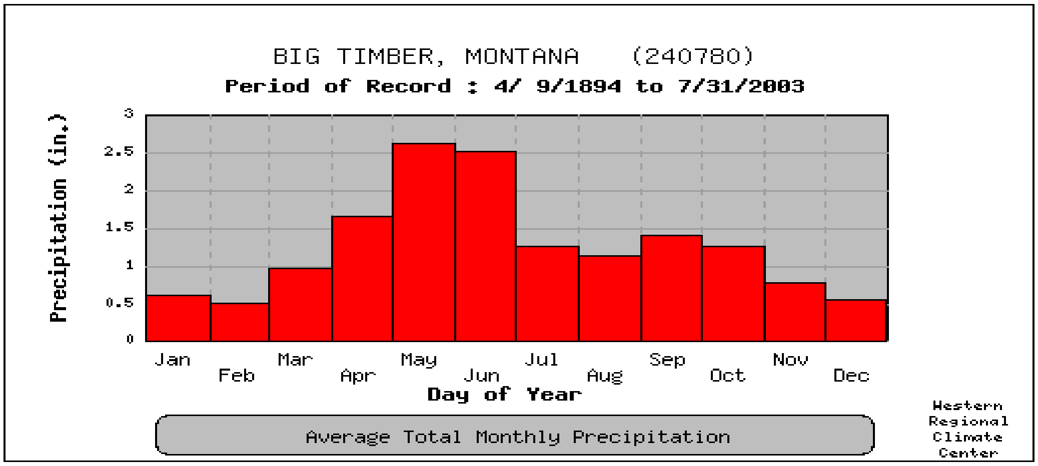

Figure 2-3. Average monthly precipitation, Big Timber, Montana

The National Oceanic and Atmospheric Administration (NOAA) collects data from three Snowpack Telemetry (SNOTEL) Stations located within the Boulder watershed. These SNOTEL stations are:

- Box Canyon, at an elevation of 6,699 feet
- Monument Peak, at an elevation of 8,852 feet
- Placer Basin, at an elevation of 8,829 feet

These stations are maintained and monitored by the Natural Resources Conservation Service (NRCS). Average annual precipitation at the Placer Basin site over the past 30 years is approximately 40 inches (including snow-water-equivalent values).

2.1.4 Hydrology

The United States Geologic Survey (USGS) National Water Information System (NWIS) online database lists five historical surface water flow gages and one current surface water flow gage in the Boulder watershed. Three of these stations occur on the main stem of the Boulder:

- USGS 06197500: Boulder River near Contact, Montana (historic site)
- USGS 06199500: Boulder River near McLeod, Montana (historic site)
- USGS 06200000: Boulder River at Big Timber, Montana (current site)

Two historic sites were located on the West Boulder River:

- USGS 06198500: West Fork Boulder River near Bruffeys, Montana
- USGS 06199000: West Boulder River at McLeod, Montana

One historic site was located on the East Boulder:

- USGS 06198000: East Boulder River near McLeod

Figure 2-4 shows flows for station USGS 06200000 for the Boulder River at Big Timber from 1947 through 2001.

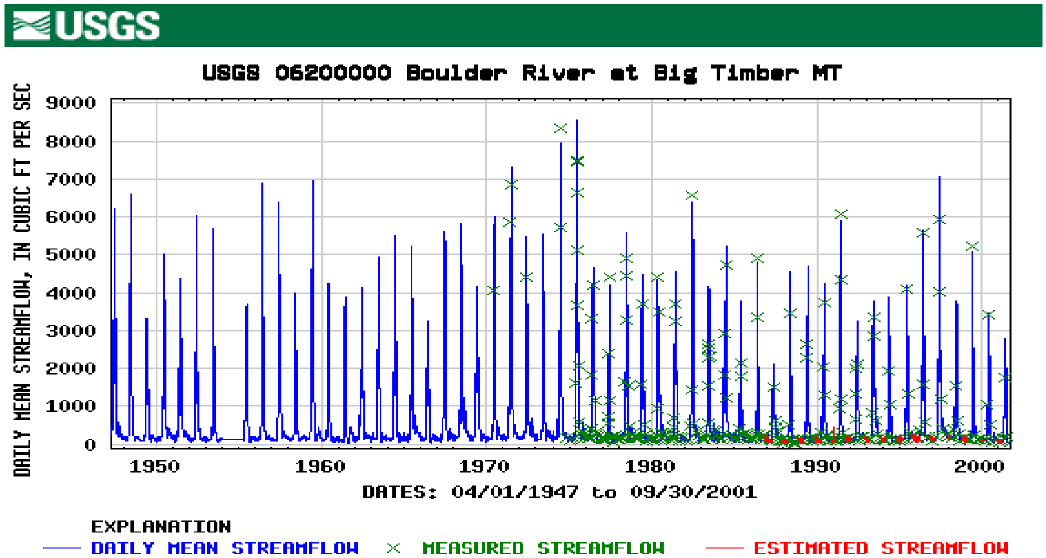

Figure 2-4. Historic flow data for Boulder River at Big Timber, Montana

Figure 2-5 shows a typical seasonal hydrograph for station USGS 06200000 compiled from average daily flows for a 54-year period of record from 1947 through 2001. Both the rising and falling limbs of the hydrograph are very steep, showing that runoff events in the Spring are intense and irrigation withdrawals and diminishing snowpacks in early summer cause steep reductions in flow.

Peak flows are typically in late May in response to rainfall and snowmelt events and average about 3,000 cubic feet per second. Flows diminish sharply through June and July in response to diminished snow pack and extensive irrigation uptakes upstream of Big Timber. By mid-July, base flows of approximately 200 cubic feet per second (cfs) are reached, with little change until the following spring's runoff.

Streamflow data has been collected in the watershed by USGS at various sites since the early 1900s. The longest running and most current data has been collected at the USGS site located near Big Timber (USGS Site 06200000). Data were available for this site from the USGS WATSTORE database for streamflow data collected from 1947 through 2001.

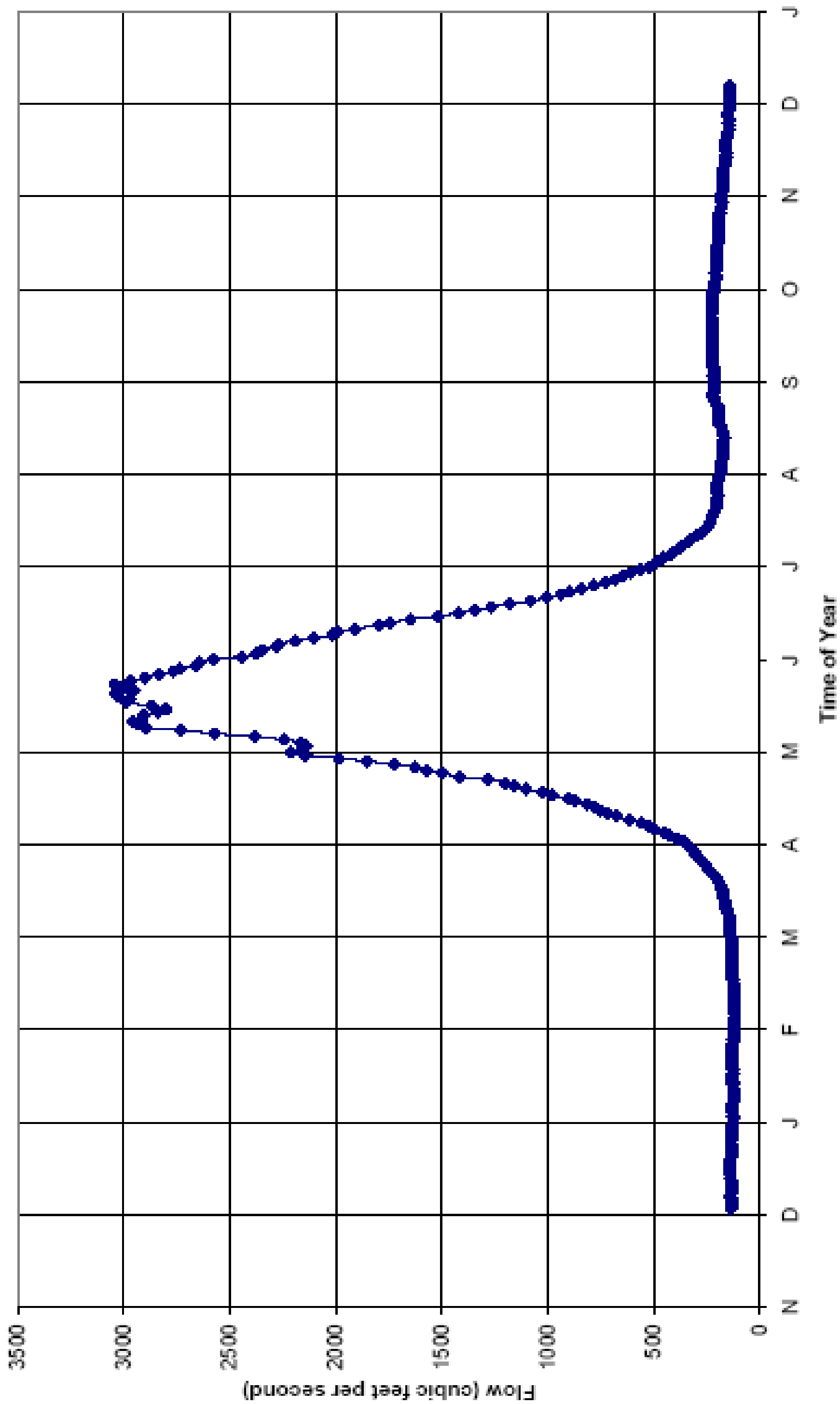

Figure 2-5. Typical hydrograph - Boulder River at Big Timber based on average daily flows 1947 - 2001

Minimum discharges usually occur during late summer when irrigation diversion is greatest. More recent data indicate the present drought in Montana. In 1999, discharge was very similar to average, with slightly below average flows in the late summer and early fall of that year. However, in 2000 and particularly in 2001, stream flow as measured at Big Timber was well below average for the Boulder River. Peak flows reached only 2,181 and 1,484 cfs in 2000 and 2001 respectively, and streamflow dropped as low as 25.5 cfs in August 2001 (DeArment 2003).

2.1.5 Geology

USGS geologic mapping shows the primary geology within the Boulder River Watershed (**Figure 2-6**). Uplifted Precambrian gneiss and schist comprise the upper watershed, and Paleozoic sedimentary rocks dominate the lower reaches below Contact. Tertiary volcanoclastics cap the Precambrian rock in the extreme upper watershed, and unconsolidated glacial deposits and alluvium drape lower portions of the watershed.

Abandoned mines are located throughout the watershed (**Figure 2-7**). Three Priority Abandoned Mine sites are located in the Independence Mining District in the Basin Creek drainage; the Poorman/Emma Mine, the Yager/Daisy Mine and a mine identified as NW SE Section 22 Mine.

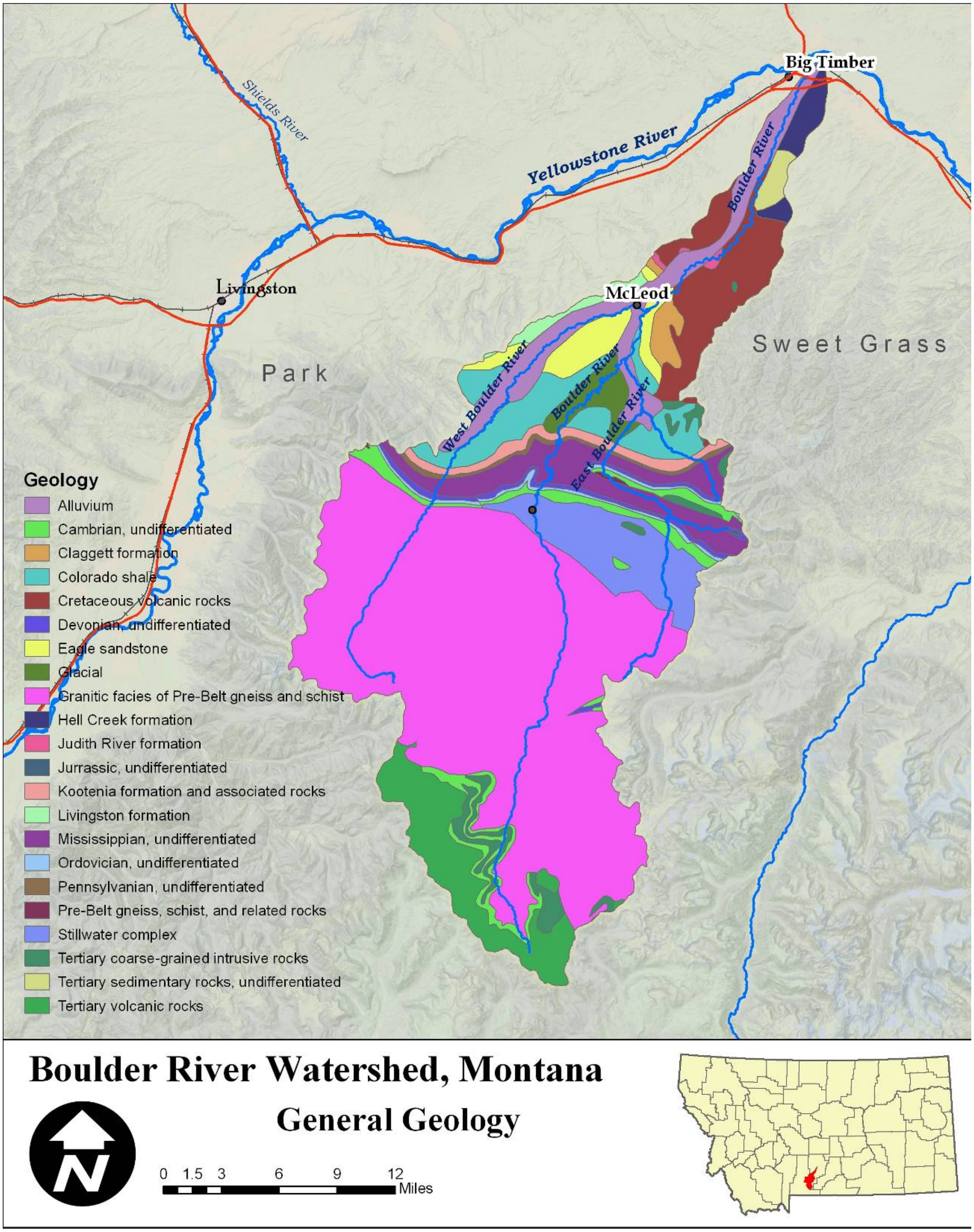

Figure 2-6. Boulder River watershed general geology map

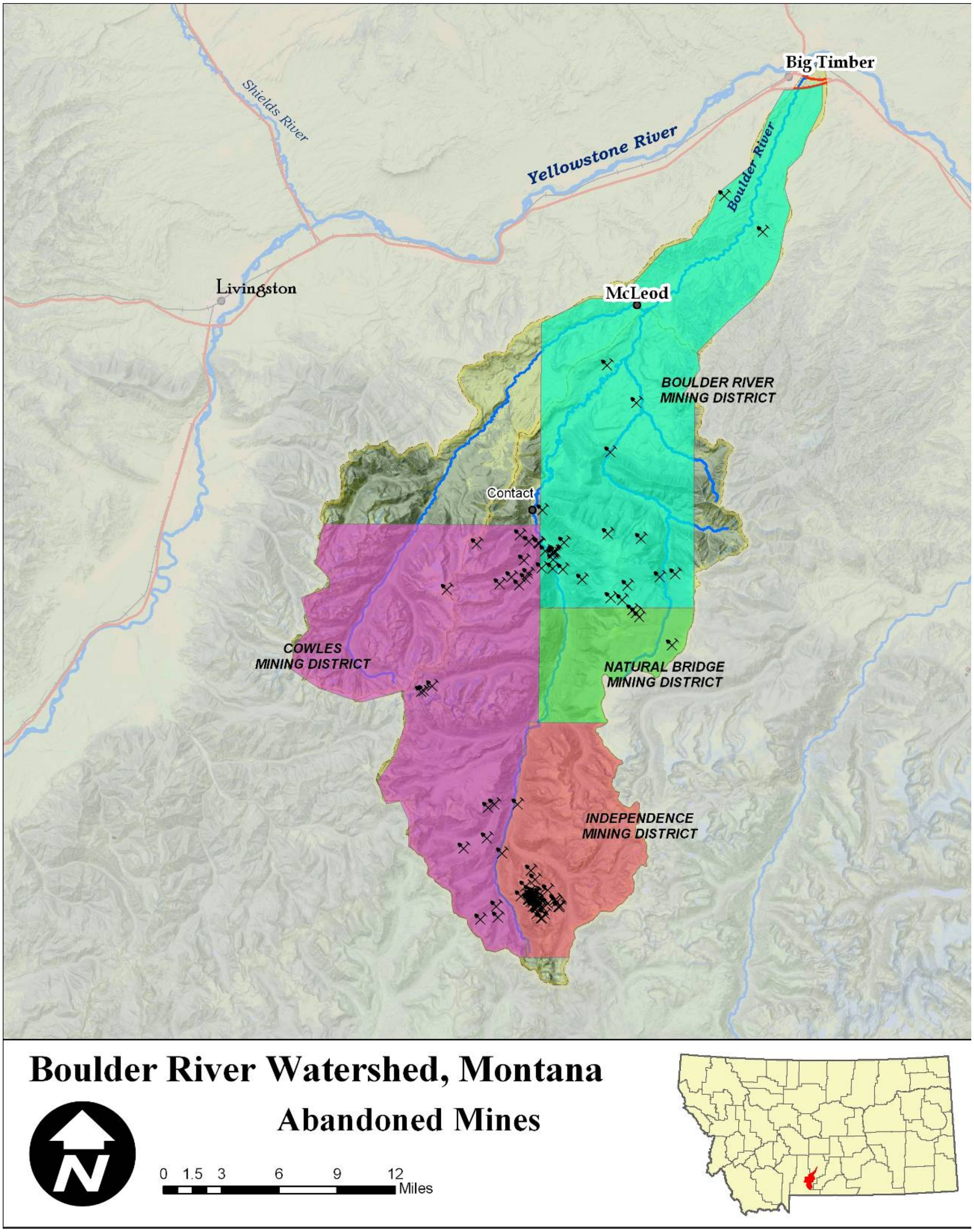

Figure 2-7. Boulder River watershed historic mining map

2.1.6 Soils

Fourteen NRCS soil mapping units occur within the Boulder River Watershed (**Figure 2-8 and Table 2-1**). Soils of the upper watershed are predominantly outcrops and shallow soils derived of calcarious and non-calcarious decomposed rock and conifer detritus, while lower watershed soils are typically deeper loamy alluvial soils.

Table 2-1. NRCS Soil Mapping Units in the Boulder River Watershed

NRCS Soil Mapping Unit	Acres	% of Area
Shadow-Garlet-Macfarlane	95,069	28.1
Rock Outcrop-Rubble Land-Cowood	72,627	21.5
Absarokee-Hilger-Big Timber	37,687	11.2
Prospect-Sublette-Teton	25,645	7.6
Shadow-Comad-Rock Outcrop	17,013	5.0
Havre-Ryell-Harlem	16,489	4.9
Shadow-Garlet-Water	15,079	4.5
Whitefish-Gallatin-Helmville	14,539	4.3
Rock Outcrop-Water-Rubble Land	13,541	4.0
Helmville-Whitore-Tropal	11,329	3.4
Sweetgrass-Hilger-Fairfield	8,254	2.4
Mirror-Bross-Vasquez	5,861	1.7
Tigeron-Garlet-Worock	4,032	1.2
Worock-Garlet-Rock Outcrop	733	0.2
TOTAL	337,898	100.0

Soils across the planning area vary with local geology, topographic relief, and climate. Soils on flood plains and terraces are more than 60 inches deep and formed in loamy material deposited by water. All other soils vary in depth from less then 20 inches to more then 60 inches. Soils on lower elevations uplands and terraces were transported by wind or water or were formed from igneous and metamorphic rocks. Soils on the higher elevation uplands form in water deposited materials or from metamorphic rock. Soils on mountains are formed mainly from glacial till or bedrock.

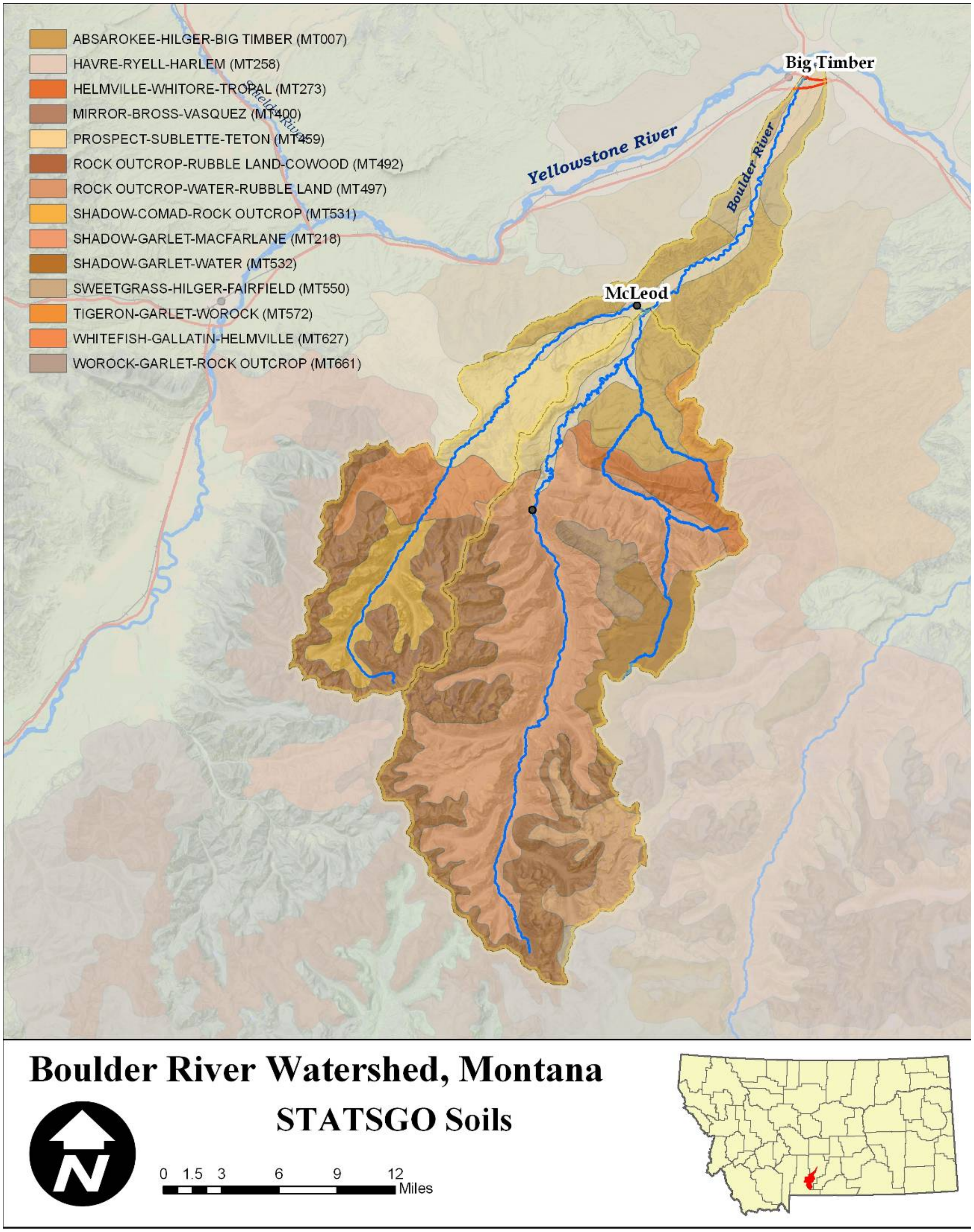

Figure 2-8. Boulder River watershed STATSGO soils map

2.1.7 Land Use and Land Cover

A simplified vegetation cover in the watershed is shown in **Figure 2-9** and is dominated by alpine forest and grasslands. In general, coniferous trees dominate the plant communities upstream of Natural Bridge while grasslands dominate below.

Several noxious weeds have been identified in the watershed and are a threat to streambank stability when they transplant native riparian vegetation. Spotted knapweed, sulfur cinquefoil, and leafy spurge have been observed.

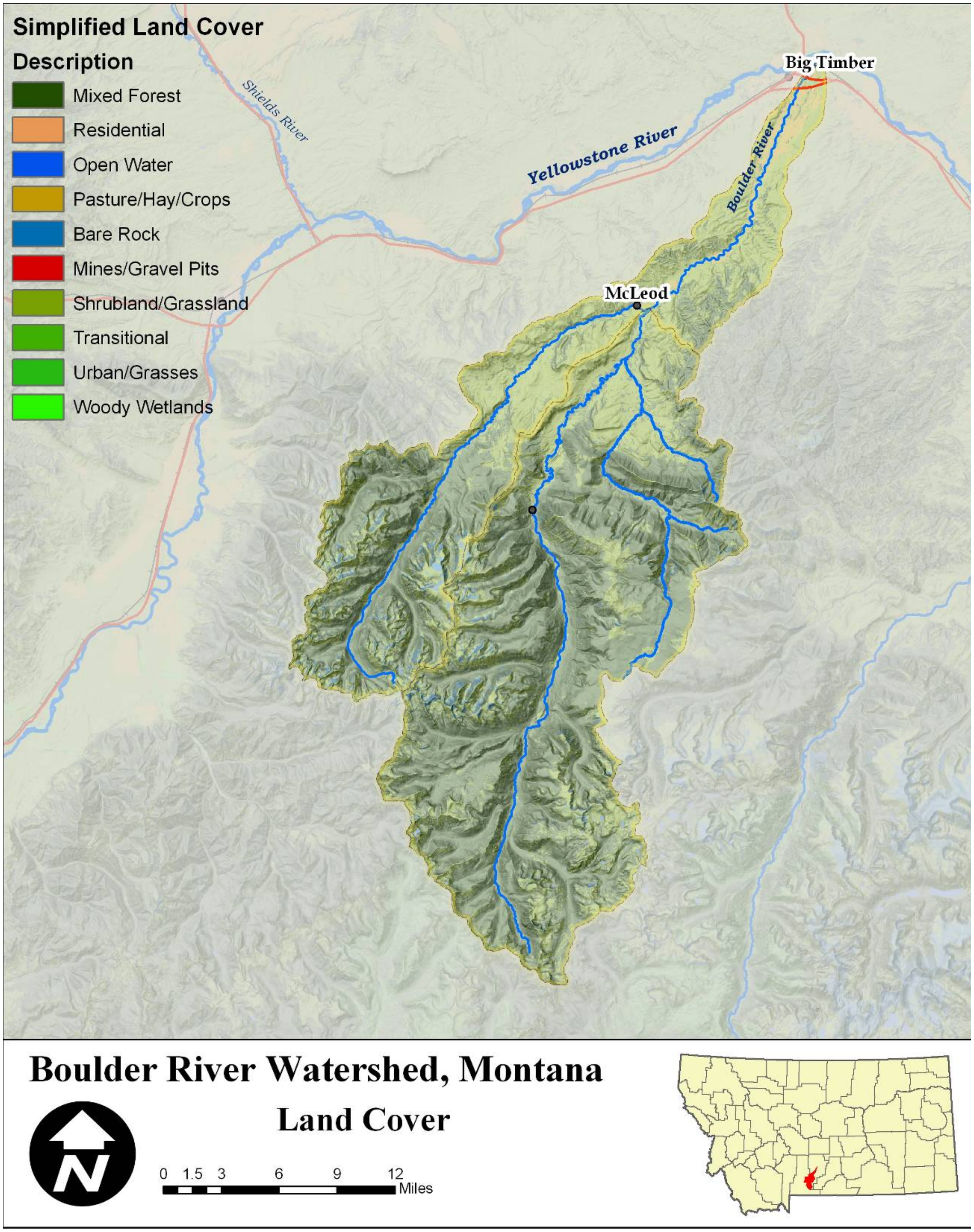

Figure 2-9. Boulder River watershed land cover/land use map

2.2 Cultural Characteristics

2.2.1 Population

Population statistics for the Boulder River watershed were compiled from the NRIS database. Population data are from the 1990 and 2000 United States Census Data. Based on the referenced sources, 1857 people lived within the Boulder River watershed in 1990. In 2000, a population of 1832 people was reported showing a slight decline in population.

Big Timber, the largest town in the watershed, has a population of approximately 1650 residents, not all of which reside within the Boulder River watershed. Most of the rural residents in the watershed live in the northern portion of the area and are involved in agriculture. The southern portion of the watershed is primarily United States Forest Service (USFS) Lands within the ABWA.

2.2.2 Land Ownership

Land ownership information was compiled from the NRIS database and the Montana Cadastral Mapping Project database. Ownership, by category, is shown in **Figure 2-10** and displayed in **Figure 2-11**. The USFS is by far the largest landowner in the Boulder River watershed, holding a total of approximately 388 square miles of the watershed, or approximately 74%. Bureau of Land Management (BLM) holds about 4.4 square miles (less than 1%), the State of Montana holds about 9.5 square miles (less than 2%), with the remaining 122 square miles (23%) privately owned.

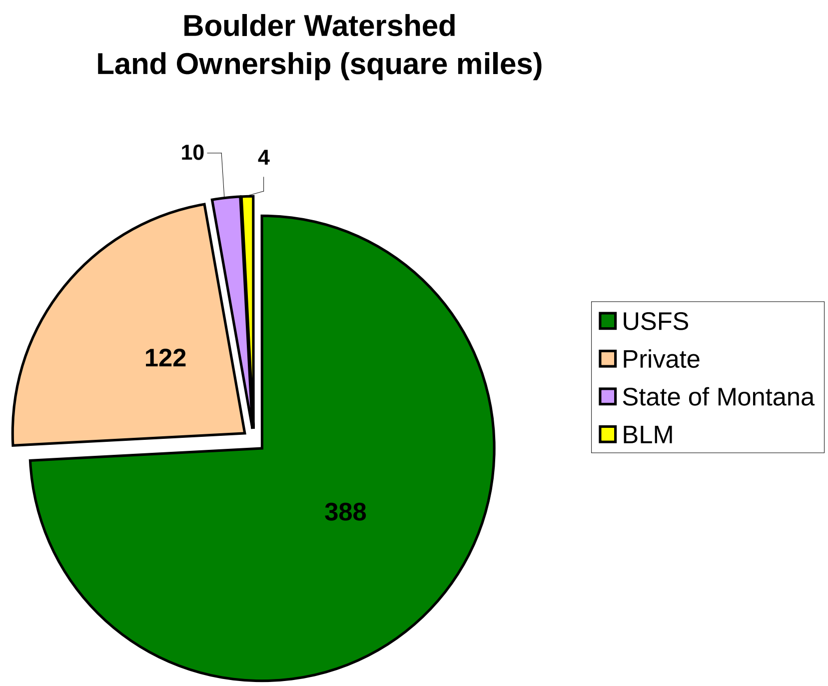

Figure 2-10. Land ownership in the Boulder Watershed

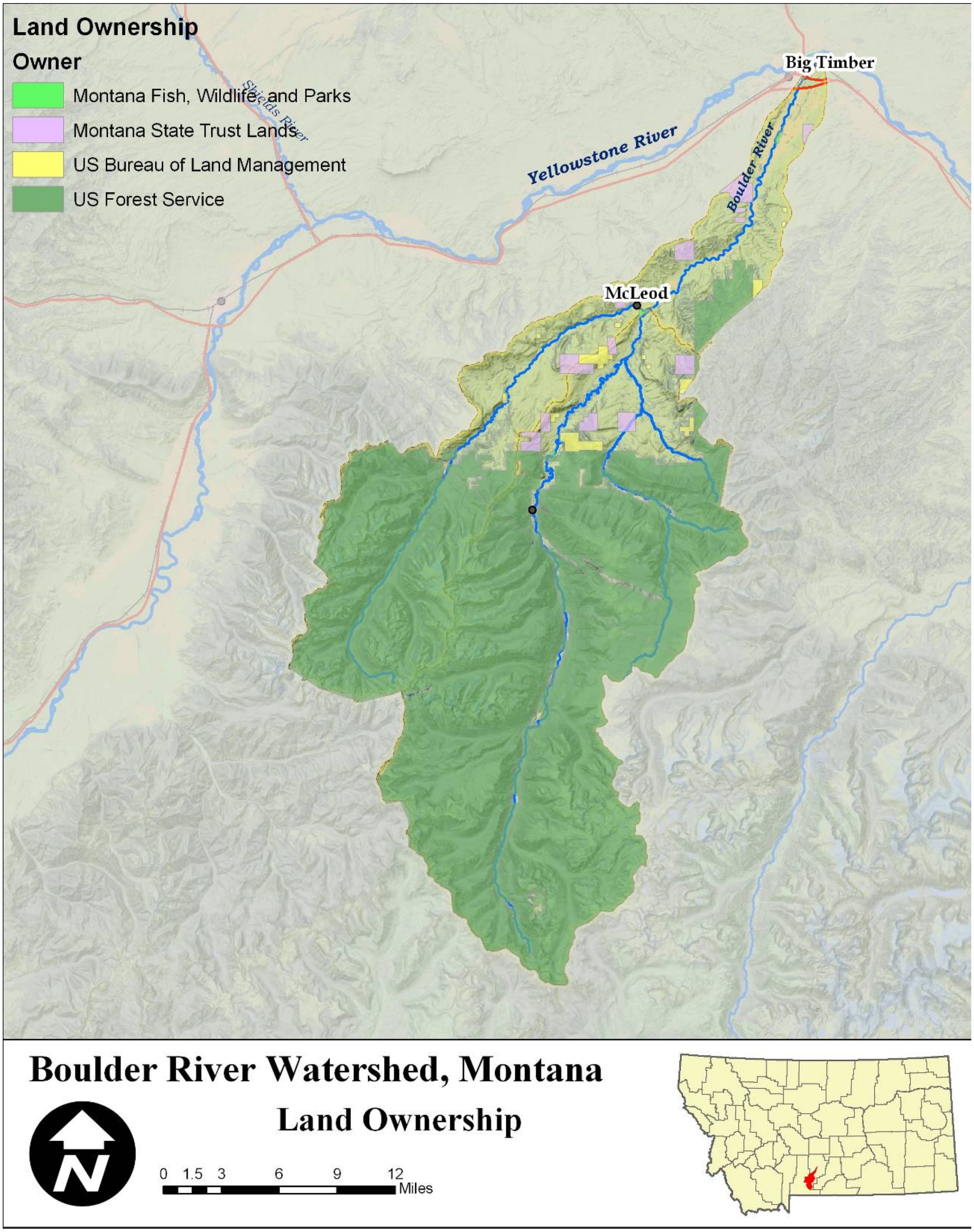

Figure 2-11. Boulder River watershed land ownership map

2.2.3 Recreation

As reported by the Statewide Comprehensive Outdoor Recreation Plan (SCORP) task force, tourism is the second largest industry behind agriculture in Montana. Outdoor recreation made up 75 % of the activities reported by non-resident travelers to Montana from 2000 to 2001 (MFISH). Popular recreational activities within the Boulder River watershed include hunting, fishing, golf, camping, hiking, horseback riding, bicycling, rafting, and skiing, among others. Coldwater fisheries are an important feature of the recreation in the Boulder River Watershed.

Montana Department of Fish, Wildlife, and Parks (MFWP), considers the Boulder River and its tributaries to provide excellent opportunities for wild trout fishing and other year around opportunities (ECON, 1992), and has designated most of the mainstem of the Boulder a blue-ribbon or Class 1 fishery (FWP website). Anglers and other recreational users have considerable access to the Upper Boulder and East Boulder Rivers primarily at fishing access sites, campgrounds, and within Forest Service boundaries. The West Boulder and Lower Boulder are less accessible due to extensive private ownership along the streams.

2.3 Biological Resources

Nearly half of the Boulder River watershed is included in the ABWA, which borders Yellowstone National Park to the south. This area contains some of the most unique and pristine alpine habitat in the world and is home to a diverse and ecologically unique population of wildlife. The biological resources of the area are a major draw for area residents as well as tourists. Biological resources include the cold-water fisheries, big-game and rare large mammals, upland game birds, waterfowl, raptors and songbirds, and fur-bearers, as well as other numerous small mammals and rodents.

2.3.1 Fisheries

The Montana Fisheries Information System (MFISH) contains information on fish species in Montana's rivers. Fish species found in the Boulder River and its tributaries, relative abundance, and stream reaches in which they occur are shown in **Table 2-2**. Abundance estimates range from abundant to common to rare.

Table 2-2. Fish Species, Location, And Relative Abundance

Species	Stream reach in river miles from the mouth of stream	Abundance
Main Boulder		
Brook Trout	37.2 to 42.2 42.2 to 47.6	Abundant Rare
Brown Trout	0 to 37.2	Abundant
Longnose Dace	0 to 22.9	Common
Longnose Sucker	0 to 37.2	Abundant
Mottled Sculpin	0 to 22.9	Common
Mountain Sucker	0 to 22.9	Common
Mountain Whitefish	0 to 37.2	Abundant
Rainbow Trout	0 to 50.1 51.9 to 56.2	Common Rare
Yellowstone Cutthroat Trout	52.2 to 65.2 0 to 11.3 East Fork of Main Boulder	Rare Abundant
East Boulder River		
Brook Trout	0 to 6.1	Rare
Brown Trout	0 to 12.2 12.2 to 15.7	Common Rare
Longnose Dace	0 to 3.1	Rare
Mottled Sculpin	0 to 6.1	Abundant
Mountain Sucker	0 to 3.1	Rare
Mountain Whitefish	0 to 3.1	Rare
Rainbow Trout	0 to 12.2 12.2 to 13.6 13.6 to 15.7	Abundant Common Rare
Yellowstone Cutthroat Trout	15.6 to 22.8	Abundant Common
West Boulder River		
Brown Trout	0 to 24.1	Common
Longnose Dace	0 to 16.9	Rare
Longnose Sucker	0 to 16.9	Common
Mottled Sculpin	0 to 16.9	Rare
Mountain Whitefish	0 to 24.1	Common
Rainbow/Cutthroat Hybrid	0 to 24.1	Rare
Yellowstone Cutthroat Trout	16.9 to 25	Common

In addition to the above data, in 2001 and 2003 fish population surveys were conducted the East Boulder River by the USFS. Data collected showed healthy trout populations of brown, rainbow, brook, and Yellowstone cutthroat trout (GEI consultants, 2003), with rainbow trout being the most abundant species in the upper Boulder watershed. Yellowstone cutthroat trout were present primarily in the upper most sampling sites.

The Dewatered Streams List was compiled by the FWP in 1991 to identify streams that have had a periodic or chronic reduction in streamflow to a point that leads to unsuitable stream habitat for fish. Chronic dewatering refers to streams that are dewatered in virtually all years, and periodic dewatering refers to streams that are dewatered in drought or water-short years. Within the Boulder River watershed, chronic dewatering has been reported (in the MFISH database) for the lowest 5 miles of Boulder River.

2.3.2 Threatened and Endangered Species

The Montana Natural Heritage Program (MNHP) compiles information on species that are endangered or threatened in Montana. Nearly half of the watershed is a designated wilderness area which borders Yellowstone National Park to the south. A diverse population of species inhabits this pristine area, often with healthy populations found in few other places. MNHP-listed species for Sweetgrass and Park Counties include listed threatened species such as the bald eagle, the grizzly bear, and the Canada lynx. The black-footed ferret is a listed endangered species, while the black-tailed prairie dog is a candidate for threatened or endangered status. MNHP also list the gray wolf as a non-essential experimental population in the area.

SECTION 3.0 TMDL REGULATORY FRAMEWORK AND WATER QUALITY STANDARDS

Section 3.0 presents the status of all 303(d) listed water bodies in the Boulder Watershed TMDL Planning Area (i.e., which water bodies are listed as impaired or threatened and for which pollutants). This is followed by a summary of the applicable water quality standards.

3.1 TMDL Regulatory Requirements

Section 303(d) of the Federal Clean Water Act (CWA) requires states to identify water bodies within its boundaries that do not meet state water quality standards. States track these impaired or threatened water bodies through the 303(d) List, a component of Montana's Water Quality Integrated Report. State law identifies that a methodology for determining the impairment status of each water body is used for consistency and the actual methodology is identified in Appendix A of Montana's Water Quality Integrated Report.

Under Montana State Law, an "impaired water body" is defined as a water body or stream segment for which sufficient credible data show that the water body or stream segment is failing to achieve compliance with applicable water quality standards (Montana Water Quality Act; Section 75-5-103(11)). A "threatened water body" is defined as a water body or stream segment for which sufficient credible data and calculated increases in loads show that the water body or stream segment is fully supporting its designated uses but threatened for a particular designated use because of either (a) proposed sources that are not subject to pollution prevention or control actions required by a discharge permit, the nondegradation provisions, or reasonable land, soil, and water conservation practices; or (b) documented adverse pollution trends (Montana Water Quality Act; Section 75-5-103(31)). State Law and section 303 of the CWA require states to develop all necessary TMDLs for impaired or threatened water bodies.

TMDLs are developed for pollutants. These are water quality impairments that can be quantified and a load can be calculated. Riparian degradation and habitat alteration are not pollutants but are considered pollution-related impairments, and thereby do not require TMDLs. Additionally, flow alteration and dewatering are impairment issues related to water quantity and when viewed alone are not subject to a TMDL. However, sediment-related impairments may be related to stream energy and flow conditions. Likewise, riparian degradation and habitat alteration when considered alone do not require a TMDL, yet are often linked to pollutant loading and may exacerbate and contribute to the loading and influence of a pollutant in a stream. As such, flow and habitat conditions are often considered when conducting TMDL analysis.

A TMDL is a pollutant budget for a water body identifying the maximum amount of the pollutant that a water body can assimilate without causing applicable water quality standards to be exceeded. TMDLs are often expressed in terms of an amount, or load, of a particular pollutant (expressed in units of mass per time such as pounds per day). TMDLs must account for loads/impacts from point and nonpoint sources in addition to natural background sources and must incorporate a margin of safety and consider influences of seasonality on analysis and compliance with water quality standards.

To satisfy the Federal Clean Water Act and Montana State Law, Total Maximum Daily Loads are developed for each water body-pollutant combination identified on the state's list of impaired or threatened waters (303(d) List). State Law (Administrative Rules of Montana 75-5-703(8)) also directs Montana DEQ to "...support a voluntary program of reasonable land, soil, and water conservation practices to achieve compliance with water quality standards for nonpoint source activities for water bodies that are subject to a TMDL…" This is an important directive that is reflected in the overall TMDL development and implementation strategy within this plan. It is important to note that water quality protection measures are not considered voluntary where such measures are already a requirement under existing Federal, State, or Local regulations.

3.2 Water Bodies and Pollutants of Concern

The assessment of streams, lakes, and wetlands to identify impaired waters for inclusion on Montana's Water Quality Integrated Report (IR) is an important step in a process intended to ensure that all water bodies in the state will have water quality adequate to support all of their classified beneficial uses. The process has been developed and shaped by legal mandates, water quality standards, the tools and techniques of water quality monitoring, the availability of information, and the funds and administrative resources that can be devoted to assessment efforts.

The impairment causes and sources determination included on the 1996 303(d) List was based on data that showed impairments, however many determinations were based on professional judgment and involved limited data. Since the development of the 1996 303(d) List, the Montana Department of Environmental Quality has instituted procedures that more fully assess and identify impaired waters. This procedure, the Sufficient Credible Data Assessment & Beneficial Use-Support Determinations (SCD/BUD) Process, conducted by the Montana Department of Environmental Quality in response to legal requirements stipulated in MCA 75-5-702, resulted in updates to the 1996 303(d) listing. Consequently, impaired uses, causes, and sources on the 2006 303(d) List may differ from the original 1996 listings as a result of the data review and associated list revisions.

While the 2006 303(d) List is now Montana's most current list, and is based on more thorough data review and analysis than the 1996 list, a ruling by the U.S. District Court (CV97-35-M-DWM) on September 21, 2000, required that the State of Montana must complete all necessary TMDLs for waters listed as impaired or threatened on the 1996 303(d) List. Where new data has resulted in changes to the 303(d) listing status for 1996-listed waters through the State's SCD/BUD process, the DEQ will complete TMDLs based on updated impairments status resulting from this new information.

Water bodies reviewed by the State's SCD/BUD process fall into 5 categories. The level of beneficial use support for the listed waters can be as fully supporting all designated beneficial uses (F), threatened (T), partially support (P), not supporting (N), and lacking sufficient credible data (X). The Beneficial Use-Support Determination for the 303(d) listed streams in the Boulder

River TMDL Planning Area is provided in **Table 3-1**. A map of segment locations is given in **Figure 3-1**.

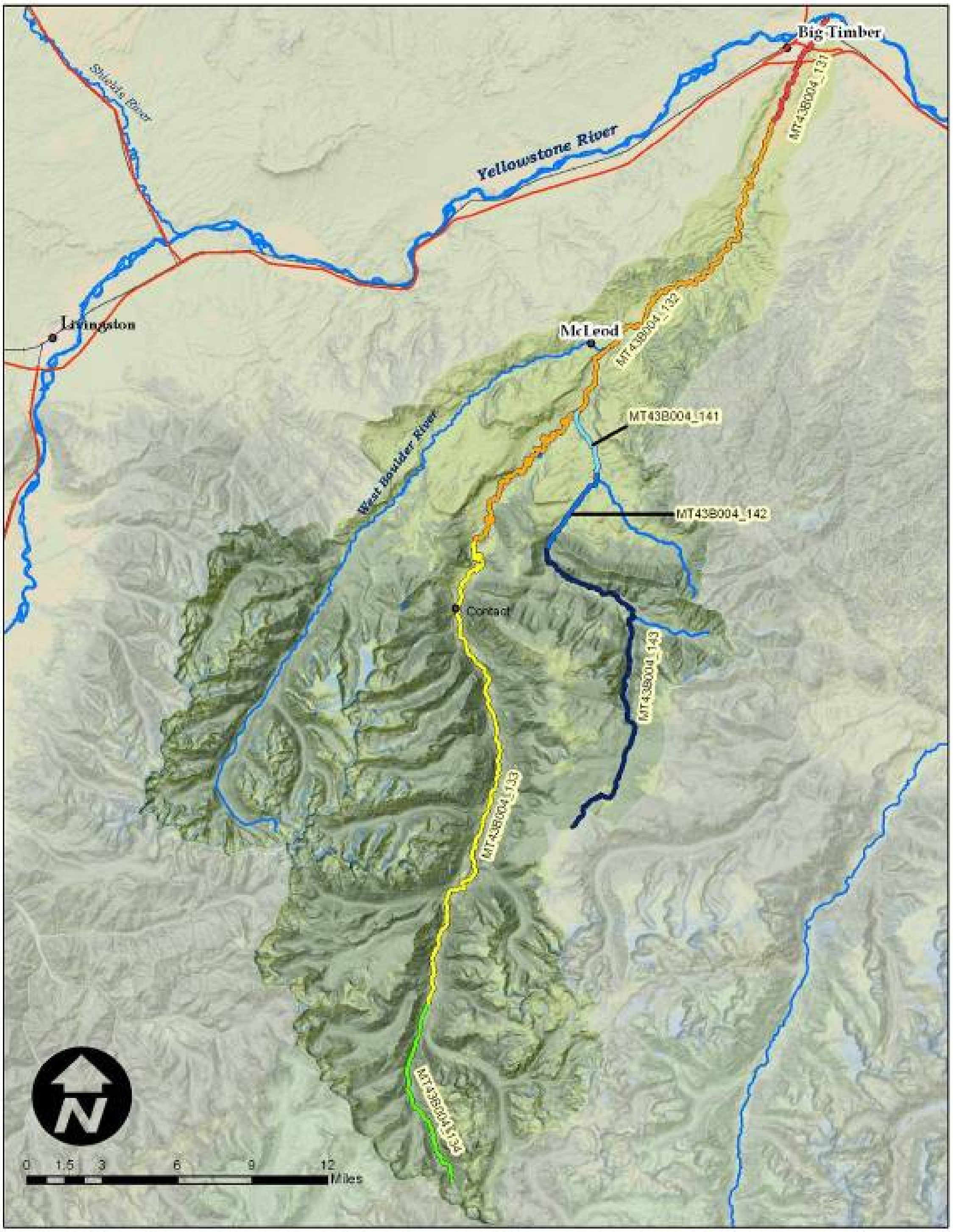

Figure 3-1. Water body Segments in the Boulder TMDL Planning Area

Table 3-1. Impaired Uses from both 1996 and 2006 303(d) Lists

Stream Reach (MT Water body ID)	1996 Use-Support							2006 Use Support						
	Use Classification	Aquatic Life	Cold Water Fishery	Drinking Water	Agriculture	Industry	Contact Recreation	Use Classification	Aquatic Life	Cold Water Fishery	Drinking Water	Agriculture	Industry	Contact Recreation
East Boulder River (from Elk Cr to the mouth) MT43B004_141	B-1	T						B-1	P	P	F	F	F	P
East Boulder River (from National Forest boundary to Elk Cr) MT43B004_142	B-1	T						B-1	P	P	X	F	F	P
East Boulder River (from National Forest Boundary to headwaters) MT43B004_143	B-1	T						B-1	F	F	F	F	F	F
Boulder River (from the mouth to five miles upstream) MT43B004_131	B-1	X	X	X	X	X	X	B-1	P	P	F	F	F	P
Boulder River (from 5 miles upstream of the mouth to the National Forest boundary) MT43B004_132	B-1	X	X	X	X	X	X	B-1	P	P	F	F	F	F
Boulder River (from the National Forest boundary to the East Fork Boulder River confluence) MT43B004_133	B-1	X	X	X	X	X	X	B-1	P	P	F	F	F	P
Boulder River (from the East Fork Boulder River to the headwaters) MT43B004_134	B-1	X	X	X	X	X	X	B-1	P	P	N	F	F	F

Source: DEQ, 1996, 2006

One water body in the Boulder River TMDL Planning area occurs on Montana's 1996 303(d) List: East Boulder River (entire reach). The cause and source of impairment for the 1996 303(d) List is shown in **Table 3-2**. The 2006 303(d) List is summarized in **Table 3-3**.

Table 3-2. 1996 303(d) List Information for the Boulder River TMDL Planning Area

Segment Name (MT Water body ID)	Length (miles)	Probable Cause	Probable Source
East Boulder River MT43B004_141 MT43B004_142 MT43B004_143	23	**Nutrients**	Resource Extraction

Source: DEQ, 1996

Table 3-3. 2006 303(d) List Information for the Boulder River TMDL Planning Area.

Segment Name (MT Water body ID)	Length (miles)	Probable Cause	Probable Source
East Boulder River MT43B004_141	3.1	**Sedimentation/Siltation** Low flow alteration Other anthropogenic substrate alterations **Chlorophyll-*a***	Flow Alterations from water diversions Streambank modifications/destabilization Source unknown
East Boulder River MT43B004_142	3	**Chlorophyll-*a*** Low flow alteration	Source unknown Agriculture
East Boulder River MT43B004_143	16.6	NA	NA
Boulder River MT43B004_131	5	**Copper** **Iron** **Lead** **Silver** Low flow alterations	Impacts from abandoned mine lands Irrigated crop production
Boulder River MT43B004_132	27.8	**Chromium** **Nickel** **Nitrate/Nitrite** **Total Kjeldahl Nitrogen** Alteration of vegetative covers	Agriculture Grazing in riparian zones Source unknown
Boulder River MT43B004_133	23.5	**Phosphorous (Total)** **Nitrate/Nitrite** **Total Kjeldahl Nitrogen** **Excess Algal Growth**	Source Unknown
Boulder River MT43B004_134	8.2	**Copper** **Lead**	Impacts from abandoned mine lands

Source: DEQ 2006.

Pollutants of concern (in bold, **Table 3-3**), i.e. those requiring TMDL evaluation include:

- Nutrients
  Nutrients describe a suite of pollutants that contribute to excessive chlorophyll-a (algae) growth. These typically include organic and inorganic forms of phosphorous and nitrogen. Presently listed nutrient impairment causes in the Boulder TPA include chlorophyll-a, excess algal growth, total phosphorous, nitrate/nitrite, and total Kjeldahl nitrogen.
- Metals
  Metals include a variety of forms (dissolved and total recoverable) and can be evaluated as forms present in both water and sediment samples. Presently listed metals impairment causes in the Boulder TPA include copper, iron, lead, silver, chromium, and nickel.
- Sediment
  Sediment-related impairments relate to excessive sediment deposited on stream bottoms and in the water column. Presently listed sediment impairment causes in the Boulder TPA include sedimentation and siltation.

Specific information regarding the status of these pollutants as causes of impairment is given in **Section 4**.

3.3 Applicable Water Quality Standards

Water quality standards include the uses designated for a water body, the legally enforceable standards that ensure that the uses are supported, and a non-degradation policy that protects the existing high quality of a water body. The ultimate goal of this TMDL plan, once implemented, is to ensure that water quality standards are met for all pollutants of concern identified on the Montana's list of impaired waters, the 303(d) List. Water quality standards form the basis for the targets described in **Section 4.0**. Pollutants addressed in this TMDL plan include: metals, nutrients and sediment. **Section 3.3.2** provides a summary of the applicable water quality standards for each of these pollutants.

3.3.1 Classification and Beneficial Uses

Classification is the assignment (designation) of a single or group of uses to a water body based on the potential of the water body to support those uses. Designated Uses or Beneficial Uses are simple narrative descriptions of water quality expectations or water quality goals. There are a variety of "uses" of state waters including: growth and propagation of fish and associated aquatic life; drinking water; agriculture; industrial supply; and recreation and wildlife. The Montana Water Quality Act (WQA) directs the Board of Environmental Review (BER, i.e., the State) to establish a classification system for all waters of the state that includes their present (when the Act was originally written) and future most beneficial uses (Administrative Rules of Montana (ARM) 17.30.607-616) and to adopt standards to protect those uses (ARM 17.30.620-670).

Montana, unlike many other states, uses a watershed based classification system with some specific exceptions. As a result, *all* waters of the state are classified and have designated uses and supporting standards. All classifications have multiple uses and in only one case (A-Closed) is a specific use (drinking water) given preference over the other designated uses. Some waters may not actually be used for a specific designated use, for example as a public drinking water supply. However, the quality of that water body must be maintained suitable for that designated use. When natural conditions limit or preclude a designated use, permitted point source discharges or non-point source discharges may not make the natural conditions worse.

Modification of classifications or standards that would lower a water's classification or a standard (i.e., B-1 to a B-3), or removal of a designated use because of natural conditions can only occur if the water was originally miss-classified. All such modifications must be approved by the BER, and are undertaken via a Use Attainability Analysis (UAA) that must meet EPA requirements (40 CFR 131.10(g), (h) and (j)). The UAA and findings presented to the BER during rulemaking must prove that the modification is correct and all existing uses are supported. An existing use cannot be removed.

Descriptions of Montana's surface water classifications and designated beneficial uses are presented in **Table 3-4**. All water bodies within the Boulder River TPA are classified as B-1.

Table 3-4. Montana Surface Water Classifications and Designated Beneficial Uses

Classification	Designated uses
B-1 CLASSIFICATION:	Waters classified B-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

3.3.2 Standards

In addition to the Use Classifications described above, Montana's water quality standards include numeric and narrative criteria as well as a nondegradation policy.

Numeric surface water quality standards have been developed for many parameters to protect human health and aquatic life. These standards are in the Department Circular DEQ-7 (DEQ, February 2006). The numeric human health standards have been developed for parameters determined to be toxic, carcinogenic, or harmful and have been established at levels to be protective of long-term (i.e., life long) exposures as well as through direct contact such as swimming.

The numeric aquatic life standards include chronic and acute values that are based on extensive laboratory studies including a wide variety of potentially affected species, a variety of life stages and durations of exposure. Chronic aquatic life standards are protective of long-term exposure to a parameter. The protection afforded by the chronic standards includes detrimental effects to reproduction, early life stage survival and growth rates. In most cases the chronic standard is more stringent than the corresponding acute standard. Acute aquatic life standards are protective of short-term exposures to a parameter and are not to be exceeded.

High quality waters are afforded an additional level of protection by the nondegradation rules (ARM 17.30.701 et. seq.,) and in statute (75-5-303 MCA). Changes in water quality must be "non-significant" or an authorization to degrade must be granted by the Department. However, under no circumstance may standards be exceeded. It is important to note that, waters that meet or are of better quality than a standard are high quality for that parameter, and nondegradation policies apply to new or increased discharges to that the water body. Nondegradation rules do not apply to impaired streams and apply only where there are existing numeric water quality standards.

Narrative standards have been developed for substances or conditions for which sufficient information does not exist to develop specific numeric standards. The term "Narrative Standards" commonly refers to the General Prohibitions in ARM 17.30.637 and other descriptive portions of the surface water quality standards. The General Prohibitions are also called the "free from" standards; that is, the surface waters of the state must be free from substances attributable to discharges, including thermal pollution, that impair the beneficial uses of a water body. Uses may be impaired by toxic or harmful conditions (from one or a combination of parameters) or conditions that produce undesirable aquatic life. Undesirable aquatic life includes bacteria, fungi and algae.

The standards applicable to the list of pollutants addressed in the Boulder River TPA are summarized below.

3.3.2.1 Nutrients

The narrative standards applicable to nutrients elsewhere in Montana are contained in the General Prohibitions of the surface water quality standards (ARM 17.30.637 et. Seq.,). The prohibition against the creation of "conditions which produce undesirable aquatic life" is generally the most relevant to nutrients.

Most waters of Montana are protected from excessive nutrient concentrations by narrative standards. The exception is the Clark Fork River above the confluence with the Flathead River, where numeric water quality standards for total nitrogen (300 ug/l) and total phosphorus (20 ug/l upstream of the confluence with the Blackfoot River and 39 ug/l downstream of the confluence) as well as algal biomass measured as chlorophyll a (summer mean and maximum of 100 and 150 mg/m^2, respectively) have been established.

3.3.2.2 Sediment

Sediment (i.e., coarse and fine bed sediment) and suspended sediment are addressed via the narrative standard identified in **Table 3-5**. The standard does not allow for harmful or other undesirable conditions related to increases above naturally occurring levels or from discharges to state surface waters. This is interpreted to mean that water quality goals should strive toward a condition in which any increases in sediment above naturally occurring levels are not harmful, detrimental, or injurious to beneficial uses (see definitions in **Table 3-2**).

Table 3-5. Applicable Rules for Sediment-Related Pollutants

Rule(s)	Standard
17.30.623(2)	No person may violate the following specific water quality standards for waters classified B-1.
17.30.623(2)(f)	No increases are allowed above naturally occurring concentrations of sediment or suspended sediment (except a permitted in 75-5-318, MCA), settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.
17.30.637(1)	State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will.
17.30.637(1)(a)	Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.
17.30.637(1)(d)	Create concentrations or combinations of materials that are toxic or harmful to human, animal, plant, or aquatic life.
	The maximum allowable increase above naturally occurring turbidity is: 0 NTU for A-closed; 5 NTU for A-1, B-1, and C-1; 10 NTU for B-2, C-2, and C-3)
17.30.602(17)	"Naturally occurring" means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil, and water conservation practices have been applied.
17.30.602(21)	"Reasonable land, soil, and water conservation practices" means methods, measures, or practices that protect present and reasonably anticipated beneficial uses. These practices include but are not limited to structural and nonstructural controls and operation and maintenance procedures. Appropriate practices may be applied before, during, or after pollution-producing activities.

3.3.2.3 Metals

Numeric criteria for metals in Montana include specific standards for the protection of both aquatic life and human health. As described above, acute and chronic criteria have been established for the protection of aquatic life. The criteria for some metals vary according to the hardness of the water. The standards for cadmium, copper, chromium (III), lead, nickel, and silver vary according to the hardness of the water. These standards have an inverse relationship to toxicity (decreasing hardness causes increased toxicity). The applicable numeric criteria for the metals of concern in the Boulder River TPA are defined in *Montana DEQ Circular, DEQ-7: Montana Numeric Water Quality Standards* and are presented in **Table 3-6**.

Table 3-6. Montana Numeric Surface Water Quality Standards for Metals

Parameter	Aquatic Life (acute) (µg/L)[a]	Aquatic Life (chronic) (µg/L)[b]	Human Health (µg/L)[a]
Chromium (III) (TR)	579 @ 25 mg/L hardness[c]	28 @ 25 mg/L hardness[c]	—
Copper (TR)	3.8 @ 25 mg/L hardness[c]	2.85 @ 25 mg/L hardness[c]	1,300
Iron (TR)	—	1,000	—
Lead (TR)	14 @ 25 mg/L hardness[c]	0.545 @ 25 mg/L hardness[c]	15
Nickel (TR)	145 @ 25 mg/L hardness[c]	16 @ 25 mg/L hardness[c]	100
Silver (TR)	0.4 @ 25 mg/L hardness[c]	—	100

[a]Maximum allowable concentration.
[b]No 4-day (96-hour) or longer period average concentration may exceed these values.
[c]Standard is dependent on the hardness of the water, measured as the concentration of $CaCO_3$ (mg/L).
Note: TR = total recoverable.

SECTION 4.0
POLLUTANT ASSESSMENT AND STATUS

4.1 Introduction

Section 4.0 includes a review of existing data for which TMDLs have been prepared (**Section 5.0**). Existing data for each water body segment is evaluated in comparison to water quality criteria (targets). Segments not meeting water quality criteria are determined to be impaired for the pollutant of concern and require the establishment of Total Maximum Daily Loads. TMDLs and load allocations for these segments are given in **Section 5**.

Water body segments on the 2006 303(d) List and associated causes of impairment are included in **Table 4-1**. Segment locations are given in **Figure 3-1**. Note that several probable causes of impairment have not been addressed by DEQ at this time. They include 1) Nitrate/Nitrite and Total Kjeldahl Nitrogen (segment MT43B004_132), and 2) Phosphorus (Total), Nitrate/Nitrite, Total Kjeldahl Nitrogen, Excess Algal Growth (segment MT43B004_133). As these pollutants were newly listed in 2006, resources were not available to provide adequate assessment and verification of these pollutant listings at the time of document production. DEQ will address these pollutants at a later date.

Table 4-1. 2006 303(d) listings in the Boulder Watershed TMDL Planning Area

MT Water Body Segment Identifier	Water body Segment	Probable Causes of Impairment
MT43B004_131	Boulder River (from the mouth to 5 miles upstream)	Copper Iron Lead Silver Low flow alterations
MT43B004_132	Boulder River (from 5 miles upstream of the mouth to the National Forest boundary)	Chromium Nickel Nitrate/Nitrite Total Kjeldahl Nitrogen Alteration of vegetative covers
MT43B004_133	Boulder River (from the National Forest boundary to the East Fork Boulder River confluence)	Phosphorus (Total) Nitrate/Nitrite Total Kjeldahl Nitrogen Excess Algal Growth
MT43B004_134	Boulder River (from the East Fork Boulder River to the headwaters)	Copper Lead
MT43B004_141	East Boulder River (from the mouth to the Elk Creek confluence)	Chlorophyll-*a* Low flow alterations Anthropogenic substrate alterations Sedimentation/Siltation
MT43B004_142	East Boulder River (From Elk Creek to the National Forest boundary)	Chlorophyll-*a* Low flow alterations
MT43B004_143	East Boulder River (From the National Forest boundary to the headwaters)	None

4.2 Assessment Framework

Assessing attainment of numeric water quality criteria (targets), and subsequent determination of whether a TMDL is necessary for each water body segment involves three steps:

1. Evaluation of pollutant sources

   Pollutant sources in a watershed are both natural and anthropogenic. Both natural and anthropogenic sources must be considered when developing appropriate water quality targets. TMDLs are not developed for streams that are not meeting water standards due solely to 'naturally occurring' pollutants.

2. Development of numeric water quality criteria (targets) that represent water quality conditions that are unimpaired for the pollutant of concern

   A required component of TMDL plans is the establishment of 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 that, either by themselves or in combination with others, reflect attainment of water quality standards (narrative and numeric) or represent a water quality condition that is unimpaired for the pollutant of concern. For pollutants with numeric standards (metals, toxins), the established state numeric standard as defined in *DEQ Circular DEQ-7* is typically adopted as the water quality target. For pollutants with narrative standards (sediment, nutrients), a translation of the narrative standard into a measurable, numeric surrogate parameter(s) is necessary. Depending on the nature of the pollutant, processes affecting impairment conditions and other factors, either a single parameter or a suite of parameters or indicators may be employed to evaluate whether water quality standards are met for the pollutant in question.

   Targets represent translations of water quality standards at the time of document preparation. As water quality standards or assessment and evaluation tools are refined or further developed, DEQ may modify targets to better reflect the state's process for evaluating attainment of water quality standards. Because numeric nutrient water quality standards are currently under development by the State of Montana, nutrient targets may be subject to change based on the results of the rule-making process.

   Targets are used to facilitate evaluation of state waters specifically for TMDL purposes and may or may not be appropriate for other planning objectives on a case by case basis as defined within each TMDL document. Appropriate use of the targets will vary based on the level of certainty regarding the target(s) value and how well that value effectively defines attainment of the narrative standard, the impacts that attainment of target value(s) may have on activities in a watershed, and whether or not the water body is impaired. If the water body is not impaired, then the targets provide the necessary numeric translations/measures to justify a decision of no impairment in addition to providing the numeric interpretation of narrative standards that existing activities can use to assist with planning and water quality protection efforts.

3. Comparison of existing data with water quality targets to evaluate water quality target attainment and, consequently, determine whether a TMDL is necessary.

   Attainment of water quality targets (and subsequent beneficial use determination) is evaluated by comparing existing water quality data and information to the established targets. Determination typically involves evaluation of many data types distributed both spatially and temporally, some of which may meet water quality targets, and some of which may not. Where such condition exists, a discussion of data and its utility in characterizing existing conditions is presented, followed by a determination of whether the stream is impaired and therefore whether a TMDL is required. Criterion for evaluating attainment of targets is defined in the Basis for Target Values within each specific target description.

4.3 East Boulder River Segment MT43B004_141 (Sediment)

The 2006 303(d) list status of water bodies in the Boulder River TPA is summarized in **Section 4.0.** East Boulder River segment MT43B004_141 (from the mouth to the Elk Creek confluence) is the only segment on the 2006 303(d) listed as impaired for sedimentation/siltation, and identifies aquatic life and cold-water fisheries as the beneficial uses that are impaired.

Since its original listing for sediment on the 2000 303(d) list, new data and information relevant to sediment impairment determinations has been gathered. Recent data shows that East Boulder River segment MT43B004_141 may be meeting the applicable narrative water quality standards for sediment; therefore, DEQ is not proceeding with a TMDL for sediment at this time. *East Boulder River Sediment Assessment* (DEQ, 2007) provides an assessment of sediment sources and an evaluation of existing conditions and data for segment MT43B004_141. Until such time as this segment is reevaluated following Montana's Water Quality Assessment Methodology (SOP WQPBWQM-001), it will remain on the 303(d) list as impaired for sediment. The *East Boulder River Sediment Assessment* will be considered along with all other readily available data when it is reevaluated for purposes of the 303(d) list.

4.4 East Boulder River Segments MT43B004_141 and MT43B004_142 (Chlorophyll-*a*/Nutrients)

In 1996 the entire East Boulder River, from headwaters to mouth, was listed as 'threatened' due to nutrients with the probable source being resource extraction. The basis for this original listing was founded on an interpretation of the term, 'threatened'. In 1997, the term 'threatened' was defined in the Montana Water Quality Act [MCA 75-5-103 (31)]. Consequently, the East Boulder River did not fit the definition of a 'threatened water body' as proposed sources are subject to pollution control measures through a state of Montana MPDES permit, and subsequent DEQ review determined that insufficient data existed to support 'adverse water quality trends'. DEQ later split the East Boulder River into three discrete segments (**Figure 3-1**), based on ecoregional influences and changes in stream type and character.

- MT43B004_141 (from the mouth to the Elk Creek confluence)
- MT43B004_142 (from Elk Creek to the National Forest boundary)
- MT43B004_143 (from the National Forest Boundary to the headwaters)

On the 2006 303(d) list, East Boulder River segments, MT43B004_141 and MT43B004_142 were listed as impaired for chlorophyll-*a* (algal growth), and identified aquatic life, cold-water fisheries, and recreation as the impaired beneficial uses. Segment MT43B004_143 was found be fully supporting its beneficial uses.

Recent data collection and evaluation shows that segments MT43B004_141 and MT43B004_142 may be meeting the applicable narrative water quality standards for nutrients; therefore, DEQ is not proceeding with a TMDL at this time. *East Boulder River Nutrient Assessment* (DEQ, 2007) provides an assessment of nutrient sources affecting chlorophyll-*a* growth, and an evaluation of existing conditions and data for segments MT43B004_141 and MT43B004_142. Until such time as these segments are reevaluated following Montana's Assessment Methodology (SOP WQPBWQM-001), they will remain on the 303(d) list as impaired for nutrients. The *East Boulder River Nutrient Assessment* will be considered along with all other readily available data when it is reevaluated for purposes of the 303(d) list.

4.5 Boulder River Segments MT43B004_131, MT43B004_132, MT43B004_133, MT43B004_134, & MT43B005_010 (Metals)

The 2006 303(d) list status of water bodies in the Boulder River TPA is summarized in **Section 4.0**. Boulder River segments MT43B004_131, MT43B004_132, and MT43B004_134 are listed as impaired for metals (copper, lead, chromium, nickel, silver, iron): aquatic life, cold-water fisheries and drinking water are the beneficial uses that have been identified as not fully supported due to these impairment conditions.

Section 4.5 provides an assessment of metals sources, metals water quality targets, and an evaluation of existing conditions and data with respect to water quality targets for segments MT43B004_131, MT43B004_132, MT43B004_133, and MT43B004_134. In addition to these segments, Basin Creek segment MT43B005-010 is evaluated. Basin Creek lies at the headwaters of the Boulder River and is a known source of abandoned mine lands that contribute metals loads to the Boulder River.

4.5.1 Metals Sources

Sources of metals in the Boulder River include nonpoint sources (natural geologic sources & historic mining sites), and point sources (permitted discharges from the East Boulder Mine, and the city of Big Timber wastewater lagoon). Additional nonpoint sources may include downstream channel and streambank/floodplain deposits where historical mining has elevated metals concentrations.

Natural sources of metals are those that contribute metals independently of human disturbance or influence. Natural sources are geologically derived from metals found within the Earth's crust. The geology throughout the watershed is mineral rich and has the potential to contribute metals to receiving waters through natural weathering processes. Abandoned mines have a large potential to affect receiving water quality through non-point source loading. Lands surrounding abandoned mines often contain exposed mineral deposits, mine dumps, adit discharges and tailings that can contaminate the surrounding watershed and ecosystem. There are a number of known abandoned mines within the Boulder River watershed. Although the total number of mines is fairly large, State priority abandoned mine sites in the basin are limited to the Independence Mining District, and the Basin Creek sub-basin. Channel and streambank/floodplain deposits can harbor higher levels of metals, as loads from upstream abandoned mine source areas move their way downstream through the river system. High flows may remobilize these sediment-metals through bank erosion and channel scouring and contribute to water quality impairment. Permitted discharges through the state's MPDES Permitting Program may contribute metals to surface water. Load limits defined in the MPDES permit are designed to maintain water quality standards.

4.5.2 Metals Water Quality Targets

Water Quality Criteria
For pollutants with numeric standards (metals), the established state numeric water quality criteria as defined in *MDEQ Circular DEQ-7* is typically adopted as the water quality target. Numeric standards apply to both human health and aquatic life protection. The numeric aquatic life criteria for most metals are dependent upon water hardness values as the hardness increases, the water quality criteria for a specific metal increase also. Water quality criteria (acute[1] and chronic aquatic[2] life, human health) for each parameter of concern at a water hardness of 25 mg/L are shown in **Table 4-2**. Consequently, where the aquatic life numeric criteria is used as the target, the water quality target values for specific metals will vary with water hardness.

Table 4-2. Water quality criteria for metals at 25 mg/L hardness

Metal	Aquatic Life Criteria (ug/L)		Human Health Criteria (ug/L)	
	Acute	Chronic	Surface Water	Ground Water
Cadmium	0.52	0.01	5	5
Chromium	579	27.7	100	100
Copper	3.79	2.85	1,300	1,300
Lead	13.98	0.545	15	15
Nickel	145	16.1	100	100
Silver	0.374	NA	100	100
Zinc	37	37	2,000	2,000
Iron	1000	1000	*[3]	*[3]

Water quality targets for metals are the State of Montana acute and chronic aquatic life criteria as defined in DEQ Circular DEQ-7. In the case of silver, which does not have a chronic criteria, the acute criteria is the target value. Compliance with *chronic* water quality criteria are based on an average water quality metals concentration over a 96 hour period. A*cute* water quality criteria are applied as a 'not-to-exceed' value. Metals water quality targets are

[1] No surface or ground water sample concentration shall exceed these values
[2] No surface or ground water average concentration shall exceed these values based upon a 4-day (96 hr) or longer period.
[3] The concentration of iron must not reach values that interfere with the uses specified in the surface and groundwater standards (17.30.601 et seq. and 17.30.1001 et seq) (DEQ, 2006))

given in **Table 4-3** for two hardness conditions that represent water quality conditions within the Boulder River.

Table 4-3. Metals water quality targets for the Boulder River TMDL Planning Area (values in ug/L)

Parameter	Water Quality Target at 25 mg/L hardness		Water Quality Target at 100 mg/L hardness	
	Acute	Chronic	Acute	Chronic
Cadmium	0.52	0.01	2.13	0.27
Chromium	579	27.7	1803	86
Copper	3.79	2.85	14.0	9.3
Lead	13.98	0.545	81.6	3.2
Nickel	145	16.1	469	52
Silver	0.37	NA	4.06	NA
Zinc	37	37	119	120
Iron	1000	1000	1000	1000

Sediment Quality Criteria

Stream sediment data may also be indicative of impairment caused by elevated metals and are used as supplementary indicators of impairment. In addition to directly impairing aquatic life that interacts with the elevated metals in the sediment, the elevated sediment values can also be an indicator of elevated concentrations of metals during runoff conditions. This can be a particularly important supplemental indicator when high flow data is lacking.

The National Oceanic and Atmospheric Administration (NOAA) has developed Screening Quick Reference Tables for stream sediment quality, and gives metals concentration guidelines for freshwater sediments. Screening criteria concentrations come from a variety of studies and investigations, and are expressed in Threshold Effects Levels (TEL) and Probable Effects Levels (PEL). TELs represent the sediment concentration below which toxic effects to aquatic life occur rarely, and are calculated as the geometric mean of the 15th percentile concentration of the toxic effects data set and the median of the no-effect data set. PELs represent the sediment concentration above which toxic effects 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.

The state of Montana does not currently have criteria that define impairment condition based on sediment quality data, however general water quality prohibitions given in **Table 3-5** 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."* TELs and PELs provide a screening tool that may assist in identification of *the presence of* toxic substances, and can be used to assist in impairment determinations where water chemistry data is limited.

Table 4-4 contains the TEL and PEL values (in parts per million) for parameters of concern in the Boulder TPA.

Table 4-4. Screening level criteria for sediment metals concentrations

Metal of Concern	TEL (ppm)	PEL (ppm)
Cadmium	0.596	3.53
Chromium	37.3	90
Copper	35.7	197
Lead	35	91
Nickel	18	36
Silver	NA	NA
Zinc	123	315

Reference: NOAA, 1999

4.5.3 Water Quality Targets Evaluation

Metals indicator data (water quality and sediment samples) are available at several locations in Boulder River Segments MT43B004_131, MT43B004_132, MT43B004_133, and MT43B004_134 (**Figure 4-1**). In this section, data collected at these sites is compared to the Boulder River metals targets established in **Section 4.5.2**, followed by a determination of whether TMDLs are developed; TMDLs are developed for those pollutants not meeting water quality targets.

TMDL determination is based on the following assumptions:

- Natural levels of metals are below the chronic water quality criteria for aquatic life under all flow conditions.
- Single water quality samples represent a 96-hour average water quality condition.

Data utilized in evaluating attainment of water quality targets consisted of water quality data collected since 1993, including additional data that was collected in 2004 and 2005 that was not readily available when making impairment determinations for the 2006 303(d) List. Historical data collected primarily in the 1970s and early 1980s was not considered due to data quality and reliability concerns (reporting limits, collection, analysis and recording methods) and because older data may not adequately characterize existing conditions.

Where there is any exceedance of the water quality target, a TMDL is developed. If there are no recent target exceedances, but there is insufficient data to fully evaluate all seasonal flow conditions, then TMDL development may not be pursued within this document, and a framework sampling plan is presented to obtain additional data to better define water quality conditions for making updated impairment determinations.

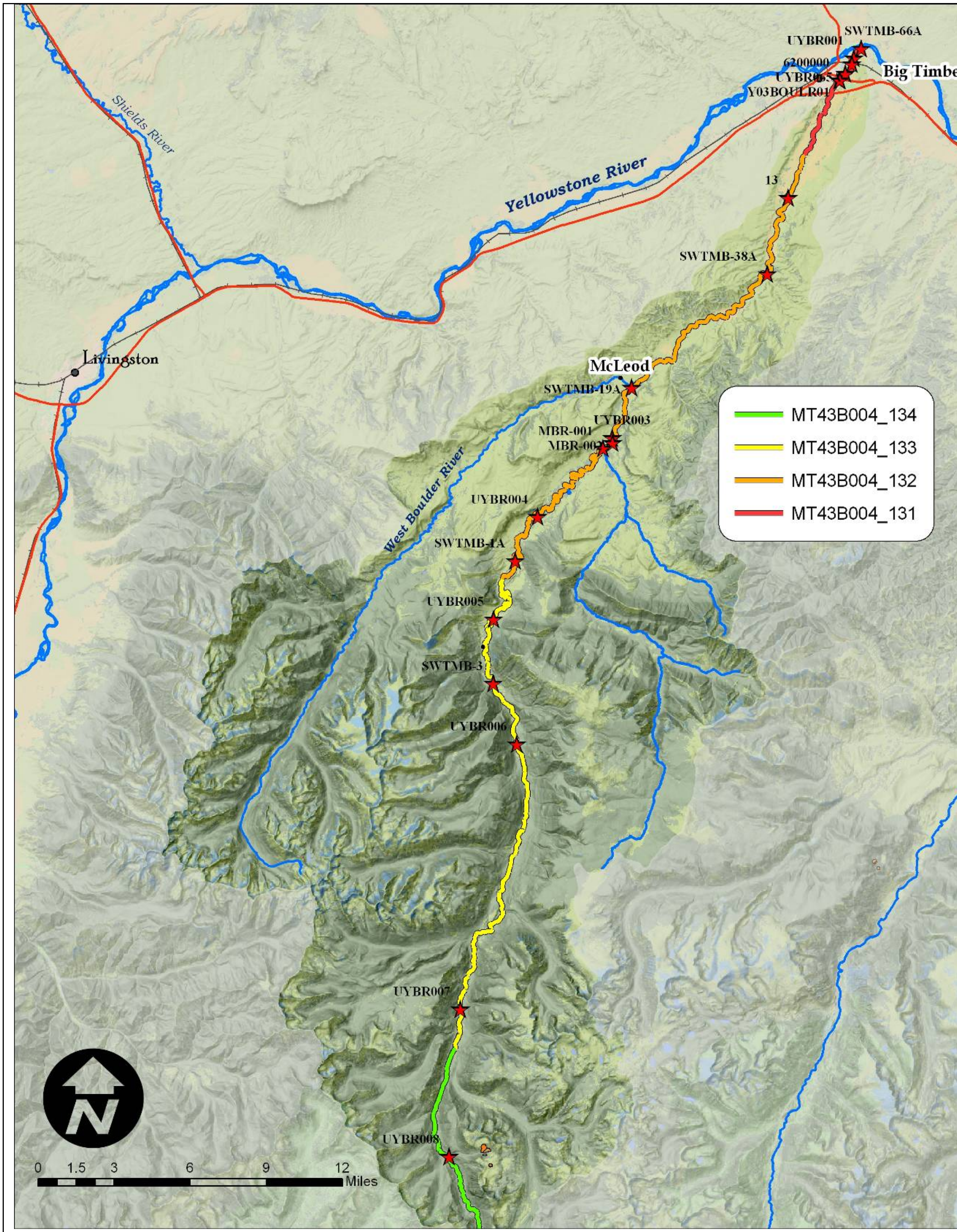

Figure 4-1. Boulder River metals sampling locations (1992-2006)

4.5.3.1 Boulder River Segment MT43B004_131

The 2006 303(d) list identifies Boulder River Segment MT43B004_131 as impaired due to metals: lead, copper, silver and iron.

Water Quality Data Results
Water quality metals samples from segment MT43B004_131 have been collected primarily by the USGS and DEQ, and are given in **Table 4-6**. For each listed pollutant, the water quality sampling result is in the '*Value*' column and the chronic and acute water quality target for the sampling event is given in columns, '*Chronic*' and '*Acute*'. Values in **bold** were unable to be evaluated because reporting limits were higher than the water quality target. Values in **grey-box bold** are exceedances of the water quality target.

Lead and copper exceed the water quality target on four separate sampling events. Each target exceedance occurred during high seasonal flows (May and June) at flows at or above 1500 cfs. There were no exceedances at flows lower than 1000 cfs.

Impairment determinations for silver and iron are based on older data that shows some exceedances of the water quality targets. There were no exceedances of silver or iron in the more recent data set presented in **Table 4-6**. June 2004 data indicates increased iron levels at higher seasonal flows (<1000 cfs), however silver and iron data was not available for high-flow sampling events (>1500 cfs) when lead and copper exceedances were observed.

Sediment Quality Data Results
Sediment quality data is limited (**Table 4-5**), and showed no exceedances of copper, lead, or silver above Threshold Effects Levels (TELs). Both chromium and nickel sediment levels were slightly elevated above TELs, however no water quality exceedances of chromium or nickel were observed.

Table 4-5. Sediment water quality metals data, Boulder River segment MT43B004_131

		Copper (ppm)			Lead (ppm)			Silver (ppm)		
Station ID	**Date**	**Value**	**TEL**	**PEL**	**Value**	**TEL**	**PEL**	**Value**	**TEL**	**PEL**
UYBR001	8/13/99	13	35.7	197	7	35	91	ND	0.733	1.77
Y03BOULR01	7/24/01	22	35.7	197	15	35	91	ND	0.733	1.77

Data Discussion
At high flows, lead and copper concentrations exceeded water quality targets. Iron and silver data did not exceed water quality targets using more recent data, and copper, lead and silver do not appear to be at elevated levels in stream sediments. Iron and silver concentrations were not available for the same sampling events when lead and copper exceedances were observed. High seasonal flows (late may through june) correlate with increased levels of most metals, suggesting runoff and stream channel sources as potential contributors. It is possible that at flows higher than 1500 cfs, some additional metals concentrations may exceed water quality targets, but only copper and lead exceedances have been verified.

Conclusion
Recent data show several water quality target exceedances for lead and copper; TMDLs will be developed for these metals.

The impairment determination listing iron and silver as causes of impairment for Boulder River segment MT43B004_131 was based on data over 20 years old. Newer data do not demonstrate impairment from silver or iron in this segment, although representative high flow data is lacking in the more recent data sets. Additional sampling should be conducted, particularly at flows > 1500 cfs to better define impairment conditions and facilitate future TMDL development for these metals.

Table 4-6. Water quality metals data, Boulder River segment MT43B004_131

Station ID	Date	Flow (cfs)	Copper (µg/L)			Lead (µg/L)			Silver (µg/L)			Iron (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
SWTMB-66A	10/02/03	72	<1	11.9	18.4	<1	4.6	118				20	1000	
UYBR001	05/25/04	~398	1.0	6.8	9.8	2	2.0	51	<1		2.1	50	1000	
UYBR001	06/04/04	~855	2.0	5.1	7.2	<1	1.3	34	<1		1.2	590	1000	
14	08/13/99		1.0	7.7	11.3	<2	2.4	61	<3		2.7	110	1000	
UYBR065A	09/03/04		1.0	12.1	18.6	<2	4.7	120	<1		6.8	20	1000	
6200000	06/17/99	3,780	**5.3**	3.1	4.2	**1.7**	0.6	16						
6200000	08/17/99	312	<1	8.8	13.1	<1	2.9	74						
6200000	11/04/99	141	0.7	11.7	17.9	<1	4.4	114						
6200000	05/31/00	2,130	2.2	3.4	4.6	<1	0.7	18						
6200000	05/16/01	2,050	**7.2**	3.0	4.1	**1.44**	0.6	15						
6200000	08/23/01	17	0.7	12.5	19.4	<1	4.9	126						
6200000	10/25/01	110	1.0	11.7	17.9	<1	4.4	114						
6200000	05/22/02	1,510	**5.5**	3.3	4.5	**1.14**	0.7	18						
6200000	05/21/03	591	1.0	7.0	10.1	0.13	2.1	53						
6200000	07/29/03	233	0.6	9.7	14.7	<0.06	3.4	87						
6200000	10/02/03	75	<1	12.0	18.4	<2	4.6	118	<3		6.7			
Y03BOULR01	06/24/04	1,500	1.0	4.0	5.5	**1.00**	0.9	23	<1		0.7	540	1000	
Y03BOULR01	07/16/05	700	<1	6.1	8.8	ND	1.7	43	<1		1.7	80	1000	
SWTMB-66A	10/02/03	72	<0.1	0.34	2.86	<1	109	2,286	<10	67	599	<10	153	153
UYBR001	05/25/04	~398	<0.1	0.21	1.46	<1	63	1,327	<10	38	342	<1	87	87
UYBR001	06/04/04	~855	<0.1	0.16	1.05	2	49	1,017	<10	29	260	<1	66	66
14	08/13/99		<0.1	0.23	1.69	2	71	1,496	<10	43	387	<10	99	99
UYBR065A	09/03/04		<0.1	0.34	2.89	<1	110	2,305	<10	67	605	<10	155	155
6200000	06/17/99	3,780	**<1**	0.11	0.58	6	30	636	6.50	18	160	<40	41	41
6200000	08/17/99	312	**<1**	0.26	1.98	<1	81	1,699	<1	49	441	<40	113	113
6200000	11/04/99	141	<0.1	0.33	2.79	<1	107	2,235	<1.8	65	586	<31	150	150
6200000	05/31/00	2,130	<0.1	0.11	0.65	2	33	691	1.14	19	174	4	44	44
6200000	05/16/01	2,050	<0.1	0.10	0.56	2	29	617	2.06	17	155	4	40	40
6200000	08/23/01	17	<0.1	0.35	3.02	<1	114	2,389	<1	70	627	<1	160	160
6200000	10/25/01	110	<0.1	0.33	2.79	<1	107	2,235	<1	65	586	1	150	150
6200000	05/22/02	1,510	<0.1	0.11	0.63	2	32	673	2.44	19	169	4	43	43

Table 4-6. Water quality metals data, Boulder River segment MT43B004_131

Station ID	Date	Flow (cfs)	Copper (µg/L)			Lead (µg/L)			Silver (µg/L)			Iron (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
6200000	05/21/03	591	<0.2	0.21	1.51	1	65	1,362	0.71	39	351	3	90	90
6200000	07/29/03	233	<0.04	0.28	2.24	<1	90	1,877	0.78	54	489	<2	125	125
6200000	10/02/03	75	<0.1	0.34	2.87				<10	67	600	<10	153	153
Y03BOULR01	06/24/04	1,500	<0.1	0.13	0.78	2	38	804	ND	23	204	2	52	52
Y03BOULR01	07/16/05	700	<0.1	0.19	1.29	<1	57	1,201	ND	34	308	1	79	79

4.5.3.2 Boulder River Segment MT43B004_132

The 2006 303(d) list identifies Boulder River Segment MT43B004_132 as impaired due to two metals: nickel, chromium.

Water Quality Data Results
Water quality metals samples from segment MT43B004_132 have been collected primarily by the USGS and DEQ, and are given in **Table 4-8**. For each listed pollutant, the water quality sampling result is in the '*Value*' column and the chronic and acute water quality target for the sampling event is given in columns, '*Chronic*' and '*Acute*'. Values in **bold** were unable to be evaluated because reporting limits were higher than the water quality target. Values in **grey-box bold** are exceedances of the water quality target.

The only exceedances of water quality targets occurred for iron during spring runoff flows. On 6/03/03 iron concentrations at sampling sites MBR-001 and MBR-002 exceeded the water quality target of 1000 ug/L. Flows were not recorded on this data, but it is assumed that samples were collected during high flows associated with runoff conditions.

Sediment Quality Data Results
Sediment quality data is limited, however data did reveal some sediment metals concentrations elevated above TELs (**Table 4-7**). One of three sediment samples contained elevated levels of chromium, and two of three contained levels of nickel above TELs.

Table 4-7. Sediment water quality metals data, Boulder River segment MT43B004_132

Station ID	Date	Cadmium (ppm)			Chromium (ppm)			Copper (ppm)		
		Value	TEL	PEL	Value	TEL	PEL	Value	TEL	PEL
UYBR003	8/13/99	ND	0.60	3.53	49	37	90	11	35.7	197
UYBR004	8/13/99	ND	0.60	3.53	30	37	90	9	35.7	197
13	8/13/99	ND	0.60	3.53	26	37	90	11	35.7	197
Station ID	**Date**	**Lead (ppm)**			**Nickel (ppm)**			**Silver (ppm)**		
		Value	**TEL**	**PEL**	**Value**	**TEL**	**PEL**	**Value**	**TEL**	**PEL**
UYBR003	8/13/99	6	35	91	27	18	36	ND	0.733	1.77
UYBR004	8/13/99	ND	35	91	19	18	36	ND	0.733	1.77
13	8/13/99	ND	35	91	16	18	36	ND	0.733	1.77

Data Discussion
At low flows, metals concentrations in water quality samples were either at very low concentrations or were undetectable. At seasonal runoff flows (May, June), metals levels increased but were predominantly below target values. The exception occurred at sampling sites MBR-001 and MBR-002 where iron exceeded the target of 1,000 ug/L on 06/03/03.

While sediment metals concentrations for chromium and nickel were elevated above the TEL, no water quality target exceedances of these metals was observed. During seasonal runoff flows, elevated chromium levels were observed but remained below the water quality target; no detects for nickel were observed in any of the water quality samples collected.

Conclusion

Recent water quality data show water quality target exceedances of iron: a TMDL will be developed for iron. There were no exceedances of water quality targets for chromium or nickel. Additional sediment and water quality assessments should be conducted, particularly at flows > 1500 cfs, to further characterize impairment conditions and facilitate future TMDL development for these metals.

Table 4-8. Water quality metals data, Boulder River segment MT43B004_132

Station ID	Date	Flow (cfs)	Copper (µg/L)			Lead (µg/L)			Silver (µg/L)			Iron (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
13	08/13/99		1.0	6.7	9.7	**<2**	1.9	50	**<3**	N/A	2.1	160	1000	
SWTMB-38A	10/01/03	70	<1	10.9	16.6	<1	4.0	102	<1	N/A	5.5	<10	1000	
UYBR002	05/25/04		1.0	6.2	8.9	<1	1.7	45	<1	N/A	1.8	50	1000	
UYBR002	06/04/04		2.0	4.4	6.2	<1	1.1	27	**<1**	N/A	0.9	490	1000	
SWTMB-19A	08/15/03	130	<1	9.0	13.4	<1	3.0	77	<1	N/A	3.7	20	1000	
SWTMB-19A	10/01/03	73	<1	11.0	16.8	<1	4.1	104	<1	N/A	5.6	20	1000	
SWTMB-19A	09/03/04		<1	9.5	14.3	<2	3.3	84	<1	N/A	4.2			
12	08/13/99		1.0	5.1	7.1	**<2**	1.3	33	**<3**	N/A	1.2	280	1000	
UYBR003	05/25/04		1.0	5.0	7.0	<1	1.2	32	<1	N/A	1.1	70	1000	
UYBR003	06/04/04		2.0	4.1	5.7	**<1**	0.9	24	**<1**	N/A	0.8	170	1000	
MBR-002	08/28/00		<1	9.3	14.0	<3	3.2	82				20	1000	
MBR-002	10/30/00	30	<1	11.1	17.0	<3	4.1	106				20	1000	
MBR-002	03/07/01		<1	11.8	18.2	<3	4.5	116				20	1000	
MBR-002	05/22/01		<1	5.3	7.6	**<3**	1.4	36				50	1000	
MBR-002	08/29/01		<1	9.7	14.7	<3	3.4	87				30	1000	
MBR-002	11/14/01	89	<1	12.1	18.6	<3	4.7	120				30	1000	
MBR-002	03/26/02		<1	10.6	16.1	<3	3.8	99				30	1000	
MBR-002	06/04/02		2	3.0	3.9	**<3**	0.6	15				830	1000	
MBR-002	08/27/02	123	<1	9.6	14.5	<3	3.3	86				30	1000	
MBR-002	11/05/02	75	<1	10.7	16.4	<3	3.9	101				20	1000	
MBR-002	03/19/03	67	1	11.8	18.1	<3	4.5	115				40	1000	
MBR-002	06/03/03		2	2.9	3.8	**<3**	0.5	14				**1160**	1000	
MBR-002	09/10/03	89	<1	7.9	11.6	**<3**	2.5	63				20	1000	
MBR-001	08/25/00		1	9.0	13.5	<3	3.0	78				30	1000	
MBR-001	10/30/00	31	<1	8.3	12.3	**<3**	2.7	68				20	1000	
MBR-001	03/07/01		<1	9.2	13.9	<3	3.1	81				20	1000	
MBR-001	05/22/01		<1	3.7	5.1	**<3**	0.8	21				80	1000	
MBR-001	08/29/01		<1	9.2	13.9	<3	3.1	81				30	1000	
MBR-001	11/14/01	78	<1	8.8	13.1	**<3**	2.9	74				30	1000	
MBR-001	03/26/02		<1	8.9	13.3	<3	3.0	76				30	1000	
MBR-001	06/04/02		2	2.9	3.8	**<3**	0.5	14				880	1000	
MBR-001	08/27/02	132	<1	9.6	14.5	<3	3.3	86				30	1000	

Table 4-8. Water quality metals data, Boulder River segment MT43B004_132

Station ID	Date	Flow (cfs)	Copper (µg/L)			Lead (µg/L)			Silver (µg/L)			Iron (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
MBR-001	11/05/02	72	<1	8.6	12.8	**<3**	2.8	72				30	1000	
MBR-001	03/19/03	58	1	9.0	13.5	<3	3.0	78				50	1000	
MBR-001	06/03/03		1	2.9	3.8	**<3**	0.5	14				**1090**	1000	
MBR-001	09/10/03	86	<1	7.8	11.5	**<3**	2.4	62				20	1000	
11	08/13/99		<1	4.0	5.5	**<2**	0.9	23	**<3**	N/A	0.7	60	1000	
UYBR004	05/25/04		1.0	3.5	4.8	**<1**	0.8	19	**<1**	N/A	0.6	70	1000	
UYBR004	06/04/04		1.0	3.2	4.4	**<1**	0.7	17	**<1**	N/A	0.5	170	1000	
SWTMB-1A	08/15/03	133	<1	4.2	5.9	<1	1.0	25	**<1**	N/A	0.8	40	1000	
SWTMB-1A	10/01/03	73	<1	5.1	7.1	<1	1.3	33	<1	N/A	1.2	100	1000	
13	08/13/99		<0.1	0.27	2.11	3	63	1,315	<10	38	339	<10	86	86
SWTMB-38A	10/01/03	70	<0.1	0.31	2.56	<1	100	2,086	<10	61	545	<10	139	139
UYBR002	05/25/04		<0.1	0.19	1.31	<1	58	1,221	<10	35	314	<1	80	80
UYBR002	06/04/04		<0.1	0.14	0.88	1	42	884	<10	25	225	<1	57	57
SWTMB-19A	08/15/03	130	<0.1	0.26	2.03	<1	83	1,735	<10	50	451	<10	115	115
SWTMB-19A	10/01/03	73	<0.1	0.31	2.59	<1	101	2,109	<10	61	552	<10	141	141
SWTMB-19A	09/03/04		<0.1	0.27	2.18	<1	88	1,833	<10	53	477	<1	122	122
12	08/13/99		<0.1	0.16	1.03	3	48	1,004	<10	28	256	<10	65	65
UYBR003	05/25/04		<0.1	0.16	1.01	<1	47	985	<10	28	251	<1	64	64
UYBR003	06/04/04		<0.1	0.13	0.81	2	39	823	<10	23	209	<1	53	53
MBR-002	08/28/00		<0.1	0.27	2.13	<1	86	1,803	<20	52	469	<10	120	120
MBR-002	10/30/00	30	<0.1	0.32	2.63	<1	102	2,136	<20	62	559	<10	143	143
MBR-002	03/07/01		<0.1	0.33	2.83	<1	108	2,263	<20	66	593	<10	152	152
MBR-002	05/22/01		<0.1	0.17	1.10	<1	50	1,055	<20	30	270	<10	69	69
MBR-002	08/29/01		<0.1	0.28	2.24	<1	90	1,877	<20	54	489	<10	125	125
MBR-002	11/14/01	89	<0.1	0.34	2.89	<1	110	2,305	<20	67	605	<10	155	155
MBR-002	03/26/02		<0.1	0.30	2.48	<1	97	2,036	<20	59	532	<10	136	136
MBR-002	06/04/02		<0.1	0.10	0.54	4	29	598	**<20**	17	150	<10	38	38
MBR-002	08/27/02	123	<0.1	0.28	2.22	<1	89	1,862	<20	54	485	<10	124	124
MBR-002	11/05/02	75	<0.1	0.31	2.52	<1	99	2,065	<20	60	540	<10	138	138
MBR-002	03/19/03	67	<0.1	0.33	2.81	<1	108	2,249	<20	66	590	<10	151	151
MBR-002	06/03/03		<0.1	0.10	0.52	4	28	579	**<20**	16	145	<10	37	37
MBR-002	09/10/03	89	<0.1	0.23	1.74	<1	73	1,533	<20	44	397	<10	101	101

Table 4-8. Water quality metals data, Boulder River segment MT43B004_132

Station ID	Date	Flow (cfs)	Copper (µg/L)			Lead (µg/L)			Silver (µg/L)			Iron (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
MBR-001	08/25/00		<0.1	0.26	2.05	<1	83	1,744	<20	50	453	<10	116	116
MBR-001	10/30/00	31	<0.1	0.24	1.85	<1	77	1,609	<20	46	417	<10	106	106
MBR-001	03/07/01		<0.1	0.27	2.11	<1	85	1,788	<20	52	465	<10	119	119
MBR-001	05/22/01		<0.1	0.12	0.71	<1	36	745	<20	21	188	<10	48	48
MBR-001	08/29/01		<0.1	0.27	2.11	<1	85	1,788	<20	52	465	<10	119	119
MBR-001	11/14/01	78	<0.1	0.26	1.98	<1	81	1,699	<20	49	441	<10	113	113
MBR-001	03/26/02		<0.1	0.26	2.02	<1	83	1,729	<20	50	449	<10	115	115
MBR-001	06/04/02		<0.1	0.10	0.52	4	28	579	**<20**	16	145	<10	37	37
MBR-001	08/27/02	132	<0.1	0.28	2.22	3	89	1,862	<20	54	485	<10	124	124
MBR-001	11/05/02	72	<0.1	0.25	1.94	<1	80	1,669	<20	48	433	<10	111	111
MBR-001	03/19/03	58	<0.1	0.26	2.05	<1	83	1,744	<20	50	453	<10	116	116
MBR-001	06/03/03		<0.1	0.10	0.52	4	28	579	**<20**	16	145	<10	37	37
MBR-001	09/10/03	86	<0.1	0.23	1.72	<1	73	1,517	<20	44	393	<10	100	100
11	08/13/99		<0.1	0.13	0.78	2	38	804	<10	23	204	20	52	52
UYBR004	05/25/04		<0.1	0.12	0.67	<1	34	713	<10	20	180	<1	46	46
UYBR004	06/04/04		<0.1	0.11	0.61	<1	31	656	<10	18	165	<1	42	42
SWTMB-1A	08/15/03	133	<0.1	0.14	0.84	<1	41	848	<10	24	215	<10	55	55
SWTMB-1A	10/01/03	73	<0.1	0.16	1.03	<1	48	1,004	<10	28	256	<10	65	65

4.5.3.3 Boulder River Segment MT43B004_133

The 2006 303(d) list does not identify Boulder River Segment MT43B004_133 as impaired due to metals. This segment is included here because additional data, unavailable during the most recent assessment, show water quality target exceedances.

Water Quality Data Results
Water quality metals samples from segment MT43B004_133 have been collected primarily by the USGS and DEQ, and are given in **Table 4-10** For each listed pollutant, the water quality sampling result is in the '*Value*' column and the chronic and acute water quality target for the sampling event is given in columns, '*Chronic*' and '*Acute*'. Values in **bold** were unable to be evaluated because reporting limits were higher than the water quality target. Values in **grey-box bold** are exceedances of the water quality target.

The only exceedance of water quality targets occurred for lead on 5/24/04 at site UYBR007, when lead concentration was elevated (1.0 ug/L) above the chronic level of 0.6 ug/L. The remainder of the lead data set (n=8) could not be evaluated, as reporting limits were higher than the chronic water quality target.

Sediment Quality Data Results
Sediment quality data is limited to two sampling sites in 1999; data did reveal that some sediment metals concentrations were elevated above TELs (**Table 4-9**). Sediment concentrations of both chromium and nickel were slightly elevated above TELs at sampling site UYBR005, but were below TELs at site UYBR006.

Table 4-9. Sediment water quality metals data, Boulder River segment MT43B004_133

		Cadmium (ppm)			Chromium (ppm)			Copper (ppm)		
		Value	TEL	PEL	Value	TEL	PEL	Value	TEL	PEL
UYBR005	8/13/1999	ND	0.596	3.53	**40**	37.3	90	10	35.7	197
UYBR006	8/13/1999	ND	0.596	3.53	28	37.3	90	7	35.7	197
		Lead (ppm)			Nickel (ppm)			Silver (ppm)		
		Value	TEL	PEL	Value	TEL	PEL	Value	TEL	PEL
UYBR005	8/13/1999	5	35	91	**22**	18	35.9	ND	0.733	1.77
UYBR006	8/13/1999	ND	35	91	17	18	35.9	ND	0.733	1.77

Data Discussion
Only one lead sample demonstrated a target exceedance, and reporting limits were too high to adequately evaluate attainment of the water quality target during all other sample events. It is possible that additional exceedances of the water quality target for lead occurred, yet analytical procedures preclude their evaluation. Since lead exceedances also occur lower in the Boulder River (segment MT43B004_131), and abandoned mine sources exist in the upper watershed, it is reasonable to assume that any lead exceedances observed on contiguous segments of the Boulder River are related to similar sources, and can be reduced through similar control efforts.

Chromium and nickel sediment concentrations are elevated above the TEL at UYBR005, however no water quality target exceedances of these metals were observed.

Conclusion

Recent water quality data show water quality target exceedances of lead: a TMDL will be developed for lead. There were no exceedances of water quality targets for other metals. Additional sediment and water quality assessments should be conducted, particularly at flows > 1500 cfs, to further characterize impairment conditions and facilitate possible future TMDL development.

Table 4-10. Water quality metals data, Boulder River segment MT43B004_133

Station ID	Date	Flow (cfs)	Cadmium (μg/L)			Chromium (μg/L)			Copper (μg/L)			Lead (μg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
10	08/13/99		<0.1	0.12	0.68	1	34	715	<1	3.6	4.8	**<2**	0.8	19
UYBR005	06/04/04		<0.1	0.11	0.64	<1	33	687	1.0	3.4	4.6	**<1**	0.7	18
UYBR005	05/25/04		<0.1	0.10	0.52	<1	28	579	1.0	2.9	3.8	**<1**	0.5	14
SWTMB-3	10/01/03	70	<0.1	0.13	0.78	<1	38	804	<1	4.0	5.5	**<1**	0.9	23
UYBR006	06/04/04		<0.1	0.10	0.58	<1	30	630	2.0	3.1	4.2	**<1**	0.6	16
UYBR006	05/25/04		<0.1	0.10	0.52	<1	28	579	1.0	2.9	3.8	**<1**	0.5	14
6	08/13/99		<0.1	0.10	0.54	2	28	593	<1	2.9	3.9	**<2**	0.6	14
UYBR007	06/04/04		<0.1	0.10	0.57	<1	30	624	1.0	3.1	4.1	**1**	0.6	16
UYBR007	05/25/04		<0.1	0.10	0.52	<1	28	579	1.0	2.9	3.8	**<1**	0.5	14
10	08/13/99		<10	20	180	<10	46	46	**<3**	N/A	0.6	80	1000	
UYBR005	06/04/04		<10	19	173	<1	44	44	**<1**	N/A	0.5	40	1000	
UYBR005	05/25/04		<10	16	145	<1	37	37	**<1**	N/A	0.4	130	1000	
SWTMB-3	10/01/03	70	<10	23	204	<10	52	52	**<1**	N/A	0.7	<10	1000	
UYBR006	06/04/04		<10	18	158	<1	40	40	**<1**	N/A	0.4	40	1000	
UYBR006	05/25/04		<10	16	145	<1	37	37	**<1**	N/A	0.4	120	1000	
6	08/13/99		<10	17	149	<10	38	38	**<3**	N/A	0.4	40	1000	
UYBR007	06/04/04		<10	17	157	<1	40	40	**<1**	N/A	0.4	40	1000	
UYBR007	05/25/04		<10	16	145	<1	37	37	**<1**	N/A	0.4	610	1000	

4.5.3.4 Boulder River Segment MT43B004_134, and Basin Creek Segment MT43B005_010

The 2006 303(d) list identifies Boulder River Segment MT43B004_134 as impaired due to metals: copper, lead. Basin Creek was not assessed and was not incorporated into the 2006 303(d) list, but is included here since one or more metals targets were exceeded.

Water Quality Data Results
Water quality metals samples from segment MT43B004_134 have been collected primarily by the USGS and DEQ, and are given in **Table 4-12**. For each listed pollutant, the water quality sampling result is in the '*Value*' column and the chronic and acute water quality target for the sampling event is given in columns, '*Chronic*' and '*Acute*'. Values in **bold** were unable to be evaluated because reporting limits were higher than the water quality target. Values in **grey-box bold** are exceedances of the water quality target.

There were no water quality exceedances of metals in the data set which included three water quality samples taken downstream of Basin Creek. Samples taken from Basin Creek by the DEQ's Abandoned Mine Program showed water quality target exceedances of both copper and lead on two separate occasions in 1993.

Sediment Quality Data Results
Sediment quality data is limited, however data did reveal some sediment metals concentrations elevated above TELs **(Table 4-11)**. Sediment concentrations of both copper and nickel were slightly elevated above TELs at sampling site UYBR008.

Table 4-11. Sediment water quality metals data, Boulder River segment MT43B004_134

		Cadmium (ppm)			Chromium (ppm)			Copper (ppm)		
		Value	**TEL**	**PEL**	**Value**	**TEL**	**PEL**	**Value**	**TEL**	**PEL**
UYBR008	8/13/1999	ND	0.596	3.53	20	37.3	90	65	35.7	197
		Lead (ppm)			**Nickel (ppm)**			**Silver (ppm)**		
		Value	**TEL**	**PEL**	**Value**	**TEL**	**PEL**	**Value**	**TEL**	**PEL**
UYBR008	8/13/1999	9	35	91	26	18	35.9	ND	0.733	1.77

Data Discussion
Water quality data, while limited, show no water quality target exceedances for segment MT43B004_134. Sediment quality data show copper and nickel concentrations above the TEL.

The Independence Mining District lies at the headwaters of Basin Creek, a tributary to the Boulder River, and is on the State's Priority Abandoned Mines List. Abandoned mines are scattered throughout this area and are likely contributors to metals contamination in Basin Creek and downstream in the Boulder River. Water quality and sediment quality data collected in Basin Creek by the DEQ's Abandoned Mines Program in August 1993 showed exceedances of copper and lead water quality targets, and sediment levels of copper and lead in Basin Creek were among the highest in the watershed. Onsite adit discharges were also sampled: maximum copper concentration was 186 ug/L.

The dearth of data for Boulder River segment MT43B004_134 limits interpretation. Known sources of metals contamination exist in Basin Creek, and Basin Creek itself shows elevated levels of metals in both the sediment and water quality samples. Additional water quality data under a variety of flow conditions is recommended in order to better characterize water quality conditions.

Conclusion

While water quality data in Boulder River Segment MT43B004_134 do not show exceedances of water quality targets, the paucity of available data precludes determination of water quality condition with a high level of certainty.

Because significant metals sources exist in Basin Creek, and there are exceedances of water quality targets, copper and lead, TMDLs will be developed for Basin Creek segment MT43B005_010.

Table 4-12. Water quality metals data, Boulder River segment MT43B004_134

Station ID	Date	Flow (cfs)	Cadmium (µg/L)			Chromium (µg/L)			Copper (µg/L)			Lead (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
UYBR008	05/25/04		<0.1	0.15	0.96	<1	45	946	1.0	4.8	6.7	<1	1.2	30
UYBR008	06/04/04		<0.1	0.14	0.83	1	40	839	2.0	4.2	5.8	<1	1.0	25
1.0	08/13/99		<0.1	0.10	0.52	3	28	579	1.0	2.9	3.8	**<2**	0.5	14
UYBR008	05/25/04		<10	27	241	<1	61	61	<1	N/A	1.0	50	1000	
UYBR008	06/04/04		<10	24	213	<1	54	54	**<1**	N/A	0.8	600	1000	
1.0	08/13/99		**<10**	16	145	20	37	37	**<3**	N/A	0.4	70	1000	

4.5.4 Boulder River Metals Summary

Present understanding of the conditions under which Boulder River water quality exceeds water quality targets for metals is limited by the spatial and temporal constraints of the existing data. Most elevated metals concentrations occur during spring runoff flows, when low hardness values make the Boulder River susceptible to chronic metals exceedances. Along its length, the Boulder River has exhibited exceedances of water quality criteria for copper, lead and iron, particularly during seasonal high flow periods. While each segment does not necessarily exhibit water quality criteria exceedances for each metal of concern, sources of metals are thought to be common to all segments and are predominantly from natural and historical mining sources (abandoned mines) throughout the watershed. Controlling and remediating loading from these sources will not only act to reduce loading of copper, lead and iron on all segments of the Boulder River, but also reduce elevated levels of other metals that may be impacting beneficial uses but where limited data limits evaluation.

TMDLs for copper, lead and iron will be prepared for Boulder River segments MT43B004_131, MT43B004_132, MT43B004_133, MT43B004_134 and Basin Creek segment MT43B005_010, and are given in **Section 5.0**. **Table 4-13** provides a summary of verified target exceedances in the Boulder River, and subsequent TMDL preparation. Additional data collection and source assessments is recommended and will allow a more accurate characterization of water quality conditions under higher flow conditions, and assist in further evaluating attainment of water quality targets.

Table 4-13. Boulder River metals impairment summary

Water Body Segment	2006 303(d) Listing (metals)	Verified Target Exceedances (metals)	TMDLs Prepared (Section 5)
MT43B004_131	Copper Lead Silver Iron	Copper Lead	Copper Lead Iron
MT43B004_132	Nickel Chromium	Iron	
MT43B004_133	None	Lead	
MT43B004_134	Copper Lead	None	
MT43B005_010	None	Copper Lead	

4.6 Monitoring Recommendations

The recommendations provided herein do not assign responsibility to specific entities, agencies or organizations for monitoring and assessment activity, but act to promote collaborative and coordinated resource management so that all beneficial uses may be maintained and protected, and that trends in water quality are identified and documented. Monitoring recommendations are meant to highlight data and information needs aimed at monitoring potential pollutant sources as well as monitoring the condition of the East Boulder River, and provide a framework for present and future monitoring activity. Implementation of monitoring recommendations may require adoption of existing monitoring frameworks, or may require the development of additional resources and technical considerations.

4.6.1 Sediment, Flow and Habitat Monitoring & Assessment

Probable anthropogenic sources of sediment in the East Boulder River identified on the 2006 303(d) list include:

- Flow alterations from water diversions
- Streambank modifications/destabilization

Flow alteration is commonly considered water *quantity* rather than water quality issues; however changes to stream flow can have a profound effect on the proper functioning of stream systems and can be a major factor influencing water quality impairments. Stream channel form evolves and stabilizes over long time periods based on the amount of stream flow (energy) and sediment supply (Leopold et al., 1964; Rosgen, 1996). When the balance between sediment supply and stream energy is disrupted, changes in channel form result. Decreases in stream energy may result in an inability of the stream to effectively transport sediments, thereby causing aggradation, or deposition of sediments in the stream channel, which further contributes to a decrease in stream energy by creating a wider and shallower channel. Consequently, appropriate duration and magnitude of peak flows (i.e. bankfull or flood flows) and base flows are critical to a stream's ability to transport sediments. Sustained low flows, whether from flow regulation, channel alteration, drought, or other natural conditions can lead to sediment-related impairments, and while TMDLs are not required for water quantity-related issues, flow alteration has been identified as a cause of sediment-related impairments on the 2006 303(d) list and is acknowledged as a factor that influences impairment condition.

Streambank modifications refer to a variety of impacts to the stream channel and associated riparian zone. These may include: removal or alteration of streamside vegetation, riparian encroachment from construction or streamside development, removal of large woody debris, alteration of channel form or substrate, bank erosion, or other alterations to terrestrial and aquatic habitat elements. Streambank modification can be a contributor or strong influence on sediment loading. For instance, removal of riparian vegetation, especially trees and woody shrubs, may lead to bank instability and increased bank erosion and consequently increases in sediment loading to a stream. Likewise, vegetation removal may also reduce the ability of vegetated buffer zones to intercept sediment-laden runoff from uplands during storm or runoff events.

Quantitative sediment and habitat data (width-to-depth ratios, percent surface fines <2mm) used to evaluate attainment with water quality targets was collected in the summer of 2005. In order to evaluate spatial and temporal water quality trends over a variety of conditions, the DEQ recommends an evaluation of methods and sampling locations used in this effort, and development of a long-term *Sediment and Habitat Monitoring Plan* that incorporates, but is not limited to the following monitoring parameters.

Percent fines <2mm in riffle habitats

East Boulder River Sediment Assessment **(DEQ, 2007)** provides rationale behind utilization of riffle fines as an indicator of aquatic life support. Long-term monitoring should identify representative riffles within segments MT43B004_141 and MT43B004_142 and establish a sampling frequency.

Percent fines <6mm in pool tail habitats

Percent fines <6mm in pool tail habitats is an indicator of the potential spawning success of salmonids. Trout typically establish redds in pool tail habitat. Excessive fine sediment in pool tails can inhibit spawning success of salmonids. Long-term monitoring should identify areas of potential salmonid spawning and establish a sampling frequency that allows evaluation of beneficial use support for cold-water fishery.

Fish habitat indicators

In addition to percent fines data, habitat assessments should be conducted that provide information on suitability of the East Boulder River to support and propagate cold-water fish species. Habitat assessments may provide information that can assist in identifying limitations and prioritizing fisheries enhancement efforts in the East Boulder watershed.

Bioassessments

Macroinvertebrate and periphyton sampling and assessment can provide information regarding biological response to pollutant loads and impacts from other pollution-related sources. Bioassessments provide a direct indicator of beneficial use support for aquatic life and, in conjunction with existing bioassessment data, can inform as to long-term biological trends in the East Boulder River.

Streamflow

DEQ recommends that local landowners, watershed organizations, and resource managers continue to work collaboratively with local and state agencies to ensure protection of beneficial uses through flow monitoring and the development of flow enhancement and management plans designed to enhance streamflows for the maintenance of both irrigation and aquatic life uses. Ongoing planning efforts in the Boulder Watershed have identified and prioritized a variety of potential implementation projects in the watershed (**Appendix B**), many of which may result in direct water quality and quantity improvements. Continued implementation of priority projects resulting in water quality improvements and *long-term* in-stream flow enhancement through local collaborative efforts is encouraged.

The framework and objectives of a long-term *Sediment and Habitat Monitoring Plan* should be developed in a way as to adequately and accurately characterize sediment and habitat conditions in the East Boulder watershed and should allow for data collection that meets a variety of objectives, including the continued evaluation of beneficial use attainment and maintenance. Key participants in the development and maintenance of stream sampling activities may include: local landowners, Sweet Grass Conservation District, Boulder River Watershed Group, Montana Department of Fish, Wildlife & Parks, Montana Department of Natural Resources & Conservation, Natural Resources Conservation Service and the Montana Department of Environmental Quality. Other organizations and non-profits that may provide assistance through technical expertise, funding, educational outreach, or other means include: Montana Water Trust, Natural Resources Conservation Service, Northern Plains Resource Council, Cottonwood Resource Council, and the Montana Water Center

4.6.2 Nutrient Monitoring & Assessment

Probable anthropogenic sources of nutrients in the East Boulder River identified on the 2006 303(d) list include:

- Agriculture sources
- Other unknown sources

Agricultural sources include nutrients such as phosphorus and nitrogen in the form of fertilizers that are applied to crops to enhance production. Agricultural associated nutrients are also found in manure, sludge, irrigation water, legumes, and crop residues. When nutrients are applied in excess of plant needs, they can wash into aquatic ecosystems where they can cause excessive plant growth which can impair recreation and aquatic life in the water bodies. In addition to cropland areas, overgrazing and poorly managed agricultural lands can expose soils, increase erosion, encourage invasion by undesirable plants, impact fish habitat, and reduce riparian vegetation necessary to maintain streambanks and provide habitat.

Stream de-watering through irrigation can result in higher water temperatures, decreased solar radiation attenuation, and increased sensitivity to external nutrient loads. These factors can contribute to and exacerbate nuisance algal growth (excessive chlorophyll-*a*).

In addition to agricultural non-point sources, there exists a nutrient point-source that has the potential to impact downstream surface water quality: the East Boulder Mine permitted wastewater discharge. The East Boulder Mine holds a Montana Pollutant Discharge Elimination System (MPDES) permit that regulates discharge of nutrients, predominantly from ammonium nitrate blast residue, through ground water. To date, there has been no direct surface water discharge from the mine. The mine's ground water discharges are regulated through the mine's MPDES discharge permit.

Other potential nutrient sources include roads and crossings, septic systems (particularly near-stream and/or failing systems), nutrient inputs from tributaries that flow into the East Boulder River, as well as nutrient inputs from natural springs and seeps. Anderson Spring, a natural spring on the East Boulder River, has documented water temperatures and nitrate concentrations above that of the East Boulder River. This combination may affect algal growth, especially during late summer low flows.

DEQ recommends the following actions in order to assess potential impacts to surface waters from potential nutrient loading:

- Continue monitoring of ground water nitrate concentrations at established monitoring wells, EBMW-2, EBMW-3, EBMW-6, EBMW-7, EBMW-8 and EBMW-9 and at surface water monitoring locations EBR-003 and EBR-004 as stipulated in permit no. MT-0026808.
- Assess the potential for groundwater loading to surface waters upstream of ground water monitoring well EBMW-7, throughout the reach from EBR-001 to EBR-003.
- Continued biological monitoring in accordance with the Biological Monitoring Plan for Stillwater Mining Company – East Boulder Project (1998) as stipulated in permit no. MT-0026808.
- Quarterly nutrient sampling and annual macroinvertebrate and chlorophyll-a (late summer) at surface water monitoring stations EBR-005 – EBR-009
- Track coverage and spread of Didymosphenia geminata in the upper Boulder River through stream reach assessments and monitoring.
- Promote, support and maintain nutrient reduction BMPs throughout the watershed.

4.6.3 Metals Monitoring & Assessment

In order to adequately characterize conditions that contribute to water quality impairment in the Boulder River, additional water quality sampling for metals is recommended. While data shows that chronic water quality criteria for some metals are exceeded at times during seasonal runoff, further water quality sampling during the rising limb, falling limb and at base flow (**Figure 4-2**) of the typical Boulder River hydrograph will assist in meeting a variety of **monitoring goals:**

- Evaluate water quality target attainment
- Identify and evaluate metals loading from abandoned mining sites
- Estimate metals loading to the Boulder River from different source areas
- Refine metals source assessments
- Establish natural background conditions
- Prioritize remediation and restoration activities.

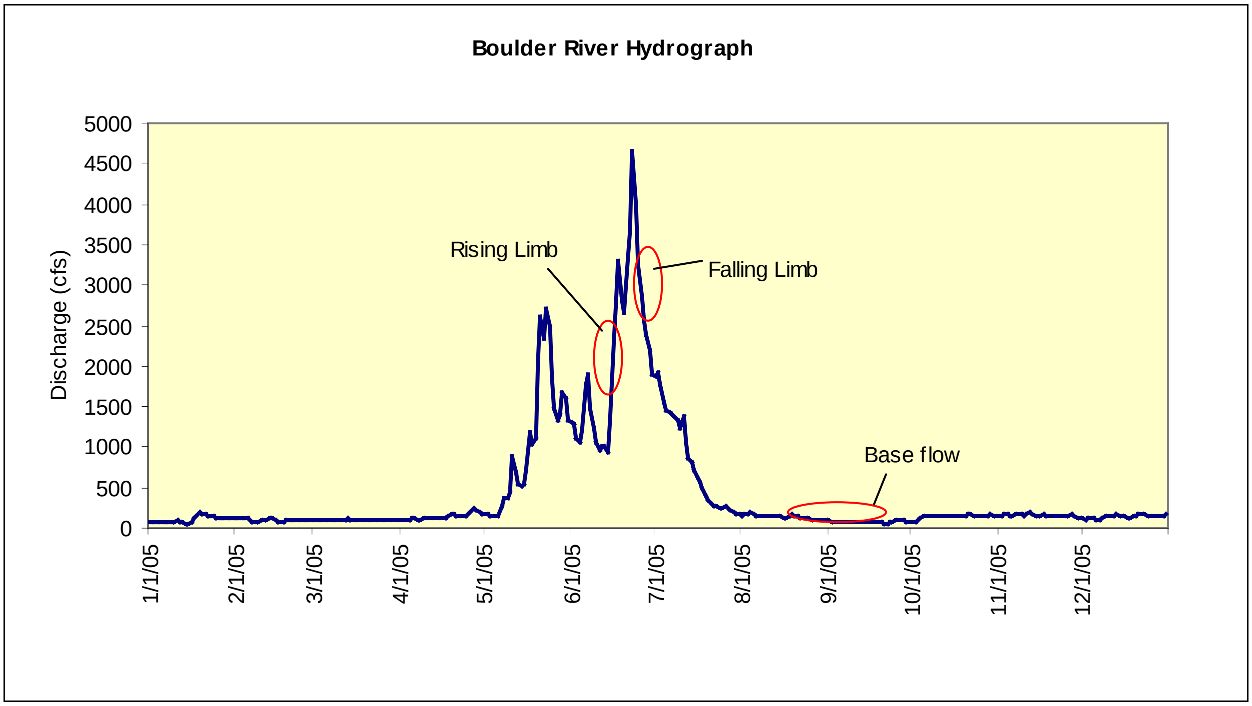

Figure 4-2. Boulder river hydrograph

Sampling sites for each synoptic sampling event should be chosen to include:

- Mouths of major tributaries (West Boulder River, East Boulder River)
- Mouths of selected tributaries known to have mining-related metals sources (including Basin Creek)
- Mouths of selected unmined tributaries.
- Permitted effluent discharges
- Multiple mainstem Boulder River sites within each segment

Water quality samples collected at each site should include, at a minimum, the following field parameters and lab analysis:

- Field Parameters (instantaneous discharge, pH, water temperature, electroconductivity)
- Water & Sediment Quality Analysis – (dissolved metals, total recoverable metals, hardness, suspended solids, sediment metals)

Provided above is a basic framework for continued monitoring and investigation of metals issues in the Boulder river watershed. Final sampling design, standard operating procedures, analytical methods, and quality assurance measures should be detailed in a formal Sampling and Analysis Plan (SAP) that has been approved by the DEQ.

SECTION 5.0
BOULDER RIVER METALS TMDLS AND ALLOCATIONS

A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs are a requirement of Section 303(d) of the Clean Water Act (CWA). To meet this requirement, MDEQ must identify water bodies not meeting water quality standards and then establish TMDLs for those pollutants responsible for water quality impairment. In general, a TMDL is a quantitative assessment of water quality problems, contributing sources, and pollution reductions needed to attain water quality standards. The TMDL specifies the amount of pollutant that must be reduced to meet water quality standards, allocates pollution control or management among sources in a watershed, and provides a framework for taking actions needed to restore a water body.

As concluded in **Section 4.0**, TMDLs for copper, lead and iron are calculated for Boulder River segments MT43B004_131, MT43B004_132, MT43B004_133 and MT43B004_134, and for Basin Creek, MT43B005_010.

Metals (copper, lead, iron) TMDLs in the Boulder River watershed will address the following elements:

- Loading Capacity (LC) or the maximum amount of pollutant loading a water body can receive without violating water quality standards
- Waste Load Allocation (WLA) or the portion of the TMDL allocated to existing and future point sources
- Load Allocation (LA) or the portion of the TMDL allocated to existing and future nonpoint sources and natural background
- Margin of Safety (MOS) or an accounting of uncertainty about the relationship between pollutant loads and receiving water quality

These elements are combined in equation 1:

$$\textbf{\textit{TMDL}} = \textbf{LC} = \boldsymbol{\Sigma}\textbf{WLA} + \boldsymbol{\Sigma}\textbf{LA} + \textbf{MOS}$$

In addition, the TMDL must also take into account the seasonal variability of pollutant loads and adaptive management strategies in order to address uncertainties inherent in environmental analyses. The above described elements will be detailed throughout the remainder of this section.

5.1 Source Characterization and Assessment

This section identifies sources of copper, lead and iron in the Boulder River watershed. Potential source categories include those from natural sources (non-anthropogenic sources), point sources (MPDES permitted sources, and other unpermitted discrete point sources), and non-point sources. Sources identified within each category are presented below.

5.1.1 Natural Sources

Natural sources of metals are those that contribute metals independently of human disturbance or influence. Natural sources are geologically derived from metals found within the Earth's crust. The geology throughout the watershed is mineral rich and has the potential to contribute metals to receiving waters through natural weathering and transport processes.

Assessing the level of natural background metals using existing data from the Boulder River watershed is problematic due to a variety of reasons:

- Spatial and temporal extent of water quality data is limited
- Abandoned mines and their associated waste were established throughout the watershed prior to any historic water quality data collection
- Detection limits associated with many water quality data are not low enough to provide detection results at low (background) concentrations.

Because of the uncertainty inherent in establishing natural background levels, water quality standards exceedance evaluations and subsequent water quality impairment determinations are based on certain assumptions:

- natural background metals concentrations remain below the chronic water quality criteria for aquatic life under all flow conditions
- single water quality samples are assumed to represent a 96-hour average water quality concentration

5.1.2 Point Sources

Point sources in the Boulder River watershed include both permitted point sources and unpermitted point sources. Unpermitted point sources refer primarily to abandoned mine adits and other discrete historic mining sources that discharge to impaired streams and their tributaries.

5.1.2.1 Permitted Point Sources

Two permitted point sources exist in the Boulder River watershed (**Figure 5-1**).

- East Boulder Mine (MPDES permit MT-0026808) located in the Upper East Boulder River watershed, discharging to the East Boulder River
- City of Big Timber domestic wastewater treatment lagoon (MPDES permit MT-0020753) located on the Lower Boulder River near the confluence with the Yellowstone River, discharging to the Boulder River.

The East Boulder Mine MPDES permit allows water discharges through groundwater and surface water outfalls. To date, no direct discharges to the East Boulder River through surface water outfall have occurred: all discharges have been disposed of via infiltration to ground water through two percolation ponds. In-stream water quality monitoring data above and below the percolation ponds show no detectable increase in metals loading from the East Boulder Mine (Kuipers & Associates 2005-2007).

The City of Big Timber MPDES permit allows direct discharges from its domestic wastewater treatment lagoon to the Boulder River. Permit MT-0020753 does not specifically provide load limits for metals, or require ambient monitoring for these water quality parameters. Consequently, existing metals loading from this point source is unknown. In order to properly evaluate metals effluent loading from the City of Big Timber's wastewater treatment lagoon, effluent monitoring should be conducted, and is included in the framework monitoring plan given in **Section 4.6.3**.

As permitted point sources and potential load contributors to metals-impaired water bodies, a metals (Cu, Pb, Fe) waste load allocation (WLA) will be provided for these point sources and is given in **Section 5.3.2**.

5.1.2.2 Unpermitted Point Sources: Adits and Abandoned Mining Sources

Section 4.0 discusses abandoned mining in the watershed and contamination sources associated with abandoned mining. These sources include adit discharges, waste rock piles and tailings. There are a number of known abandoned mines within the watershed. Mining districts within the Boulder River basin (**Figure 2-7**) include the following and are discussed in more detail below:

- Boulder River (gold, silver, copper, lead and chromium)
- Natural Bridge (gold, silver, and copper)
- Independence (gold, silver, copper and lead)

Boulder River District
The Boulder River Mining District was located in the Contact Mountain area and at the head of the East Boulder River about 30 miles south of Big Timber. Most of the mines in the district exploited the lower Stillwater Complex, which was relatively rich in copper and nickel sulfides, and chromite (chromium oxide). The most important mines in the area were the East Boulder, the Gish, Hubble Gulch, the Minnie, and Wright Gulch. None of the mines in the district are on the Priority Abandoned Mines List, and only one, the Gish, was reported to have an adit flow. No data were available from the Gish adit.

Natural Bridge District
The Natural Bridge District was located in the area of Placer Basin, which is a tributary of the East Boulder River. The district was to exploit the copper, gold and silver associated with the basal Stillwater Complex; however, mine production consisted only of test shipments.

Independence District
The Independence Mining District was located about 60 miles south of Big Timber near the head of the main stem of the Boulder River, including the area around Independence Peak and extending to Carbonate Mountain to the northwest. Gold, silver, copper, and lead were produced in the district from the free-milling oxidized zones of fissure veins within granite and diorite. The most important mines in the district were the Hidden Treasure, the Yager/Daisy, the Poorman, and the Independence, all of which had their own stamp mills and concentrators. Each of the principal mines had one or more shafts or adits, some of which discharge to Basin Creek, a tributary to Boulder River. In 1993, the Montana Department of State Lands conducted an evaluation of the Yager/Daisy, the Poorman, and the Independence properties and inventoried

the volume of unimpounded tailings/waste rock, and identified and sampled discharging adits at each site. The sampling results for the adit discharges from the Yager and Poorman sites are presented in **Table 5-1**.

Table 5-1. Adit Discharge Data from Yager and Poorman Sites

Property	Sample Number	Flow (cfs)	Copper (ug/L)	Copper (lbs/day)	Lead (ug/L)	Lead (lbs/day)
Poorman	49-003-GW-1		3.2		1.07	
Poorman	49-003-GW-2		1.9		0.72	
Yager	49-002-GW-1	0.033	5.37	0.0010	1.33	0.0002
Yager	49-002-GW-2	0.022	8.13	0.0010	0.72	0.0001
Yager	49-002-GW-3	0.011	186	0.0110	1.22	0.0001
Yager	49-002-GW-4	0.013	3.07	0.0002	9.37	0.0007

Reference: MDEQ 1993

In addition to the samples taken from adit sources, two surface water samples were taken at the Yager location from Basin Creek. **Table 5-2** contains these data as well as an estimated load being introduced to Basin Creek from this location.

Table 5-2. Surface Water Samples and Estimated Load from Yager Site

Sample Number	Flow (cfs)	Copper (ug/L)	Copper (lbs/day)	Lead (ug/L)	Lead (lbs/day)
49-002-SW-1	2.01	4.53	0.049	1.05	0.011
49-002-SW-2	0.825	2.27	0.010	0.75	0.003

Reference: MDEQ 1993

All samples (adit and surface water) were collected in August, 1993 and are considered to be low flow data. It is presumed, however, that loading of copper and lead to Basin Creek would be greater under higher flow conditions as lower quality waters are often flushed from mine workings and waste piles during runoff.

While data from the Yager and Poorman sites demonstrate that metals sources from abandoned mine operations exists, the absence of water quality and flow data preclude calculation of loading estimates under higher flow conditions when water quality exceedances have been observed.

During TMDL implementation, adit discharges identified here should be more thoroughly investigated in order to evaluate loading conditions and target attainment under a variety of flow conditions. Further investigation into additional potential adit sources throughout the watershed should also be conducted to better evaluate metals loading from adit sources and develop potential future allocations to these sources.

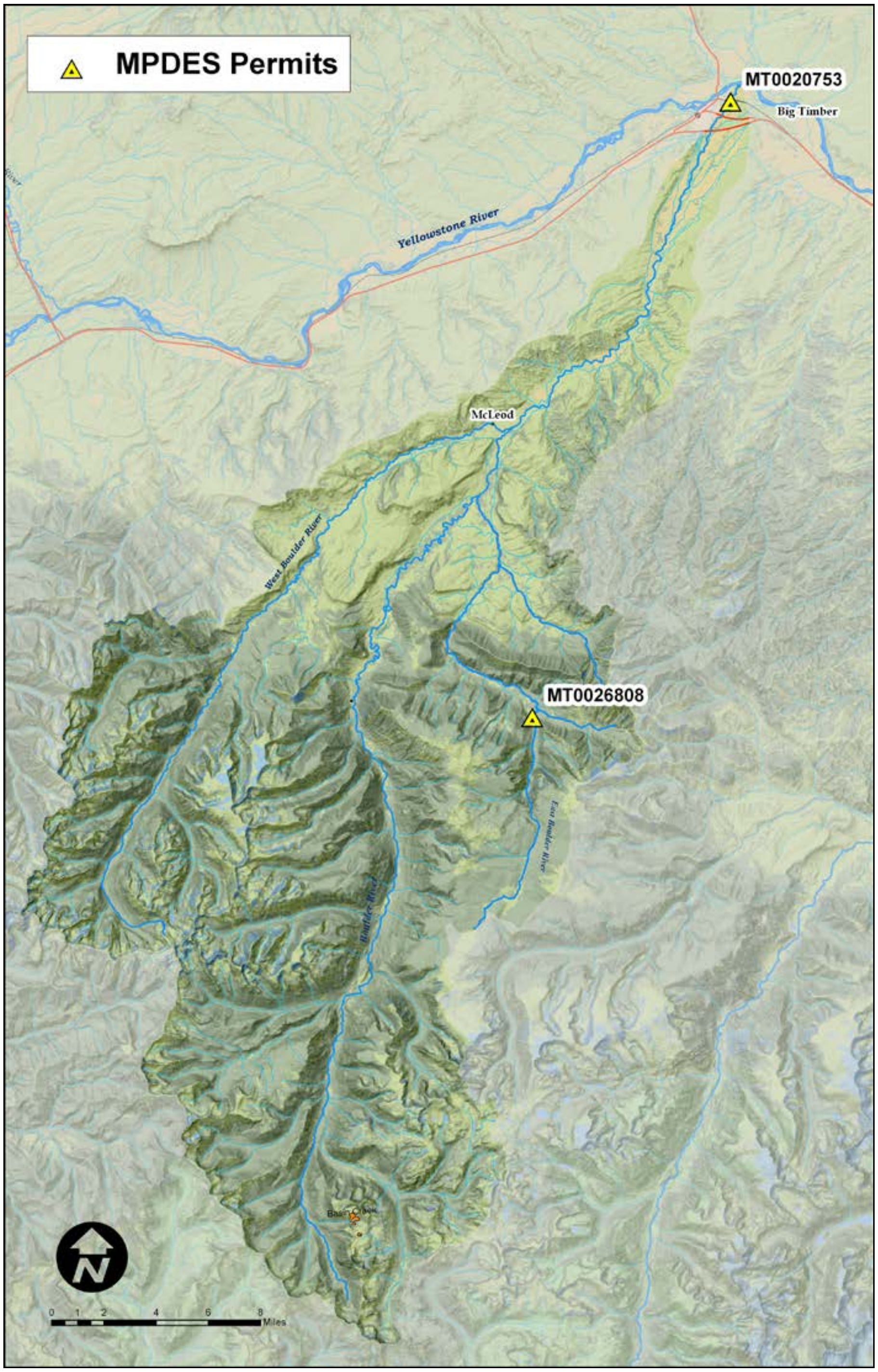

Figure 5-1. MPDES Permit Locations in the Boulder River Watershed

5.1.3 Non-point Sources

Non-point source pollutants originate from diffuse sources throughout the watershed. This type of pollution is caused primarily by rainfall, snowmelt and/or ground water moving over and through the landscape. As the runoff moves, it picks up and transports pollutants and deposits them into area receiving waters.

5.1.3.2 Other Non-Point Sources

Another source of metals associated with abandoned mining is contaminated sediment. Historic practices have likely distributed metals throughout the stream channels downstream of mining sites. Over time, metals settled into the substrate and streambanks and are reintroduced to the system during high flow events when streambanks are eroded and sediments are disturbed. Sediment data are limited and were discussed in **Section 4.4.2**. The extent of loading from contaminated sediments is unknown; however, future monitoring (discussed in **Section 4.5.5.1**) may help evaluate the significance of this source.

5.1.4 Source Assessment Summary

Anthropogenic sources of metals in the Boulder Watershed are derived mainly from historic mining practices and abandoned mines scattered throughout the watershed. Metals are introduced to the stream primarily through land runoff and adit discharges. The Boulder River is particularly susceptible to water quality standards exceedences during high flows when 1) metals from land runoff are entering the stream and 2) low hardness values result in lower water quality criteria. Presently, permitted discharges do not appear to contribute significant metals loads to the Boulder River. Unpermitted point sources (mine adits and associated mining waste rock) are thought to contribute to water quality exceedences in the Boulder River watershed.

5.2 TMDLs and Load Allocations

TMDLs and load allocations are presented below for 4 discrete segments of the Boulder River, MT43B004_131, MT43B004_132, MT43B004_133 and MT43B004_134, and for Basin Creek segment MT43B005_010 (**Table 5-3**).

Table 5-3. Boulder River TMDLs

Water Body Segment	TMDLs
Boulder River MT43B004_131	copper, lead, iron
Boulder River MT43B004_132	copper, lead, iron
Boulder River MT43B004_133	copper, lead, iron
Boulder River MT43B004_134	copper, lead, iron
Basin Creek MT43B005_010	copper, lead, iron

5.2.1 Total Maximum Daily Loads

A water body's allowable daily loading capacity, or total maximum daily load, for most metals is dependent upon two factors: the water quality target and the streamflow. As described in **Section 4.0**, the adopted water quality target is the State of Montana's numeric aquatic life criteria. As the water quality target for copper and lead varies with water hardness, total maximum daily loads for copper and lead for any given flow will also vary with water hardness.

Total Maximum Daily Loads for copper, lead and iron are calculated using equation 2 (below). Note that chronic aquatic life criteria are adopted as the target and used to calculate the total maximum daily load. Using the chronic criteria to calculate an allowable daily load, rather than a 96-hour load limit[4] affords a margin of safety in calculating TMDL and also establishes a daily load limit expression.

Equation 2

TMDL = (X) (Y) (0.0054)

TMDL= Total Maximum Daily Load in lbs/day
X= the chronic aquatic life use criteria (target) with hardness adjustments where applicable in ug/l
Y= streamflow in cubic feet per second
(0.0054) = conversion factor

To illustrate, TMDLs and estimated load reductions are calculated for typical seasonal flow conditions in the Boulder River (**Table 5-4, 5-5**). **Table 5-4** also shows the metals loading capacity when water hardness = 25mg/l and flow = 1500 cfs. Necessary load reductions to meet water quality targets are given in the far column. This condition represents water quality conditions experienced in the lower Boulder River periodically during seasonal runoff or other times of year when water hardness levels are their lowest.

Table 5-4. High Flow TMDL (1500 cfs, 25 mg/l hardness)

Metal	Target ug/l	TMDL lbs/day	Existing Load* lbs/day	Assimilative Capacity lbs/day	Necessary % reduction
Copper	2.85	23.09	34.3	-11.3	33%
Lead	0.545	4.41	10.7	-6.3	59%
Iron	1,000	8,090	9,100	-1010	11%

*assume average metals concentrations at flows >1500 cfs (DEQ data)

During typical low flow conditions (hardness = 100 mg/l, flow = 38 cfs) the TMDL is less, but due to higher water hardness, the water quality target is higher, resulting in in-stream loads under the allowable loading capacity.

[4] Chronic aquatic life criteria are based on a 96-hour average in-stream concentration (DEQ-7)

Table 5-5. Low Flow TMDL (38 cfs, 100 mg/l hardness)

Metal	Target ug/l	TMDL lbs/day	Existing Load* lbs/day	Assimilative Capacity lbs/day	Necessary % reduction
Copper	9.33	1.91	0.102	1.81	0%
Lead	3.18	0.65	0.102	0.55	0%
Iron	1,000	205	6.1	199	0%

*assume average metals concentrations at flows <100cfs (DEQ data)

Data shows (**Section 4.0**) that copper and lead concentrations in the lower Boulder River are elevated above water quality targets under most high flow conditions (flows > 1500 cfs) during May and June. Iron concentrations have also exceeded the water quality target during high flow conditions. Necessary load reductions therefore apply particularly to high flow conditions, and strategies to reduce pollutant loading should address those processes and mechanisms that influence elevated metals concentrations during seasonal runoff.

5.2.2 Allocations

The TMDL is the sum of the waste load allocations (WLA) (point sources) plus the sum of the load allocations (LA) (nonpoint sources) for a water body, plus a margin of safety (MOS).

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

As discussed in **Section 5.1.2.2**, there are several abandoned mines in the Boulder River TPA, however, data is too limited to adequately distinguish point source loading from abandoned mines, adits, tailings, etc (WLA) from non-point source loading. *Therefore, a* ***composite wasteload allocation (*WLA$_C$)** *that includes the contribution from both* ***unpermitted abandoned mine sources*** *(e.g. adits, waste rock, and tailings) and* ***background (non-point) sources*** *is established. This WLAc applies to contributing watershed of each stream segment.*

WLA$_C$ = Composite waste load allocation from:

- Unpermitted abandoned mining sources
- Non-point sources

Boulder River segments MT43B004_134, MT43B004_133 and Basin Creek segment MT43B005_010 have no permitted point-source discharges. Consequently, the wasteload allocation for these segments will consist solely of the composite waste load allocation from unpermitted abandoned mining sources and non-point sources. Boulder River segments MT43B004_132 and MT43B004_131 have permitted point sources (**Figure 5-1**) within their contributing watershed area, requiring separate waste load allocations for these permitted sources in addition to a composite waste load allocation. Margin of safety (**Section 5.2.3.2**) is addressed implicitly in this TMDL through incorporation of various safety factors and contingencies incorporated into the TMDL development process. A separate explicit allocation as a margin of safety is therefore unnecessary.

5.2.2.1 Basin Creek Segment MT43B005_010 and Boulder River Segments MT43B004_134 and MT43B004_133: TMDLS and Allocations

For Basin Creek Segment MT43B005_010 and Boulder River Segments MT43B004_134 and MT43B004_133, metals TMDLs are equivalent to the composite waste load allocation for each metal.

$$\mathbf{TMDL}_{(MT43B005\_010)} = \mathbf{WLA}_{\mathbf{C}(MT43B005\_010)}$$
$$\mathbf{TMDL}_{(MT43B004\_134)} = \mathbf{WLA}_{\mathbf{C}(MT43B004\_134)}$$
$$\mathbf{TMDL}_{(MT43B004\_133)} = \mathbf{WLA}_{\mathbf{C}(MT43B004\_133)}$$

The total composite waste load allocation ($\mathbf{WLA_C}$) is equal to the total maximum daily load (Equation 2, **Section 5.2.1**) and includes the combined load from unpermitted abandoned mining sources and nonpoint sources.

5.2.2.2 Boulder River Segments MT43B004_132 and MT43B004_131: TMDLS and Allocations

For Boulder River segments MT43B004_132 and MT43B004_131, TMDLs will consist of the sum of the permitted and composite wasteload allocations for each stream segment:

$$\mathbf{TMDL}_{(MT43B004\_132)} = \mathbf{\Sigma WLA}_{\mathbf{P}(MT43B004\_132)} + \mathbf{WLA}_{\mathbf{C}(MT43B004\_132)}$$
$$\mathbf{TMDL}_{(MT43B004\_131)} = \mathbf{\Sigma WLA}_{\mathbf{P}(MT43B004\_131)} + \mathbf{WLA}_{\mathbf{C}(MT43B004\_131)}$$

$\mathbf{\Sigma WLA_P}$ **=** Sum of the permitted waste load allocations that contribute to the stream segment of interest (see below)

$\mathbf{WLA_C}$**=** Composite wasteload allocation within the stream segment of interest from:

- *Unpermitted abandoned mining sources*
- *Non-point sources*

5.2.2.2.1 Waste Load Allocations (permitted)

Waste load allocations for cooper, lead and iron are provided for permit *MT-0020753 City of Big Timber,* and for permit *MT-0026808 Stillwater Mining Company* (**Figure 5-1**).

MPDES Permit MT-0020753 City of Big Timber

The City of Big Timber operates a wastewater treatment lagoon that discharges directly to impaired Boulder River segment MT43B004_131. Existing metals loading from the lagoon to the Boulder River is unknown, as effluent water quality data for metals does not exist for this facility. Limited data from similar lagoon systems in Montana, however, suggest that existing metals concentrations are not likely to be elevated above chronic aquatic life criteria. Additional effluent monitoring is recommended in order to verify this supposition.

In order to ensure that discharges do not contribute to in-stream target exceedances under all flow conditions, effluent metals concentrations should remain below the chronic aquatic life criteria. Water quality data for the Boulder River show that hardness values periodically drop to or below 25 mg/L hardness during all seasons. The chronic water quality target at 25 mg/l is therefore used to calculate permitted waste load allocations.

The waste load allocations for the City of Big Timber permit *MT-0020753* **(Table 5-6)** are calculated using the existing design flow of the facility and an effluent concentration at the chronic water quality target (see **Section 4.5.2**). Waste load increases may be permitted with increases in design flow as long as effluent concentrations remain at or below the chronic criteria.

$\mathbf{WLA}_{(MT\text{-}00207053)}$ = (design flow) * (chronic criteria at 25 mg/l hardness) * (0.0054)

Table 5-6. City of Big Timber MPDES Permit MT-0020753: Metals waste load allocations

Copper $WLA_{(MT\text{-}00207053)}$	**0.009 lbs/day**	= (0.603 cfs) * (2.85 ug/L) * (0.0054)
Lead $WLA_{(MT\text{-}00207053)}$	**0.002 lbs/day**	= (0.603 cfs) * (0.545 ug/L) * (0.0054)
Iron $WLA_{(MT\text{-}00207053)}$	**3.26 lbs/day**	= (0.603 cfs) * (1000 ug/L) * (0.0054)

<u>MPDES Permit MT-0026808 Stillwater Mining Company</u>

The Stillwater Mining Company operates the East Boulder Mine and is permitted to discharge wastewater to the East Boulder River segment MT43B004_142 through ground water and surface water outfalls. Because flow from the East Boulder River contributes to Boulder River segments, MT43B004_131 and MT43B004_132, a wasteload allocation from this source is provided for both segments. To date, no direct discharges to the East Boulder River through surface water outfall have occurred: all discharges have been disposed of via infiltration to ground water through two percolation ponds. In-stream water quality monitoring data above and below the percolation ponds show no detectable increase in metals loading from the East Boulder Mine (Kuipers & Associates 2005-2007).

Waste load allocations **(Table 5-7**) were developed by calculating Average Monthly Limits (AMLs) using analyses established in *EPA Technical Support Document (TSD) for Water Quality-based Toxics Control* (EPA, 1991). AMLs were derived (**Appendix C**) in consultation with DEQ's Water Quality Permitting Section and are consistent with processes used to define pollutant limits in MPDES permits. AML concentration values for copper, lead, and iron were multiplied by the design flow of the facility to calculate daily loads. Using AMLs to derive daily loading limits ensures protection from chronic exceedances in the East Boulder River and, as the Boulder River 7Q10 flow (38 cfs) is considerably greater than the East Boulder River 7Q10 flow (5 cfs), the WLAs provided are thereby protective of water quality conditions in the Boulder River.

$\mathbf{WLA}_{(MT\text{-}0026808)}$ = (design flow) * (AML value) * (0.0054)

Table 5-7. Stillwater Mining Company permit MT-0026808: Metals waste load allocations

Copper $WLA_{(MT\text{-}0026808)}$	**0.061 lbs/day**	= (1.65 cfs) * (6.9 ug/L) * (0.0054)
Lead $WLA_{(MT\text{-}0026808)}$	**0.005 lbs/day**	= (1.65 cfs) * (0.60 ug/L) * (0.0054)
Iron $WLA_{(MT\text{-}0026808)}$	**28.5 lbs/day**	= (1.65 cfs) * (3200 ug/L) * (0.0054)

5.2.2.2.2 Waste Load Allocations (composite)

The composite waste load allocation (**WLA_C**) includes the combined load from background (non-point) sources and unpermitted mining-related sources within the contributing watershed and is calculated by subtracting the permitted waste load allocations (**ΣWLA_P**) above from the Total Maximum Daily Load **(TMDL)** for each segment:

$$\mathbf{WLA_C = TMDL - \Sigma WLA_P.}$$

5.2.2.2.3 Boulder River Segment MT43B004_132: TMDLS and Allocations

The TMDL for Boulder River segment MT43B004_132 equals the sum of the permitted waste load allocations (**ΣWLA_P**) and the composite waste load allocation ***(*****WLA_C)**. As the East Boulder Mine is the only permitted point source that contributes to this segment**, ΣWLA_P** is equal to the waste load allocation established for the East Boulder Mine (**Table 5-7**).

$$\mathbf{TMDL}_{(MT43B004\_132)} = \mathbf{WLA}_{(MT\text{-}0026808)} + \mathbf{WLA}_{\mathbf{C}(MT43B004\_132)}$$

As the TMDL is a function of flow and water hardness, TMDLs and WLA_C will vary with the season. To illustrate allocations under different conditions, **Tables 5-8** and **5-9** show calculated TMDLs and waste load allocations for typical high and low flows for lower Boulder River segment MT43B004_132.

Table 5-8. High Flow TMDL and Allocations: Boulder River Segment MT43B004_132

High Flow TMDL*			
Pollutant	**TMDL** *lbs/day*	**WLA_C** *lbs/day*	**ΣWLA_P** *lbs/day* ***WLA*** *(MT-0026808)*
Cu	23.09	23.03	0.061
Pb	4.41	4.405	0.005
Fe	8,090	8061	28.5

*flow = 1500 cfs, hardness = 25 mg/l

Table 5-9. Low Flow TMDL and Allocations: Boulder River Segment MT43B004_132

Low Flow TMDL*			
Pollutant	**TMDL** *lbs/day*	**WLA_C** *lbs/day*	**ΣWLA_P** lbs/day ***WLA*** *(MT-0026808)*
Cu	1.91	1.85	0.061
Pb	0.65	0.645	0.005
Fe	205	177	28.5

*flow = 38 cfs, hardness = 100 mg/l

5.2.2.2.4 Boulder River Segment MT43B004_132: TMDLS and Allocations
The TMDL for Boulder River segment MT43B004_131 equals the sum of the permitted waste load allocations (**ΣWLA$_P$**) and the composite waste load allocation ***(*WLA$_C$)**. As the East Boulder Mine and the City of Big Timber are permitted point sources that contribute to this segment**, ΣWLA$_P$** is equal to the sum of the waste load allocations established for these two point sources (**Tables 5-6** and **5-7**).

$$\mathbf{TMDL}_{(MT43B004\_131)} = \{\mathbf{WLA}_{(MT\text{-}0026808)} + \mathbf{WLA}_{(MT\text{-}00207053)}\} + \mathbf{WLA}_{C(MT43B004\_131)}$$

As the TMDL is a function of flow and water hardness, TMDLs and WLA$_C$ will vary with the season. To illustrate allocations under different conditions, **Tables 5-10** and **5-11** show calculated TMDLs and waste load allocations for typical high and low flows for lower Boulder River segment MT43B004_131.

Table 5-10. High Flow TMDL and Allocations: Boulder River Segment MT43B004_131

High Flow TMDL*				
Pollutant	**TMDL**	**WLA$_C$**	**ΣWLA$_P$** *lbs/day*	
	lbs/day	*lbs/day*	***WLA*** *(MT-0026808)*	***WLA*** *(MT-0020753)*
Cu	23.09	23.02	0.061	0.009
Pb	4.41	4.40	0.005	0.002
Fe	8,090	8058	28.5	3.26

*flow = 1500 cfs, hardness = 25 mg/l

Table 5-11. Low Flow TMDL and Allocations: Boulder River Segment MT43B004_131

Low Flow TMDL*				
Pollutant	**TMDL**	**WLA$_C$**	**ΣWLA$_P$** lbs/day	
	lbs/day	*lbs/day*	***WLA*** *(MT-0026808)*	***WLA*** *(MT-0020753)*
Cu	1.91	1.84	0.061	0.009
Pb	0.65	0.64	0.005	0.002
Fe	205	173	28.5	3.26

*flow = 38 cfs, hardness = 100 mg/l

Under most circumstances, the Boulder River does not exceed water quality targets and maintains assimilative capacity. It is under periodic high flow conditions (expressed in **Table 5-4**) that the TMDL is typically exceeded. It is expected that reductions in abandoned mining loads through mitigation and restoration of abandoned mining sites and associated impacts in the upper watershed will reduce the loading from controllable metals sources to levels that fall within the allowable allocation and satisfy the TMDLs for each stream segment under high flow conditions. Both permitted facilities are discharging consistent with the WLAs. Most of the suspected sources of elevated and controllable loading to meet the composite WLAs are in the upper portions of the Boulder River watershed. Therefore, addressing TMDLs in the upper watershed (**Section 5.2.2.1**) should result in meeting the above TMDL goals for the two lower Boulder River stream segments via abandoned mines loading reductions.

5.2.3 Seasonality and Margin of Safety

All TMDL documents must consider the influence of seasonal variability on water quality impairment conditions, maximum allowable pollutant loads (TMDLs), and allocations. TMDL development must also incorporate a margin safety into the load allocation process to account for uncertainties in pollutant sources and other watershed conditions, and ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses. This section addresses considerations of seasonality and a margin of safety in the Boulder River watershed metals TMDL development process.

5.2.3.1 Seasonality

Seasonality addresses the need to ensure year round beneficial use support. Seasonality was considered for assessing loading conditions and for developing water quality targets, TMDLs, and allocation schemes. As with most metals TMDLs, seasonality is critical due to varying metals loading pathways and varying water hardness during high and low flow conditions. Loading pathways associated with overland flow and erosion of metals-contaminated soils and wastes tend to be the major cause of elevated metals concentrations during high flows, with the highest concentrations and metals loading typically occurring during the rising limb of the hydrograph. Loading pathways associated with ground water transport and/or adit discharges tend to be the major cause of elevated metals concentrations during low or baseflow conditions. Hardness tends to be lower during higher flow conditions, thus leading to lower water quality standards for some metals during the runoff season. Seasonality is addressed in this document as follows:

- Metals impairment and loading conditions are evaluated for both high flow and low flow conditions.
- Metals TMDLs incorporate streamflow as part of the TMDL equation.
- Metals targets apply year round, with monitoring criteria for target attainment developed to address seasonal water quality extremes associated with loading and hardness variations.
- Example targets, TMDLs and load reduction needs are developed for high and low flow conditions.

5.2.3.2 Margin of Safety

A margin of safety is applied implicitly by using conservative assumptions throughout the TMDL development process (U.S. EPA, 1999). This implicit margin of safety is addressed in several ways as part of this document:

- Target attainment, refinement of allocations, and, in some cases, impairment determinations are all based on an adaptive management approach that relies on future monitoring and assessment for updating planning and implementation efforts.
- Chronic criteria was used to calculate a daily load rather than a 96-hour load limit
- The most protective hardness condition (25 mg/l hardness) was used to calculate load limits for waste load allocations

- Sediment metals concentration criteria were used as secondary indicators.
- Metals allocations for MPDES permit MT-0020752 are based on meeting chronic aquatic life criteria in wastewater effluent.

5.3 Monitoring Strategy

Refer to **Section 4.6** for a framework monitoring strategy.

5.4 Restoration Strategy

This section outlines strategies for addressing metals loading sources in need of restoration activities within Boulder River watershed. The restoration strategies focus on regulatory mechanisms and/or programs applicable to the controllable source types present within the watershed, which for the most part are associated with historic mining and mining legacy issues.

Potential metals loading sources include abandoned mining disturbances: discharging mine adits and mine waste materials on-site and in-channel. Following is a discussion of general restoration programs and funding mechanisms that may be applicable to these sources. The need for further characterization of impairment conditions and loading sources in the Boulder River is addressed through the framework monitoring plan in **Section 4.6**.

5.4.1 General Restoration & Remediation Funding Options

A number of state and federal regulatory programs have been developed over the years to address water quality problems stemming from nonpoint sources of pollution. Nonpoint sources of pollution, particularly historic mines and associated disturbances, constitute a source of metals loading to the Boulder River an Basin Creek. Some regulatory programs and approaches considered most applicable to Prospect Creek watershed include:

- The State of Montana Mine Waste Cleanup Bureau's Abandoned Mine Lands (AML) Reclamation Program
- The Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA) which incorporates additional cleanup options under the Controlled Allocation of Liability Act (CALA) and the Voluntary Cleanup and Redevelopment Act (VCRA).

Montana Mine Waste Cleanup Bureau Abandoned Mine Reclamation Program
The Montana Department of Environmental Quality's Mine Waste Cleanup Bureau (MWCB), part of the MDEQ Remediation Division, is responsible for reclamation of historical mining disturbances associated with abandoned mines in Montana. The MWCB abandoned mine reclamation program may be a viable alternative for addressing metals loading sources in the Boulder River watershed.

The MWCB abandoned mine reclamation program is funded through the Surface Mining Control and Reclamation Act of 1977 (SMCRA) with SMCRA funds distributed to states by the federal government. In order to be eligible for SMCRA funding, a site must have been mined or affected by mining processes, and abandoned or inadequately reclaimed, prior to August 3, 1977 for private lands, August 28, 1974 for Forest Service administered lands, and prior to 1980 for lands administered by the U.S. Bureau of Reclamation. Furthermore, there must be no party (owner, operator, other) who may be responsible for reclamation requirements, and the site must not be located within an area designated for remedial action under the federal Superfund program or certain other programs.

Within the Boulder River TPA, the Yager/Daisy Mine in the Independence Mining District is ranked 99th on the MDEQ priority list.

Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA)
Reclamation of historic mining-related disturbances administered by the State of Montana and not addressed under SMCRA typically are addressed through the MDEQ State Superfund or CECRA program. The CECRA program maintains a list of facilities potentially requiring response actions based on the confirmed release or substantial threat of a release of a hazardous or deleterious substance that may pose an imminent and substantial threat to public health, safety or welfare or the environment (ARM 17.55.108). Listed facilities are prioritized as maximum, high, medium or low priority or in operation and maintenance status based on the potential threat posed. Currently there are no CECRA-listed facilities in Boulder River watershed.

CECRA also encourages the implementation of voluntary cleanup activities under the Voluntary Cleanup and Redevelopment Act (VCRA), and the Controlled Allocation and Redevelopment Act (CALA). It is possible that any historic mining-related metals loading sources identified in the watershed in the future could be added to the CECRA list and addressed through CECRA, with or without the VCRA and/or CALA process. A site can be added to the CECRA list at MDEQ’s initiative, or in response to a written request made by any person to the department containing the required information.

Other Programs
In addition to the programs discussed above, other funding may be available for water quality restoration activities. These sources may include the yearly RIT/RDG grant program or the EPA Section 319 Nonpoint Source yearly grant program. The RIT/RDG program can provide up to $300,000 to address environmental related issues. This money can be applied to sites included on the MWCB’s AML priority list but of low enough priority where cleanup under AML is uncertain (possibly the Yager/Daisy site). RIT/RDG program funds can also be used for conducting site assessment/characterization activities such as identifying specific sources of water quality impairment.

Section 319 grant funds are typically used to help identify, prioritize, and implement water quality protection projects with focus on TMDL development and implementation of nonpoint source projects. Individual contracts under the yearly grant typically range from $20,000 to $150,000, with a 25% or more match requirement. RIT/RDG and 319 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.

5.4.2 General Restoration & Remediation Priorities

The source characterization and assessment performed for this study identified abandoned mining sites associated the Independence Mining District located in the headwaters of the Boulder River watershed. It is possible that these apparent sources constitute a significant portion of the metals loading sources in the drainage area. Efforts should focus on reclamation of these identified sources following more detailed site characterization as outlined in the Monitoring Strategy. Detailed surface water sampling should be initiated when feasible to better quantify metals loading rates and mechanisms from this area. Additional information in the form of stream sediment chemistry and mine waste physical and chemical characteristics should be obtained so that reclamation planning can be pursued as soon as feasible.

5.5 Adaptive Management Strategy

The water quality restoration targets and associated metals TMDLs developed for the Boulder River are based on future attainment of the B-1 classification water quality standards. In order to achieve attainment, all significant sources of metal loading must be addressed via all reasonable conservation practices. Because of the potential for metals contributions from natural sources as well as from controllable anthropogenic sources, an adaptive management approach is adopted for all metals targets described within this document.

In previous sections, a monitoring strategy was suggested that will provide further information on source characterization, target attainment and effectiveness of restoration activities. The adaptive management strategy presented in this section describes the process for modifying the Boulder River restoration strategy when deemed necessary. As is the case with all restoration activities, this adaptive management strategy will be best accomplished through cooperation with personnel with the authority and time to make a commitment of resources and technical personnel with the ability to evaluate monitoring data and identify scientific issues accordingly.

Possible scenarios for metals identified in this plan include:

- Implementation of restoration activities resulting in full attainment of restoration targets for all parameters;
- Implementation of restoration activities fails to result in target attainment due to underperformance or ineffectiveness of restoration actions. Under this scenario the water body remains impaired and will require further restoration efforts associated with the pollutants of concern. The target may or may not be modified based on additional information, but conditions still exist that require additional pollutant load reductions to support beneficial uses and meet applicable water quality standards. This scenario would require some form of additional, refocused restoration work.
- Implementation of restoration activities fails to result in target attainment, but target attainment is deemed unachievable even though all applicable monitoring and restoration activities have been completed. Under this scenario, site-specific water quality standards and/or the reclassification of the water body may be necessary. This would then lead to a new target (and TMDL) for the pollutant(s) of concern, and the new target could either reflect the existing conditions at the time or the anticipated future conditions associated with the restoration work that has been performed.

The MDEQ Remediation Division and/or MDEQ Standards Program personnel will lead this effort within MDEQ to make determinations concerning the appropriateness of specific mine cleanup activities relative to expectations for mining cleanup efforts for any impairment condition associated with mining impacts. This includes consideration of appropriate evaluation of cleanup options, actual cleanup planning and design, as well as the appropriate performance and maintenance of the cleanup activities. Where NPDES permitted point sources are involved, the MDEQ Permitting Program will also be involved. MDEQ TMDL program personnel will need to be involved in adaptive management to make sure there is consistency in water quality restoration goals as they apply to beneficial use support. Determinations on the performance of all aspects of restoration activities, or lack thereof, will then be used along with available in-stream data to reevaluate impairment determinations. The information will also help determine any further cleanup/load reduction needs for any applicable water body and will ultimately help determine the success of water quality restoration. Other stakeholders, including opportunities for public comment, will also be involved as required under applicable regulations. Public involvement is discussed further in **Section 6**.

SECTION 6.0
PUBLIC INVOLVEMENT

Public and stakeholder involvement is a component of TMDL planning efforts. Stakeholders, including the Sweet Grass County Conservation District, Boulder Watershed Committee, Montana Department of Natural Resources and Conservation, Montana Department of Fish, Wildlife & Parks, Stillwater Mining Company, Northern Plains Resource Council, Cottonwood Resource Council, and the Gallatin National Forest were kept abreast of the TMDL process through periodic meetings of the Boulder Watershed Committee, and were provided opportunities to review and comment on technical documents. Stakeholder review drafts were provided to several agency representatives, landowners, conservation district and government representatives, and representatives from conservation and watershed groups. Stakeholder comments, both verbal and written, were accepted and addressed.

An additional opportunity for public involvement is the 30-day public comment period. This public review period was initiated on May 14th, 2007 and extended to June 18th, 2007. At public meeting on May 16th in Big Timber, MT, DEQ provided an overview of the Boulder River Watershed Total Maximum Daily Loads, made copies of the document available to the public, and solicited public input and comment on the plan. Appendix A includes DEQ’s response to all official public comments received during the 30-day comment period. The final document was updated, based on public input and comment.

SECTION 7.0
REFERENCES

Advent Group, Inc. 2001. East Boulder Mine Good Neighbor Agreement Biological Monitoring Results for the East Boulder River – 2000. Golden, CO: The Advent Group, Inc.

Advent Group, Inc. 2002. East Boulder Mine Good Neighbor Agreement Biological Monitoring Results for the East Boulder River – 2001. Golden, CO: The Advent Group, Inc.

Advent Group, Inc. 2003. East Boulder Mine Good Neighbor Agreement Biological Monitoring Results for the East Boulder River – 2002. Golden, CO: The Advent Group, Inc.

Advent Group, Inc. 2003b. East Boulder Mine Biological Monitoring Results for the East Boulder River 1998 – 2002. Golden, CO: The Advent Group, Inc.

Advent Group, Inc. 2005. East Boulder Mine Good Neighbor Agreement Biological Monitoring Results for the East Boulder River 1998-2004. Golden, CO: The Advent Group, Inc.

Armour, C. L., D. A. Duff, and W. Elmore. 1991. The effects of livestock grazing on riparian and stream ecosystems. Fisheries 16(1): 7-11.

Bahls, Loren. 1988. State of Montana Nonpoint Source Assessment Report. Helena, MT: MDHES, Water Quality Bureau.

Bahls, Loren. 1999. Support of Aquatic Life Uses in the Upper Boulder River (Yellowstone River Drainage) Based on Diatom Species Composition and Diatom Association Metrics. Helena, MT: Hannaea.

Bahls, Loren and Erich Weber. 1999. Support of Aquatic Life Uses in the Boulder River (Yellowstone River Drainage) Based on the Composition and Structure of the Periphyton Community (August 1999 Samples). Helena, MT: MDHES, Water Quality Bureau.

Bahls, Loren L. 2003. Biological Integrity of the Boulder River Montana. Helena, MT: Montana Department of Environmental Quality.

Bauer, Stephen B. and Timothy A. Burton. 1993. Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams. Moscow, ID: Idaho Resources Institute, University of Idaho.

Beak Consultants. 1982. Stillwater PGM Resources, Technical Report #8. Aquatic Resources. Portland, OR: Beak Consultants.

Beak Consultants. 1982. Stillwater PGM Resources, Technical Report #4. Surface Water Resources. Portland, OR: Beak Consultants.

Berry, W., N. Rubinstein, B. Melzian and B. Hill. 2003. The Biological Effects of Suspendedand Bedded Sediment (SABS) in Aquatic Systems: A Review. Internal Report of the U.S.EPA Office of Research and Development, Narragansett, RI. Available at: http://www.epa.gov/waterscience/criteria/sediment/appendix1.pdf

Bollman, Wease. 1998. Bioassessment of the East Boulder River, Sweetgrass County, Montana. Missoula, MT: Rhithron Biological Associates

Bollman, Wease. 2000. Macroinvertebrate Bioassessment of the Boulder River, Sweetgrass and Park Counties, Montana. Missoula, MT: Rhithron Biological Associates.

Bollman, Wease. 2002. Aquatic Invertebrates and Habitat at a Fixed Station on the Boulder River, Sweetgrass County, Montana. Missoula, MT: Rhithron Associates, Inc.

Bollman, Wease.2003. A Biological Assessment of Sites in the Boulder River Watershed, Sweetgrass County, Montana. Missoula, MT: Rhithron Associates, Inc.

Buchman, M. F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report. Seattle, WA: National Oceanic and Atmospheric Administration Coastal Protection and Restoration Division.

Carlson, J. 2001. Montana Animal Species of Special Concern. Helena, MT: Montana Natural Heritage Program.

Center for Science in Public Participation. 2002. SMC East Boulder Project Baseline Water Quality Review. Bozeman, MT: Center for science in Public Participation.

Cordone, A.J. and D.W. Kelley. 1961. Influences of inorganic sediment on the aquatic life of streams. California Fish and Game 47: 189-228.

CRC and NRCS, 1999. Chlorophyll and Nutrient Sample Results. http://nris.state.mt.us/wis/tmdlapp/detailsheets/MT43B004_142.xls

CRC and NRCS. 1999. Support of Aquatic Life Uses in the East Boulder River based on Periphyton Composition and Community Structure. Washington, D.C.: Natural Resources Conservation Service.

DeArment, John (U of M Thesis Research). 2000. First Progress Report Boulder River Study Results of August 1999 Stream Assessment. Missoula, MT: University of Montana.

DeArment, John (U of M Thesis Research). 2000. Third Progress Report Boulder River Study. Missoula, MT: University of Montana.

DeArment, John (U of M Thesis Research). 2003. Nutrient, Algae and Beneficial Use Support Assessment of the Boulder River. Missoula, MT: University of Montana.

DEC (Tennessee Department of Environment and Conservation), 2004. Tennessee's Plan for Nutrient Criteria Development. Revised October, 2004. Planning and Standards Section, Tennessee Department of Environment and Conservation, Nashville, TN.

Dillman, D.A., 2000. Mail and Internet Surveys, the Tailored Design Method, 2nd Edition. John Wiley and Sons, Inc.: New York, New York.

Dodds, W.K., V.H. Smith, and B. Zander, 1997. Developing Nutrient Targets to Control Benthic Chlorophyll Levels in Streams: A Case Study of the Clark Fork River. Water Research 31: 1738-1750.

ECON, Inc. and Montana Fish, Wildlife and Parks. 1992. Boulder River Fisheries Management Plan, 1992-1996 (MP-30). Helena, MT: MFWP.

ENSR Consulting. 1995. Evaluation of the Periphyton Biomass, Benthic Macroinvertebrates, and Limiting Nutrient in the East Boulder River Near Big Timber, MT – Final Report. Fort Collins, CO: ENSR Consulting, Engineering, and Remediation.

Feltis, R. D. and D.W. Litke. 1987. Appraisal of Water Resources of the Boulder and Stillwater River Basins, including the Stillwater Complex, South-Central Montana, Memoir 60. Butte, MT: MT Bureau of Mines and Geology.

GEI Consultants. 2003. East Boulder River Fisheries Monitoring Report, 2003. Missoula, MT: GEI Consultants, Inc.

Hankin, D. G.; and G. H. Reeves. 1988. Estimating Total Fish Abundance and Total Habitat Area in Small Streams Based on Usual Estimation Methods. Canadian Journal of Fisheries and Aquatic Sciences. 45: 834-844.

Hawkins, R.H. 2002. Survey of methods for sediment TMDLs in western rivers and streams of the United States. Grant # 827666-01-0 final report, U.S. EPA Office of Water, Washington DC. 51 pp.

Hill, B. H., Herlihy, A. T., Kaufmann, P. R., Stevenson, R. J., McCormick, F. H., Johnson, and C. Burch. 2000. Use of periphyton assemblage data as an index of biotic integrity. Journal of the North American Benthological Society 19:50-67.

Hill, K., & G. Phillips. 1984. Statewide Water Pollution Studies Biennial Report: 1982-83 Helena, MT: Montana Department of Fish, Wildlife and Parks

Kendy, Eloise and R.E.Tresch. 1996 Geographic, Geologic, and Hydrologic Summaries of Intermontane Basins of the Northern Rocky Mountains, Montana. USGS Water-Resoruce Investigations Report 96-4025. Helena, MT: United States Geological Survey.

Kraft, Melvin Earl.1968. (The) Effects of Controlled Dewatering on a Trout Stream. Bozeman, MT: Montana State University.

Kuipers and Associates, LLC. 2003. Good Neighbor Agreement 3-Year Water Quality Review Stillwater Mining Company East Boulder Mine June 2000 – June 2003. Big Timber, MT: Stillwater Mining Company.

Kuipers and Associates, LLC. 2005-2007. SMC East Boulder Mine Quarterly Water Monitoring Reports. Unpublished.

Land and Water Consulting. 2003. Review of the 1998-2002 Biological Water Quality Monitoring Program Data for the East Boulder River. Helena, MT: Land and Water Consulting.

Leopold, L. B.; M. G. Wolman; and J. P. Miller. 1964. Fluvial Processes in Geomorphology. Dover Publications, Inc., New York. 522 p.

Levine, Christian (DEQ). 1996. Boulder River Nutrient and Algae (Upper Yellowstone River Drainage) Monitoring Results. Helena, MT: Montana Department of Environmental Quality.

McCabe, J. M., and C. L. Sandretto. 1985. Some aquatic impacts of sediment, nutrients, and pesticides in agricultural runoff. Publication No. 201. East Lansing, MI: Dept. of Fisheries and Wildlife, Michigan State University.

McClay, W. 1968. Effects of Controlled Flow Reductions on Aquatic Insects in a Stream Riffle; August 1968, Report T-76. Bozeman, MT: Montana State University.

Mebane, C. A. 2001. Testing Bioassessment Metrics: Macroinvertebrate, Sculpin, and Salmonid Responses to Stream Habitat, Sediment, and Metals. Environmental Monitoring and Assessment 67:293-322.

Montana Department of Environmental Quality. 1996. Montana List of Water bodies in Need of Total Maximum Daily Load Development. Helena, MT: Montana Department of Environmental Quality. http://www.deq.mt.gov/CWAIC/

Montana Department of Environmental Quality, 1997. Montana Numeric Water Quality Standards. Circular WQB-7. Helena, MT: Montana Department of Environmental Quality.

Montana Department of Environmental Quality. 2000. Montana 303(d) List. A Compilation of Impaired and Threatened Water bodies in Need of Water Quality Restoration. Helena, MT. http://www.deq.mt.gov/CWAIC/

Montana Department of Environmental Quality. 2003. Montana Department of Environmental Quality, Draft Section 3, Water Quality Concerns and Impairment Status, Bitteroot Headwaters Water Quality Restoration Plan. Helena, MT: Montana DEQ.

Montana Department of Environmental Quality. 2006. Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates. Helena, MT: Montana DEQ Available at: http://deq.mt.gov/wqinfo/QAProgram/WQPBWQM-009rev2_final_web.pdf

Montana Department of Environmental Quality. 2006. Water Quality Assessment Process and Methods. Helena, MT: Montana Department of Environmental Quality. http://www.deq.state.mt.us/wqinfo/QAProgram/SOP%20WQPBWQM-001.pdf

Montana Department of Environmental Quality. 2007. East Boulder River Nutrient Assessment (unpublished assessment report).

Montana Department of Environmental Quality. 2007. East Boulder River Sediment Assessment (unpublished assessment report).

Montana Department of Environmental Quality. Abandoned Mine Section. MWCB, http://www.deq.state.mt.us/AbandonedMines/Index.asp (accessed May 10, 2007).

Montana Department of Fish, Wildlife and Parks Website: http://fwp.mt.gov/default.html.

Montana Department of Fish, Wildlife, and Parks. 1991. Dewatered Streams List 1991. Helena, MT: Montana Department of Fish, Wildlife and Parks.

Montana Fish, Wildlife, and Parks. 1996. Future Fisheries Improvement Program Report to 1997 Legislature and Fish, Wildlife and Parks Commission. Helena, MT: Montana Fish, Wildlife, and Parks.

Montana Department of Fish, Wildlife, and Parks. 1997. Dewatered Streams List 1997. Helena, MT: Montana Department of Fish, Wildlife and Parks.

Montana Fisheries Information System. (MFISH) http://maps2.nris.mt.gov/wis/mfishapp/Intro2002.html

Montana Natural Heritage Program (MNHP). Species of Concern 2003. http://nhp.nris.state.mt.us/mtnhp_info.asp

Newcombe, Charles P. and Jorgen O.T. Jensen 1996. Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries Vol. 16, No. 4: 693-727

Overton, C. K.; S. P. Wollrab; B. C Roberts; and M. A. Radko. 1997. R1/R4 (Northern/Intermountain Regions) Fish and Fish Habitat Standard Inventory Procedures Handbook. General Technical Report INT-GTR-346. Ogden, UT: USDA Forest Service, Intermountain Research Station. 73 p.

Peterman, Larry G. 1982. Yellowstone River Instream Reservation: Third Annual Report. Helena, MT: Montana Department of Fish, Wildlife, and Parks.

Phillips, Glenn R., Kurt Hill, and Ann B. Humphrey. 1987. Statewide Water Pollution Studies Triennial Report: 1984-86, Pollution Control Information Series: Technical Report No.6. S.L.:S.N.

Pioneer Technical Services. 1989. Abandoned Hardrock Mine Priority Sites, 1995 Summary Report. Butte, MT: Pioneer Technical Services.

Platts, W. S. 1978. Livestock Grazing and Riparian/Stream Ecosystems- An Overview. In: Cope, Oliver B. (ed.). Denver, CO.: Trout Unlimited, Inc.

Platts, William S.; Carl Armour; Gordon D. Booth; Mason Bryant; Judith L. Bufford; Paul Cuplin; Sherman Jensen; George W. Lienkaemper; G. Wayne Minshall; Stephen B. Monsen; Rodger L. Nelson; James R. Sedell; and Joel S. Tuhy. 1987. Methods for Evaluating Riparian Habitats With Applications to Management. USDA Forest Service Int. Res. Sta. General Technical Report INT-221, 177 pp.

Platts, W. S., R. J. Torquemada, M. L. McHenry, and C. K. Graham. 1989. Changes in salmon spawning and rearing habitat from increased delivery of fine sediment to the South Fork Salmon River, Idaho. Transactions of the American Fisheries Society 118:274-283.

Poore, Michiel and James E. Darling. 1997. Statewide Fisheries Investigations: Survey and Inventory of Coldwater Streams: Mid-Yellowstone Drainage Investigations. Helena, MT: Montana Department of Fish, Wildlife, and Parks

Relyea, Christina D, G. Wayne Minshall, Robert J. Danehy. 2000. Stream Insects as Bioindicators of Fine Sediment. Stream Ecology Center: Dept. of Biological Sciences: Idaho State University, Pocatello, ID

Riggers, Brian W.; Arne Rosquist; Richard Kramer; and Mike Bills. 1998. An Analysis of Fish Habitat and Population Conditions in Developed and Undeveloped Watersheds on the Lolo National Forest. U.S. Forest Service, Lolo National Forest. Missoula, MT.

Rinne, J. N., and A. L. Medina. 1988. Factors influencing salmonid populations in six headwater streams, central Arizona, USA. Polish Archives of Hydrobiology 34:515-532.

Rosgen, Dave L. 1996. Applied River Morphology. Wildland Hydrology. Lakewood, CO.

Sando, Steven Kent. 1981. The Spawning and Rearing Habitats of Rainbow Trout and Brown Trout in Two Rivers in Montana. Bozeman, MT: Montana State University.

Somers, Dave, J. Smith, and R. Wissmar. 1991. Watershed and Stream Channel Cumulative Effects Analysis using Aerial Photography and Ground Survey Data. Olympia, WA: Washington State Department of Natural Resources.

Sosiak, A., 2002. Long-term Response of Periphyton and Macrophytes to Reduced Municipal Nutrient Loading to the Bow River (Alberta, Canada). Canadian Journal of Fisheries and Aquatic Sciences 59: 987-1001.

Stillwater Mining Company and Hydrometrics, Inc. Stillwater Mining Company : 2001 Water Resources Monitoring Report : East Boulder Project. Big Timber, MT: Stillwater Mining Company.

Story, Mark and Cheryl Taylor. 1999. East Boulder River Sediment, Turbidity & Discharge Monitoring Report April 1998-November, 1998. S.L.: Gallatin National Forest.

Story, Mark and Cheryl Taylor. 2000. East Boulder River Sediment, Turbidity & Discharge Monitoring Report April 1999-November 1999.. S.L.: Gallatin National Forest.

Story, Mark and Cheryl Taylor. 2003. East Boulder River Sediment, Turbidity & Discharge Monitoring Report April 2002-November 2002.. S.L.: Gallatin National Forest.

Suplee, M. W., A. Varghese, and J. Cleland, 2007. Developing Nutrient Criteria for Streams: an Evaluation of the Frequency Distribution Method. Journal of the American Water Resources Association 43: 453-472.

U.S. Environmental Protection Agency. 1991. Technical Support Document for Water Quality-based Toxics Control. EPA/505/2-90-001. Washington, D.C. U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 1997. Appendix D: Screening Values for Chemicals Evaluated (National Sediment Inventory). Washington, D.C: U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 1999. Protocol for Developing Nutrient TMDLs EPA 841-B-99-007. Washington, D.C.: U.S. Environmental Protection Agency

U.S. Environmental Protection Agency. 2000. Ambient Water Quality Criteria Recommendations: Rivers and Streams in nutrient Ecoregion II. Document EPA 822-B-00-015. Washington, D.C.: U.S. Environmental Protection Agency

University of Montana, 1998 East Boulder Algae Sampling Results and Field Notes. Missoula, MT: University of Montana.

Varghese, A., and J. Cleland. 2005. Seasonally Stratified Water Quality Analysis for Montana Rivers and Streams-Final Report. Fairfax, VA: ICF International Consulting.

Varghese, A., and J. Cleland. 2006. Bootstrap Confidence Intervals and Updated Statistical Analyses of Water Quality Data from Montana Rivers and Streams. Fairfax, VA: ICF International.

Vincent, E. Richard and C.G. Clancey, W. Fredenberg, R.A. Oswald, B.J.Rehwinkel. 1990. Southwest Montana Major River Fisheries Investigation, Survey and Inventory of Cold Water Streams, Statewide Fisheries Investigations, July 1, 1989 through June 30. Helena, MT: Montana Department of Fish, Wildlife, and Parks.

Watson, V., P. Berlind, and L. Bahls. 1990. Control of Algal Standing Crop by P and N in the Clark Fork River. In: Proceedings of the 1990 Clark Fork River Symposium, V. Watson (Editor). University of Montana, Missoula, pp 47-62. Available at http://ibscore.dbs.umt.edu/clarkfork/Past_Proceedings/1990_proceedings/watson/Watson.htm

Watson, Vicki, et al. 1999. Clark Fork Nutrient and Benthic Chlorophyll Standards and Targets Missoula, MT: University of Montana..

Weidenheft, W. 1982. South Central Montana Fisheries Investigations - Inventory of Waters of the Project Area (Boulder River) (F-20-R-26 Ia supplement). Helena, MT: Montana Department of Fish, Wildlife, and Parks.

Western Regional Climate Center (WRCC). http://www.wrcc.dri.edu/cgibin/cliMAIN.pl?mtalde

Wilber, C. G. 1983. Turbidity in the Aquatic Environment: An Environmental Factor in Fresh and Oceanic Waters. Springfield IL: Charles C. Thomas Publishers.

Waters, T. F. 1995. Sediment in Streams: Sources, Biological Effects, and Control. American Fisheries Society Monograph 7. Bethesda, MD.

Welch, E. B., Jacoby, J. M., Horner, R. R., and M. R. Seeley. 1988. Nuisance Biomass Levels of Periphytic Algae in Streams. Hydrobiologia 157: 161-168.

Woods, A.J., J.M. Omernik, J.A. Nesser, J. Sheldon, and S.H.Azvedo. 1999. Ecoregions of Montana (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia: U.S. Geological Survey.

Woods, A.J., J. M. Omernik, J. A. Nesser, J. Shelden, J. A. Comstock, and S. J. Azevedo. 2002. Ecoregions of Montana, 2nd edition. (Color Poster with Map, Descriptive Text, Summary Tables, and Photographs): Reston, Virginia: U.S. Geological Survey

Wolman, M. G. 1954. A Method of Sampling Coarse River-Bed Material. Transactions of the American Geophysicists Union 35:951-956.

Zweig, L. D., and C. F. Rabeni. 2001. Biomonitoring for Deposited Sediment Using Benthic Invertebrates: A Test on Four M issouri Streams. Journal of the North American Benthological Society 20:643-657.

Personal Communication with the Following Professionals:

Avey, Bill, United States Forest Service

Bahls, Loren, Hannaea

Beeson, Dave, Advent Environmental

Darling, Ron, Montana Fish, Wildlife and Parks

DeArment, John, University of Montana (now with PBS&J Consulting)

Dolan, Larry, Montana Department of Natural Resources and Conservation

Kellogg, Warren, Natural Resources Conservation Service

Mehus, Chris, Boulder River Watershed Group

Olsen, Jim, Montana Fish, Wildlife and Parks

Schuler, Scot, United States Forest Service

Story, Mark, United States Forest Service

Watson, Vicky, University of Montana

Zuzulock, Sarah, Kiepers and Associates.

ACRONYMS

ABWA	Absarokee-Beartooth Wilderness Area
AML	Abandoned Mine Lands
ARM	Administrative Rules of Montana
BER	Board of Environmental Review
BLM	Bureau of Land Management
BNF	Beaverhead National Forest
CALA	Controlled Allocation of Liability Act
CECRA	Montana Comprehensive Environmental Cleanup and Responsibility Act
cfs-	Cubic Feet Per Second
CWA	Clean Water Act
DEQ	Montana Department of Environmental Quality
DMR	Discharge Monitoring Report
EPT	Ephemeroptera, Plecoptera, Trichoptera
IR	Integrated Report
LA	Load Allocation
LC	Loading Capacity
LNF	Lolo National Forest
MCA	Montana Code Annotated
MDEQ	Montana Department of Environmental Quality
MFISH	Montana Fisheries Information System
MFWP	Montana Department of Fish, Wildlife and Parks
MMI	Multi-Metric Index
MNHP	Montana Natural Heritage Program
MOS	Margin of Safety
MPDES	Montana Pollutant Discharge Elimination System
MWCB	Mine Waste Cleanup Bureau
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resource Conservation Service
NWIS	National Water Information System
O/E	Observed/Expected
PEL	Probable Effects Levels
RIVPACS	River Invertebrate Prediction and Classification System
SABS	Suspended and Bedded Sediments
SAP	Sampling and Analysis Plan
SCD/BUD	Sufficient Credible Data/Beneficial Use Determination
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SMCRA	Surface Mining Coal and Reclamation Act
SNOTEL	Snowpack Telemetry
TEL	Threshold Effects Levels
TMDL	Total Maximum Daily Loads
TN	Total Nitrogen
TP	Total Phosphorus
TPA	TMDL Planning Area
UAA	Use Attainability Assessment

USEPA United States Environmental Protection Agency
USFS United States Forest Service
USGS United States Geological Survey
VCRA Voluntary Cleanup and Redevelopment Act
WLA Waste Load Allocation
WQA Water Quality Act
WQRP Water Quality Restoration Plans

APPENDIX A
RESPONSES TO PUBLIC COMMENTS

As described in **Section 6.0**, the formal public comment period for the Boulder Watershed Total Maximum Daily Loads (TMDL) extended from May 14th to June 18th, 2007. Three individual comments letters were submitted to DEQ during the public comment period. Excerpts from comment letters are provided below. Where appropriate, the DEQ has compiled and selected excerpts and arranged them topically. Responses prepared by MDEQ follow each of the individual comments. Original comment letters are held on file at the DEQ and may be viewed upon request.

The Final TMDL document includes necessary TMDLs in the Boulder: those water body-pollutant combinations that demonstrated exceedences of water quality standards. Where assessments demonstrated that waters were meeting narrative water quality standards, these assessments have been removed from the final TMDL document and are kept on-file on the DEQ. Consequently, **Sections 4.3 and 4.4** (sediment and nutrient assessments) have been removed from the final document.

Comment #1:

The sediment assessment **Section 4.3** and **Nutrient Section 4.4** are clear and reasonable. The documentation provides a good summary of sediment and nutrient data and develops a clear documentation of the non-impairment and no need for sediment and nutrient TMDLs at this time. We support your recommendation of continued nutrient monitoring, particularly in the East Boulder River. The sediment conclusion is consistent with our East Boulder River monitoring which as documented low sediment concentrations with some increases below the NF boundary due to geomorphic changes, agricultural activity, and residences.

The **Section 4.5** conclusion of copper and lead impairment is not as well supported since the existing metals data is quite limited. However, the suggestion of historic mining activities in Basin Creek as a likely source of the high flows metals seems logical. The primary source may be instream sediments in Basin Creek which could be mobilized during snowmelt runoff which would account for the data which shows exceedences only occurring at flows (in the Boulder River) over 1500 cfs. The quality information, particularly regarding potential sources, could help clarify the sources of the elevated copper and iron. I agree with the monitoring goals on page 91, but would suggest some sediment analysis in Basin Creek sediments to augment the surface water data. This additional data may help refine the TMDL allocations in **Section 5.2** which are based on very limited data.

The restoration strategy in **Section 5.4** provides helpful information about potential funding sources and programs for any abandoned mine rehabilitation. It would be helpful if you would contact our Forest Hydrologist, Mark Story (587-6735) for field recon assistance support for potential future abandoned mine reclamation activities in the Basin Creek area.

Comment #1 Response:

The DEQ thanks you for your comment and your support. Because the East Boulder River appears to be meeting water quality criteria for sediment and nutrients and TMDLs are not developed for these pollutants, these assessments (**Sections 4.3 and 4.4**) were edited from the final TMDL document and are kept on file at the DEQ.

It is agreed that metals data is rather limited in some stretches of the Boulder River. Additional metals data collection (both water column samples and stream sediment samples) is planned at high and low flows in order to refine metals source assessment information and to determine the magnitude and spatial extent of sources. A framework metals monitoring plan is provided in **Section 4.5.5.1.** It is the intent of the DEQ to fully cooperate with USFS and all interested parties in the assessment and remediation/restoration of abandoned mine sites in the watershed.

Comment #2:

Section 2.3 Biological Resources

Section 2.3.1 Fisheries

Table 2-2 (page 22) lists fish species, location and relative abundance for the East Boulder River. As part of the Good Neighbor Agreement, Stillwater Mining Company conducted fish population surveys in 2001 and 2003 that should be used to update information on fish populations in the East Boulder River. Results from the 2001 and 2003 population surveys generally do not agree with relative abundance data provided in **Table 2-2**. For example, **Table 2-2** lists Yellowstone Cutthroat Trout as abundant/common and results from the 2001 and 2003 studies indicate Yellowstone Cutthroat Trout are rare. In general the 2001 and 2003 studies show Brown Trout and Rainbow Trout as the most abundant species observed.

Fish tissue analyses were conducted on the East Boulder River in 1997 and 2003. Samples were collected using standard fish tissue sampling protocols, and analyzed for mercury in fillet tissue both years. Harvested liver tissue was analyzed for lead, chromium, copper, cadmium, arsenic and silver in 1997 and 2003 with the addition of zinc in 2003. In 1997 metals data was mostly below analytical detection limits for Hg, Pb, Cr, Cd, As and Ag. Copper was above detection limits in all samples. In 2003 mean metals concentrations were higher in all cases except for Pb which exhibited a lower overall mean concentration. In all cases metal levels were below EPA fish tissue screening levels for health risks, non-cancer hazards, and FDA action and tolerance guidelines. Fish tissue Hg was well below the Montana recommended threshold of 0.10 parts per million restricting consumption. Results from 1997 and 2003 do not indicate the need for restrictions or limitations on fish consumption in the East Boulder River.

The following studies discussed above were provided to the Montana Department of Environmental Quality on 4 June 2007 for consideration in the final TMDL report:

1. “Final East Boulder River Fisheries Monitoring, 2001” prepared for Montana Trout Unlimited by Apex Aquatics dated March 2002.

2. "East Boulder River Fisheries Monitoring Report 2003" prepared for Montana Trout Unlimited by GEI Consultants, Inc. dated January 2004.
3. "Fish Tissue Analyses East Boulder River 1997 and 2003" prepared for Stillwater Mining Company East Boulder Mine by The Advent Group dated April 2004.

Comment #2 Response:

DEQ thanks you for the additional fisheries data and reports. The data and information provided in **Table 2-2** comes from the Montana Fish Wildlife and Parks fish population surveys. The final document (**Section 2.3**) was amended to include the additional information provided from USFS fish population surveys conducted in 2001 and 2003. Original FWP survey data provided in **Table 2-2** was not amended.

Fish tissue data collected in 1997 and 2003 was from the upper reach of the East Boulder River (MT43B004_133). As segment MT43B004_133 was listed as fully supporting its beneficial uses, a complete review of data and water quality condition was not conducted for this document. For this reason the data and information was not included in the final TMDL document. The information is relevant, however, to water quality conditions in the upper East Boulder River and will be entered into DEQ's water quality library for future consideration in subsequent beneficial use evaluations.

Comment #3:

Section 4.1 Introduction

Table 4-1 provides the 2006 303(d) listings in the Boulder Watershed TMDL Planning Area and lists no probable causes of impairment for MT43B004_143 (East Boulder River from National Forest boundary to the headwaters). CRC would like to see chlorophyll-a evaluated as a probable cause for impairment in this segment of the East Boulder River in future 303(d) listing evaluations.

Periphyton monitoring including chlorophyll-a sampling conducted in 2006 for this segment of river resulted in chlorophyll-a concentrations averaging approximately 122 mg/m^2 over three monitoring locations. These results are approximately 45% higher than chlorophyll-a concentrations observed at these monitoring locations in 2005, and greater than the Montana DEQ benthic chlorophyll-a impairment criteria of 50 mg/m^2. The increase in chlorophyll-a concentrations is likely attributed to expansive growth of *Didymosphenia geminata* that has been observed since 2004. Results from the 2006 monitoring have been summarized in "East Boulder River Biomonitoring Monitoring Report September 13-15, 2006" prepared for Stillwater Mining Company by Advent-Environ dated May 2007.

Comment #3 Response:

DEQ is keenly aware of the recent *Didymosphenia geminata* proliferation in segment MT43B004_133 and recommends continued monitoring activities (**Section 4.6**) to track and assess the mechanisms influencing biologic productivity in this reach. Because segment MT43B004_133 was not listed as impaired on the State's most recent (2006) impaired waters list, TMDL development activities did not establish specific water quality criteria (targets) for this reach, nor was recent data evaluated for compliance with water quality criteria.

DEQ shares concern over recent *D. geminata* proliferation and elevated chlorophyll-a levels in this reach, and maintains a process for assessing and evaluating streams for beneficial use impairment, defined in the State's *Monitoring and assessment Quality Assurance Project Plan.* Please also refer to MCA 75-5-702 for articulation of the State's public involvement process for updating the list of impaired water bodies.

Comment #4:

Section 4.4.4.2 East Boulder Mine

DEQ recommendations to assess potential impacts from the East Boulder Mine (page 66) include continued biological monitoring in accordance with the "Biological Monitoring Plan for Stillwater Mining Company – East Boulder Project" (1998). Since development of this plan the Montana DEQ permitting and compliance division has allowed modifications to the programs described in that document. Annual monitoring of chlorophyll *a* and macroinvertebrates is now required at sites EBR-002, -003 and -004. The macroinvertebrate requirement is also dependent on a review of the data on an annual basis by the agencies to evaluate the need for continued monitoring.

CRC agrees than an annual biological monitoring program including periphyton, chlorophyll-a and macroinvertebrates is warranted in the upper East Boulder River to monitor the ongoing *D. geminata* bloom; however, CRC does not believe SMC should be responsible for monitoring non-mine related impacts. Interested parties (MDEQ, USFS, SMC, CRC) should work together to develop a monitoring plan including funding (319 funds) for ongoing monitoring of this unique situation.

SMC monitoring plans for 2007 include chlorophyll-a and macroinvertebrate monitoring at sites EBR-002, EBR-003 and EBR-004. In order to continue annual full spectrum monitoring in 2007 additional funding is required to collect, analyze and interpret results for periphyton samples.

Comment #4 Response:

DEQ understands and acknowledges that modifications to the original biological monitoring plan, *Biological Monitoring Plan for Stillwater Mining Company – East Boulder Project*, and contends that the collaboration among agencies and local stakeholders to modify the Plan is appropriate. DEQ agrees that monitoring efforts aside from regulatory requirements should be a collaborative effort among agencies and stakeholders in the watershed, yet does not assign any specific responsibility for monitoring actions. DEQ encourages collaborative funding approaches to address monitoring needs, and recommends that interested parties contact DEQ staff regarding 319 funding opportunities through the DEQ.

Comment #5:

The Montana League of Cities and Towns has reviewed the Boulder River TMDL and the League's comments on the nutrient aspects of this TMDL are attached. Although this TMDL does not establish load allocations for nutrient parameters, it does establish procedures for setting extremely restrictive instream targets that may serve as the basis for future allocations in other watersheds. These procedures have not been adopted in state law or approved by USEPA under the Clean Water Act. We are greatly concerned that this action, as in other recent TMDLs prepared by the Department, establishes requirements that are not necessary to ensure that uses of the stream are being protected. Moreover, it is apparent that the cost impacts associated with these "targets" will be severe and will cause "widespread adverse economic impacts". Prior to imposing such onerous and questionable burdens on Montana communities, there must be a high certainty that the expenditures are necessary and will produce demonstrable environmental benefits.

The approach being applied by the Department includes a target level for benthic chlorophyll 50 mg/m^2. This benthic chlorophyll target is a very low value, in particular when compared with the adopted water quality standard for the Clark Fork River (100 mg/m^2 growing season average; 150 mg/m^2 maximum). If uses in the Clark Fork River are not affected at these much higher levels, we question why a much lower level is required to protect primary contact recreation in East Boulder River and elsewhere. Moreover, whether or how primary contact recreation (swimming) is affected at this level of plant growth is not demonstrated in the TMDL or its reference documents.

The Department has also developed target levels for nitrogen and phosphorus based on a statistical evaluation of reference streams in the Middle Rockies ecoregion. Specifically, nutrient concentrations at the 85^{th} percentile of the reference stream concentration are being used as an indicator of beneficial use impairment. However, no demonstration is made to show that these target levels are necessary to maintain beneficial uses. In fact, it is not apparent that nutrient levels were the primary factors controlling plant growth for these streams.

The chosen target levels are extremely low and will result in very significant treatment costs for communities throughout the state if a similar approach is applied elsewhere. In fact, we question whether treatment technologies exist that will achieve compliance under these conditions. Consider, for example, the total nitrogen target of 0.38 mg/L (the 85^{th} percentile of the distribution for reference streams). It is unlikely that any assimilative capacity would exist for point sources if such "targets" were applied to downstream waters. As it is expected that the best technology cannot achieve this level of treatment, a facility would need to remove the discharge from the stream to comply with the target. In many cases, this will result in significantly diminished downstream flow and the loss of all beneficial uses. Thus, implementation of this approach may result in more aquatic life harm than improvement.

We are aware that other states are not using the "reference stream" approach because the approach has no objective connection to environmental need. The implications for this approach are very significant and we question whether it is prudent for the Department to proceed in this manner prior to a full public discussion of this issue and the adoption of state-side nutrient standards. We request that further action on this TMDL be deferred until a stakeholder meeting regarding the development and application of new nutrient standard occurs.

Although this TMDL does not establish load allocations for nutrient parameters, it does establish procedures for setting extremely restrictive instream targets that may serve as the basis for future allocations in other watersheds. These procedures have not been adopted in state law or approved by USEPA under the Clean Water Act. We are greatly concerned that this action, as in other recent TMDLs prepared by the Department, establishes requirements that are not necessary to ensure that uses of the stream are being protected. Moreover, it is apparent that the cost impacts associated with these “targets” will be severe and will cause “widespread adverse economic impacts”. Prior to imposing such onerous and questionable burdens on Montana communities, there must be a high certainty that the expenditures are necessary and will produce demonstrable environmental benefits.

The implications for this approach are very significant and we question whether it is prudent for the Department to proceed in this manner prior to a full public discussion of this issue and the adoption of state-side nutrient standards. We request that further action on this TMDL be deferred until a stakeholder meeting regarding the development and application of new nutrient standard occurs.

Comment #5 Response:

DEQ appreciates the thoroughness of the *Montana League of Cities & Towns’* (the League) comments and the opportunity to respond. Detailed comments were submitted by the League relating to the Department’s development and application of nutrient water quality targets within the Boulder Watershed TMDL draft document. Because nutrients and sediment do not presently appear to be impairing East Boulder River segments MT43B004_141 and MT43B004_142, and TMDLs have not been developed at this time, nutrient and sediment assessments (previous S**ections 4.3 and 4.4**) have been removed from the final Boulder Watershed TMDL document, and will be held on-file at the DEQ. Due to this edit, responses to specific technical comments provided by the League regarding these assessments are not provided.

DEQ acknowledges the League’s concern regarding the application of nutrient targets for setting wasteload allocations, and shares an interest in ensuring that ‘widespread adverse economic impacts’ are not the result of TMDL allocations. As defined in MCA 75-5-703(1):

> *“the department shall consider applicable guidance from the federal environmental protection agency, as well as the environmental, economic, and social costs and benefits of developing and implementing a TMDL.”*

As the Department is specifically directed to consider the ‘environmental, economic and social costs and benefits’, any required wasteload allocations resultant from TMDL development must take into account much more than a strict application of nutrient targets in order to calculate load limits. It is the intent of the Department to approach any potential wasteload allocations with an understanding of economic considerations, technological limitations, and the cumulative influences of upstream and downstream sources in order to develop equitable allocation strategies. The Department understands the implications of establishing numeric nutrient criteria for Montana water bodies, welcomes dialogue regarding criteria and its application, and will continue to engage municipalities and individual permitted dischargers in the Departments public process related to numeric standards development and their application.

APPENDIX B
PLANNING CONSIDERATIONS

Boulder River Mainstem

Segment #1: Fourmile Guard Station to Two-Mile Bridge (Mile 53 to 40)

- ***Small Tract Development/Church Camps***
  Buildings situated too close to the river may potentially cause channel instability, restrict floodplain access, and be sources of water quality pollutants. Proper set-backs of structures, the maintenance of healthy riparian buffers, control of weeds, and effective septic maintenance should be promoted. Sponsoring small landowner workshops (DNRC small landowner workshops), mail-outs, and personal contacts would be an approach to inform small tract landowners about these issues.
  Medium Priority

- ***Noxious Weeds***
  Infestations of *Ox-Eye Daisy, Common Tansy, and Sulphur Cinquefoil* are common throughout this reach. Many of these infestations are found in pastures off from the river. A comprehensive weed management education and control program should target small tract, seasonal residents.
  High Priority

Boulder River Mainstem

Segment #2: Two-Mile Bridge to Natural Bridge (Mile 40 to 33)

- ***Small Tracts***
  Whispering Pines and Ken-Dan Acres Subdivisions: Floodplain and channel encroachment from structures, landscaping, septic systems, and channel rip-rap/floodplain dikes are common (Mile 34.5 to 39.5). Small landowner workshops that emphasize riparian buffers, weed management, septic system evaluations/maintenance, and structure set-backs should be conducted.
  High Priority

- ***Noxious Weeds***

  Ox-Eye Daisy, Canada Thistle, Spotted Knapweed, and Common Tansy infestations vary in extent throughout this reach. There have also been small patches of *Tall Butter*cup and *Blue Weed* found. There is a weed management project currently wrapping up on Ken-Dan Acres subdivision. The Whispering Pines subdivision needs a similar effort. A cooperative, long-term weed management effort from the headwaters down to Natural Bridge should be formally organized to curb their spread.

  High Priority

- ***Stream Bank Stabilization***

  The four mile section of river immediately above the Natural Bridge (Mile 33.5 to 38) is especially sensitive to bank instability due to inherent erodible soils and natural channel dynamics. This reach requires a detailed reach investigation to develop site-specific management alternatives to maintain and improve long-term channel stability. Management alternatives may include riparian fencing, off-stream livestock water development, and bioengineered bank stabilization measures.

  Medium Priority

Boulder River Mainstem

Segment #3: Natural Bridge to East Boulder Road Bridge (Mile 33 to 23)

- ***Livestock Management***

  Many sections of river are traditionally used as *calving and/or winter feeding pastures* that sometimes times exhibit heavy browse of the riparian vegetation and bank trampling by livestock. Maintaining a healthy riparian buffer in these high use areas (with temporary fencing and off-stream water) would reverse this trend.

  Medium Priority

  The reach of the river immediately upstream from the East Boulder Road Bridge has experienced *heavy livestock impacts* (Mile 23 to 24.5). Developing off-stream water and power fencing would be necessary to reverse the downward trend of the riparian plant community.

  Low Priority

- ***Irrigation Infrastructure***

  McLeod Irrigation Ditch: More detailed investigation is necessary to determine if there are cost-effective alternatives that may work to stabilize the ditch canal along the toe of the land slide on the Beaver Meadows Ranch (Mile 32). There are other sections of this ditch that also need attention.

Low Priority

Boe-Engle Ditch: Because the Boe-Engle Ditch is situated high up on the east valley wall, there is an excellent opportunity for gravity or low pressure sprinklers on the upper benchland and/or the valley floor. A more detailed feasibility investigation would be necessary to develop specific alternatives.

Medium Priority

- ***Noxious Weeds***

Leafy Spurge and Canada Thistle: Infestations of these two weeds are widespread throughout this reach. A cooperative multi-landowner weed management program has been initiated and will run to 2008. An integrated, long-term approach to effectively contain the spread of these weeds has the best likelihood of success.

High Priority

Spotted Knapweed, Common Tansy, Ox-Eye Daisy, Whitetop, Woodland Sage, Blue Weed, and Houndstongue: Infestations of these species throughout this reach are sporadic. A focused landowner weed management and education program could contain and potentially eradicate some of these species over time.

High Priority

- ***Channel Stability***

Floodplain Dike (near Mile 30) located on the Beaver Meadows Ranch should be removed to restore high water access to the historic floodplain and reduce pressure on the downstream river banks.

Low Priority

Unstable Channel (Mile 25 to 27) located on the Engle Ranch is primarily due to a high bedload and historic stream bank rip-rap/floodplain dike restrictions. This two mile reach requires a detailed investigation to develop alternatives that would return this reach of the river back to a more natural state.

High Priority

Boulder River Mainstem

Segment #4: East Boulder Road Bridge to West Boulder Confluence (Mile 23 to 19.5)

- ***Channel Stability***

  Floodplain Dike (Mile 22) should be removed to allow high water access to the floodplain and to reduce the active erosion and instability of a downstream terrace.

  Medium Priority

- ***Irrigation Tailwater***

  Irrigation Tailwater coming off hayfields above and below the Susie Creek Bridge (Mile 21) is causing bank sloughing and erosion where the tailwater drops off the field into the Boulder River. Constructing tailwater ditches, dikes and/or tailwater drop pipes would prevent further damage. Another possible alternative would be to convert from flood irrigation to sprinkler irrigation (big gun).

  Medium Priority

- ***Grazing Management***

  Heavy Livestock Use of riparian vegetation and the trampling of the river bank is occurring (Mile 20) across from the Boulder River Fishing Access. Relatively low-cost practices such as riparian fencing and off-stream water development would greatly reduce livestock impacts on this reach.

  Low Priority

Boulder River Mainstem

Segment #5: West Boulder River Confluence to 8 Mile Bridge (Mile 19.5 to 11)

- ***Irrigation Infrastructure***

  Goeddel Irrigation Headgate/Ditch (Mile 18.5) – downstream from the West Boulder Confluence: This rock irrigation diversion is situated on an outside bend that tends to catch debris during high water events. A redesign of this diversion would reduce maintenance time and costs.

  Medium Priority

  Smoot Irrigation Headgate/Diversion (Mile 14): The existing rock diversion tends to catch debris during high flows. Redesign/reconstruction of the rock diversion would reduce long-term maintenance costs.

  Low Priority

  Crest Ditch Headgate (Mile 12): Concrete is breaking up on parts of the headwall. Repairs are needed to maintain the future integrity of the structure.

  Low Priority

- ***Irrigation Water Management***

  1) Irrigation Tailwater: Throughout this segment of the Boulder River, irrigation tailwater sporadically flows directly over the river bank back into the river often creating small gullies and delivering sediment to the river. On-farm irrigation improvements, tailwater collection ditches, and constructed discharge outlets would help remedy this situation.

  2) Ditch Seepage: Water leakage from conveyance ditches on the adjacent benches is common. Sections of conveyance ditches should be considered for lining or sealing. Water loss measurements are necessary to identify the most critical sections of ditch to optimize water savings.
  Medium Priority

  McComb-Campbell Irrigation Ditch: Investigate the lower end of the ditch system for possible conversion from flood irrigation to gravity sprinkler irrigation (Mile 13.5 to 14.5).
  Medium Priority

- ***Grazing Management***

  Heavy livestock use/small corral systems occur in a few locations along this river segment. These high use areas are often associated with a large weed infestation. Grazing land improvements such as fencing, off-stream livestock water development, and riparian buffer establishment would greatly benefit these areas.
  Low Priority

- ***Noxious Weeds***

  Leafy Spurge, Common Tansy, and Houndstongue: Infestations are widespread along this entire reach. An integrated landowner weed management program to contain these weeds is needed.
  Medium Priority

Boulder River Mainstem

Segment #6: 8 Mile Bridge to Interstate 90 Bridge (Mile 11 to 2.5)

- ***Irrigation Infrastructure/Channel Stability/Fish Capture***

  Ellison Mutual Irrigation Ditch Diversion (Mile 10.5): A minor redesign of the in-channel diversion using bedded angular rock would reduce the need for continual maintenance after high water events.

Low Priority

Clause-Weaver Irrigation Ditch (Mile 10)*:* A detailed evaluation of the entire ditch system would be necessary to determine gravity/low pressure sprinkler opportunities and to develop alternatives that will prevent the ditch from eventually sloughing into the river where it is located immediately next to the river (Mile 8.5).

High Priority

Lamp-Nelson Irrigation Diversion/Ditch (Mile 9):

1) Redesign the rock diversion to incorporate larger and more angular rock that would assure long-term permanence and less annual maintenance.
2) Detailed evaluation of the entire ditch system to determine gravity/low pressure sprinkler opportunities, ditch consolidation potential with the Clause-Weaver Ditch, and the development of alternatives to keep the ditch from sloughing into the river at the same site (Mile 8.5) where the Clause-Weaver Ditch is being threatened.

High Priority

Post-Kellogg Irrigation Diversion (Mile 7): Redesign of the rock/canvas diversion to reduce annual maintenance costs and impacts to the river.

Medium Priority

Clayton Irrigation Headgate (Mile 5): 1) The concrete footings of the headgate are being undercut. The headgate structure needs repairs for it to remain functional. 2) Consider the possibility of consolidating the Clayton Ditch with the Conwell Ditch.

Low Priority

Hansen Irrigation Headgate (Mile 5): Headgate is close to being washed out and needs to be totally replaced and relocated. The headgate also needs a viable diversion to check water into the structure. An alternative approach would be to investigate the possibility of consolidating this ditch with upstream conveyance systems (Conwell or Clayton).

Low Priority

Electric Light Irrigation Diversion (Mile 4): A redesign of the rock/canvas diversion would reduce debris entrapment and maintenance costs. The headgate should eventually be moved upstream to lessen the need for such a large diversion.

Medium Priority

Pioneer Irrigation Diversion (Mile 3): The design and construction of a permanent diversion is critical to reduce annual maintenance costs, eliminate the periodic impacts to the river, and maintain the adequate delivery of water to the system. In addition, an engineering review of the upstream dike and rip-rap structures should be made to determine if these channel modifications should be altered to reduce their impacts on the river.

High Priority

Fish Capture: Develop a cooperative program with Montana Fish Wildlife and Parks to survey the amount of fish capture by the major irrigation ditches. Where surveys show significant numbers of fish being captured, voluntary cost-effective solutions should be developed that would reduce fish capture in these irrigation ditch systems.

Medium Priority

Irrigation Conveyance Ditch Seepage: Develop alternatives to reduce irrigation delivery ditch loss. Specific sections of ditch to target would be determined by the water measurement efforts being conducted by DNRC and the Boulder River Watershed group.

Low Priority

- ***Small Tract Development/Church Camps***

  Small tract development, horse pastures, and small corrals situated too close to the river often cause channel instability and are potential sources of water quality pollutants. Proper set-backs of structures, the maintenance of healthy riparian buffers, control of weeds, and effective septic maintenance should be encouraged. Sponsoring small landowner workshops (DNRC small landowner workshops) would be an approach to better inform small tract landowners about these issues.

  Medium Priority

- ***Noxious Weeds***

  Leafy Spurge, Spotted Knapweed, Canada Thistle, Musk Thistle, and Common Tansy infestations vary in extent throughout this reach, although weeds are more prevalent than in upstream reaches. A cooperative, multi-landowner weed management effort is necessary to begin curbing their spread.

  Medium Priority

Boulder River Mainstem

Segment #7: Interstate 90 Bridge to Mouth (Mile 2.5 to 0)

- ***Noxious Weeds***

  Spotted Knapweed, Leafy Spurge, Canada Thistle, and Common Tansy infestations are abundant throughout this reach. A cooperative effort by the Montana Dept. of Transportation (MDT), the town of Big Timber, and small tract landowners is needed in this reach to control the further spread of these weeds.

High Priority

- ***Small Tracts and Town Lots***

  Urban Development on the high benches along the river may be a potential source of water quality pollution to the river stemming from lawn fertilizers/pesticides, stormwater run-off, and poorly functioning septic systems. Appropriate set-backs of structures, stormwater education programs, weed management, proper lawn care, and septic maintenance would be important topics for small landowner workshops or campaigns.

  Medium Priority

- ***River Crossings***

  There are *three major bridges* (Interstate 90, Old Boulder Road, and Highway 10) and *one BNSF Railroad trestle* in this reach. All of them have bedload deposition/islands formed immediately upstream of each structure that forces flow laterally creating bank instability. When these structures are scheduled for replacement or major maintenance, MDT and BNSF should be encouraged to properly design replacement structures that will provide adequate high flow capacity.

  Low Priority

- ***Irrigation Infrastructure***

  Irrigation Headgate (underneath BNSF trestle – Mile 1) – This small irrigation headgate should be replaced and possibly relocated to make it more functional.

  Low Priority

- ***Car Bodies***

  Old car bodies (Mile 0.5) placed in the channel as bank stabilization should be removed and disposed of. Bioengineered stabilization measures should then be installed to protect this bank and provide fish habitat.

  High Priority

- ***Big Timber Lagoon***

  Discharge from the Big Timber Sewage Lagoon appears to be the source of nutrients causing heavy algal growth in the lower Boulder River. The Boulder River Watershed group may want to work with the town of Big Timber and the Montana DEQ to determine if the current lagoon discharge permit is adequately taking care of nutrient pollution. If not, the Boulder River Watershed group may want to work closely with the town of Big Timber to help them up-grade their sewage lagoon system.

  Medium Priority

West Boulder River: USFS Campground to Mouth (Mile 17 to 0)

- ***Noxious Weeds***

  Sulphur Cinquefoil and Spotted Knapweed: These weeds are sporadically found along the West Boulder River. Target areas are the West Boulder Reserve and downstream from the Swingley Bridge. A focused multi-year weed management effort could effectively eradicate this isolated infestation before it spreads further. High Priority

  Leafy Spurge: The target reach for leafy spurge begins at the Swingley Bridge and goes upstream for approximately 1.5 miles (Mile 9 to 10.5). There is an excellent opportunity to contain this infestation (possibly even eradicate it) if a multi-year weed control campaign is actively implemented.

  High Priority

  Musk Thistle: The target reach begins at the Swingley Bridge and goes downstream for approximately two miles (Mile 7 to 9). Most of the musk thistle infestations are found on upper benches adjacent to the river. Smaller infestations of Musk Thistle were sporadically found above and below this target reach. Some landowners have begun active musk thistle control (EQIP Program) which needs to be continued.

  Medium Priority

  Canada Thistle, Burdock, Houndstongue, and Black Henbane: The extent of these weeds varies throughout the drainage. The encouragement and education of individual landowners to help them identify and control these weeds would be the best approach.

  Low Priority

- ***Riparian Grazing Management***

  Targeted reach: Swingley Bridge area (Mile 7 to 9) - *Livestock trailing, noxious weed infestations, and heavy browsing of riparian shrubs*. There are other smaller segments of the West Boulder River where comparable livestock impacts are occurring. Grazing improvements have been recently initiated (EQIP Program) on some riparian areas and should be expanded further to help reverse the trend.

  Medium Priority

- ***Irrigation Infrastructure Improvements***

  Elges Ditch Turnout (near Mile 8):

  1) This irrigation system needs a headgate to manage water flows entering the ditch. Headgate installation is scheduled for 2005.
  2) The conveyance ditch also commonly plugs up with debris at farm road culvert crossings causing ditch overtopping that often creates small headcuts down to the river. Ditch crossing should be redesigned to allow adequate transport of water and passage of debris. A full evaluation of the ditch system is encouraged.

     Medium Priority

  Elges-Muncaster Headgate (near Mile 7): Concrete headgate structure needs repairs to the scoured footings to prevent future failure of the structure. Repair work was initiated in 2005.

  Low Priority

  Rule-Work Diversion/Headgate (Mile 2.5): There needs to be a major redesign of the irrigation diversion, headgate structure, and river channel to adequately divert irrigation water while allowing debris in the river to effectively by-pass the headgate.

  High Priority

- ***Small Tract Development***

  There are some *small tracts* associated with horse pastures, pens, lawns, and buildings located immediately next to the river channel. Riparian buffers and reasonable set-backs for development are suggested to adequately maintain stream bank integrity and water quality. Small landowner workshops (DNRC-CARDD) may serve this drainage well to educate non-agricultural residents about noxious weeds, grazing management, and water quality. If future development continues along the river, this item should be reevaluated as possibly a higher priority.

  Low Priority

East Boulder River: USFS Campground to Mouth (Mile 8 to 0)

- ***Livestock Management***

  Concentrated livestock use and corrals are located at the mouth of *Enos Creek* before it joins the East Boulder River (Mile 3). This site may be a potential source of nutrient pollutants to the East Boulder River. Off-stream livestock water, channel buffers, and corral relocation would be possible alternatives to alleviate this condition.

Medium Priority

The *East Boulder River* reach near the mouth (Mile 0 to 0.5) is a bedload depositional reach that is highly braided and dynamic, highly vulnerable to bank erosion. Proper livestock grazing management is especially important on the lower end of the East Boulder River.

Medium Priority

The middle section of the *Craft Ditch* passes through summer livestock rangeland where the ditch banks are being heavily trampled by livestock. This impact is causing erosion of the ditch banks that is generating a noticeable sediment load in the ditch ultimately finding its way to Elk Creek and the East Boulder River. Constructed livestock ditch crossing and water gaps (rock fords) would reduce the impacts of livestock and improve the long-term stability of the ditch.

High Priority

- ***County Road/Bridges***

The *county bridge* at Mile 4.5 encroaches into the active river channel. When this bridge is replaced, it should be replaced with a wider spanned bridge to allow unimpeded high water flows.

Low Priority

County Road:

1) Segments of the East Boulder River have the county road located immediately alongside. R*oad sediment* is often pushed directly into the river when the road is being maintained.
2) *Magnesium chloride* is occasionally applied for dust control so it undoubtedly enters the river directly or indirectly with the sediment bladed off the road. Discussions with the Stillwater Mine Co. and the County Commissioners should be initiated to determine what can be done to mitigate this activity.

Low Priority

- ***Noxious Weeds***

Ox-Eye Daisy: There are varying degrees of infestation along the river. (Mile 0 to 8). More landowner education and encouragement on managing this weed should be encouraged.

Medium Priority

Leafy Spurge: This weed is primarily concentrated just upstream of the Elk Creek confluence on down to the mouth (Mile 0 to 3.5). A multi-landowner effort is needed to keep leafy spurge from moving upstream and to contain it on the lower reach of the East Boulder River.

High Priority

Spotted Knapweed and Woodland Sage: Small, sporadic patches of both these weeds exist along the stream corridor (Mile 0 to 7). There is an excellent opportunity to eradicate these weeds on the East Boulder with a focused landowner weed management effort.

High Priority

Canada Thistle, Bull Thistle, Burdock, and Houndstongue: The extent of these weeds varies throughout the drainage. The continued education of individual landowners to help them identify and control these weeds is the best approach.

Low Priority

- ***Irrigation Infrastructure Improvements***

Craft Ditch (east bench): Upper sections of the Craft Ditch are leaking significant amounts of water. The downslope saturation may be exacerbating the occurrence of large land slides (Mile 3 to 5) in an already geologically unstable area. Based upon more detailed water measurement investigations, sections of ditch should be considered for lining or sealing.

High Priority

Boe-Engle Ditch: The irrigation headgate needs repair and the diversion should be constructed to be more permanent and require less maintenance (upstream from Mile 6). The conveyance ditch system has not been fully investigated, but there are probable opportunities to improve water use efficiencies (gravity sprinklers), turnout structures (drop pipes), and wastewater ditch erosion. A full ditch evaluation for cost-effective improvements is recommended.

Medium Priority

Miles Flower Ditch (Mile 2) and Davenport Ditch (Mile 1) Headgate/Diversions: The irrigation diversions associated with these two headgates/ditches should be designed and replaced with permanent diversions that require less maintenance and are more compatible with the stream.

Low Priority

Elk Creek: Yerk-Woolsey Headgate to Mouth (Mile 3 to 0)

- ***Livestock Management***

There are several segments of Elk Creek that are experiencing *concentrated*

livestock use/small corrals and pens immediately along the creek. This heavy use is causing stream bank trampling and inputs of nutrient pollutants in some areas. Proper distribution of livestock is a challenge in this narrow valley, but off-stream livestock water development, riparian buffers, and fencing may be appropriate practices to consider in alleviating excessive livestock pressure on the creek bottom.
High Priority

- ***Irrigation Infrastructure Improvements***
  Yerks-Woolsey & Davenport Ditches – Late in the summer, the entire stream flow is often being captured by these ditches. There may be opportunities to improve the conveyance system and increase on-farm efficiencies to maintain an in-stream flow. This item should maybe be up-graded to a higher priority if the landowners express interest in investigating alternatives for water savings.
  Low Priority

- ***Noxious* Weeds**
  Leafy Spurge, Ox-Eye Daisy, and Houndstongue are sporadically found along the Elk Creek stream corridor and adjacent county road. This area is currently a focus area for the County Weed District.
  High Priority

APPENDIX C
BOULDER TMDL METALS LIMIT CALCULATIONS AND ASSUMPTIONS

Water Quality-based Effluent Limits for metals using EPA-recommended limit calculation using *EPA Technical Support Document (TSD) for Water Quality-based Toxics Control* (EPA, 1991).

Table C-1. Criteria for Aquatic Life Protection (at 25 mg/l water hardness), Cr

Pollutant	Acute (ug/L)	Chronic (ug/L)
Cu	3.79	2.85
Fe	--	1000
Pb	13.98	0.545

Table C-2. Receiving water quality (East Boulder River), Cs

Pollutant	mg/L, total recoverable
Cu	0.001
Fe	0.03
Pb	0.0005

Table C-3. Receiving Water Flow (East Boulder River), Qs

Chronic	7Q10 (cfs)	5
Acute	10% 7Q10 (cfs)	0.5
Effluent Discharge, Q(eff), cfs:		1.65

Wasteload concentrations are derived from the following formula:

$$C_d = \frac{C_r * (Q_d + Q_S) - C_s * Q_S}{Q_d}$$

Where: C_d = resulting WLA, mg/L
Cr = receiving water standard, mg/L
Q_d = discharge rate, cfs
Q_s = 7Q10 of receiving water, cfs
C_s = upstream receiving water concentration, mg/L (median value)

Table C-4. Wasteload Concentration (C_d)

Pollutant	Acute	Chronic
Cu	0.0046	0.0085
Fe		3.9394
Pb	0.0181	0.0007

Calculate Long-term Average (LTA)
Assumptions for multiplier (Table 5-1, TSD)

CV = 0.6	
Use 99th percentile for both	
Multiplier - Acute:	0.321
Multiplier - Chronic:	0.527

Table C-5: Long Term Average

Pollutant	Acute	Chronic
Cu	**0.00149**	0.00446
Fe		**2.07606**
Pb	0.00580	**0.00036**

Calculate Limits - Maximum Daily (MDL) and Ave. Monthly (AML)

Most restrictive LTA is used	
Assumptions for multiplier (Table 5-1, TSD)	
MDL - assume CV = 0.6, 99th percentile	
AML - assume CV = 0.6, 95th percentile	
MDL multiplier	3.11
AML multiplier	1.55

Table C-6. Concentration Limits

Pollutant	MDL	AML
Cu	0.0139	**0.0069**
Fe	6.4565	**3.2179**
Pb	0.0011	**0.0006**

APPENDIX D
CITY OF BIG TIMBER DISCHARGE CHARACTERIZATION AND STAGED IMPLEMENTATION FOR WASTELOAD ALLOCATIONS

This appendix (Appendix D) is an addendum to the Boulder River Watershed Total Maximum Daily Loads (referred to as the 2009 document). One purpose of this appendix is to characterize the City of Big Timber treatment lagoon discharge characteristics using information obtained between the time of original document approval in 2009 and the addition of this Appendix D addendum in 2016. This characterization includes an evaluation of lagoon discharge impacts on Boulder River water quality when water quality standards are not being met as defined within the 2009 document. A second purpose is to then use this information to provide implementation guidance for the metals wasteload allocations (WLAs) developed for the City of Big Timber treatment lagoon discharge, which is permitted under the Montana Pollutant Discharge Elimination System (MPDES).

D.1 Defining the City of Big Timber Wasteload Allocations

The metals WLAs for the City of Big Timber wastewater treatment lagoon (MPDES Permit MT0020753) are defined within **Section 5.2.2.2.1** of the 2009 document. These WLAs are developed for copper, lead, and iron using the lowest applicable aquatic life standard for each metal multiplied by the design flow of the City of Big Timber treatment lagoon. The resulting WLAs are presented in **Table 5-6** of the 2009 document and also below in **Table D-1.** They are based on **Equation D-1** using the treatment lagoon design flow of 0.603 cfs.

Equation D-1: Defining Wasteload Allocations

$WLA_{(MT00207053)}$ = (design flow) * (chronic criteria at 25 mg/L hardness) * (0.0054 conversion factor)

Table D-1. City of Big Timber MPDES Permit MT0020753: Metals Wasteload Allocations

Copper $WLA_{(MT00207053)}$	**0.009 lbs/day**	= (0.603 cfs) * (2.85 µg/L) * (0.0054)
Lead $WLA_{(MT00207053)}$	**0.002 lbs/day**	= (0.603 cfs) * (0.545 µg/L) * (0.0054)
Iron $WLA_{(MT00207053)}$	**3.26 lbs/day**	= (0.603 cfs) * (1,000 µg/L) * (0.0054)

In addition to the **Table D-1** WLAs, language in the 2009 document states that in order to ensure that discharges do not contribute to in-stream target exceedances under all flow conditions, effluent metals concentrations should remain below the chronic aquatic life criteria.

D.2 City of Big Timber Discharge Flow and Metals Concentrations

Consistent with the recommendations of the 2009 document, the City of Big Timber has further characterized the quality of their wastewater discharge by sampling for copper, lead, and iron between 2012 and 2016. During this period, discharges often ranged between 0.1 and 0.2 cfs, which is considerably less than the 0.603 cfs design flow.

For copper, the discharge concentrations were routinely between 28 and 50 µg/L. These values are significantly higher than the lowest applicable chronic criteria of 2.85 µg/L, resulting in loading to the Boulder River routinely above the **Table D-1** copper WLA. Copper loads can be as high as 0.054 lbs/day when higher copper concentrations occur at the high end of recently recorded treatment lagoon discharge flows that ranged between 0.1 to 0.2 cfs. If discharges were increased up to the treatment lagoon design flow of 0.603 cfs, the loading could be as high as 0.162 lbs/day.

For lead, the discharge concentrations were routinely between 0.4 µg/L and 1.5 µg/L and are thus routinely higher than the lowest applicable chronic criteria of 0.545 µg/L. Based on recent discharge flows that ranged between 0.1 to 0.2 cfs, the loading to the Boulder River was normally below the **Table D-1** lead WLA. Lead loads can be as high as 0.0016 lbs/day when higher lead concentrations occur at the high end of recently recorded treatment lagoon discharge flows. If discharge were increased up to the treatment lagoon design flow of 0.603 cfs, the loading could be as high as 0.0049 lbs/day, which is higher than the **Table D-1** lead WLA.

For iron, the discharge concentrations are routinely below 310 µg/L and thus are routinely below the lowest applicable chronic criteria of 1,000 µg/L. Loading has remained below the **Table D-1** iron WLA. Even at design flow and a concentration of 310 µg/L, the iron load would be 1.01 lbs/day, which is significantly less than the **Table D-1** iron WLA. These results suggest that there are no concerns regarding iron levels in the City of Big Timber treatment lagoon discharge.

In the 2009 document, it was stated that limited data from lagoon systems similar to that of the City of Big Timber are not likely to be elevated above chronic aquatic life criteria. Based on the above information, this is true for iron, but it is not true for lead and copper within the City of Big Timber discharge. In fact, the very high copper values suggest a potentially unique source of copper loading to the City of Big Timber wastewater system.

D.3 High Flow TMDLs, Existing Loads, and Load Reductions

As noted in the 2009 document, lead and copper exceed the water quality target on four separate sampling events in the segment of the Boulder River that receives the City of Big Timber wastewater discharge. Each target exceedance occurred during high seasonal flows (May and June) at flows at or above 1,500 cfs. There were no exceedances at flows lower than 1,000 cfs and the TMDL is effectively focused on reducing metals loading under high flow conditions. Necessary load reductions therefore apply particularly to high flow conditions, and strategies to reduce pollutant loading should address those processes and mechanisms that influence elevated metals concentrations during seasonal runoff.

High flow TMDLs, existing loads and required load reductions are calculated and presented in **Table 5-4** of the 2009 document and also presented below for copper and lead within **Table D-2**.

Table D-2. High Flow TMDLs, Existing Loads and Reductions for Copper and Lead (1,500 cfs, 25 mg/L hardness)

Metal	Target µg/L	TMDL lbs/day	Existing Load* lbs/day	Assimilative Capacity lbs/day	Necessary % reduction
Copper	2.85	23.09	34.3	-11.3	33%
Lead	0.545	4.41	10.7	-6.3	59%

*assume average metals concentrations at flows >1,500 cfs (DEQ data)

D.4 City of Big Timber Copper Loading Evaluation

Based on wastewater characteristics defined in **Section D-2**, the existing copper wastewater load is less than 0.16% ((0.054/34.3)*(100)) of the copper load within the Boulder River when the Boulder River copper concentrations are elevated above the water quality standard. The maximum expected copper wastewater load under design flow conditions is only 0.70% ((0.162/23.09)*(100)) of the TMDL. These values show that the City of Big Timber wastewater discharge is only a very minor source of copper loading under the high flow conditions of concern.

If the existing copper discharge concentrations were reduced to meet the target concentration of 2.85 µg/L, then there could be a total existing load reduction of 0.051 lbs/day [(50 µg/L)(0.2 cfs)(0.0054) – (2.85 µg/L)(0.2 cfs)(0.0054)]. This represents 0.45% of the total required load reduction identified in **Table D-2**, and would reduce the average existing elevated copper concentration in the Boulder River from about 4.234 µg/L to 4.228 µg/L. This level of change would probably not be detected using applicable water quality sampling methods, meaning that there would likely be no measureable improvement in Boulder River copper concentrations at the flows of concern.

D.5 City of Big Timber Lead Loading Evaluation

Based on wastewater characteristics defined in **Section D-2**, the existing lead wastewater load is less than 0.015% ((0.0016/10.7)*(100)) of the lead load within the Boulder River when the Boulder River lead concentrations are elevated above the water quality standard. The maximum expected lead wastewater load under design flow conditions is only 0.111% ((0.0049/4.41)*(100)) of the TMDL. These values show that the City of Big Timber wastewater discharge is only a very minor source of lead loading under the high flow conditions of concern.

If the existing lead discharge concentrations were reduced to meet the target concentration of 0.545 µg/L, then there could be a total existing load reduction of 0.00103 lbs/day [(1.5 µg/L)(0.2 cfs)(0.0054) – (0.545 µg/L)(0.2 cfs)(0.0054)]. This represents less than 0.02% of the total required load reduction identified in **Table D-2**, and would reduce the average existing elevated lead concentration in the Boulder River from about 1.32099 µg/L to 1.32086 µg/L. This level of change is not detectable using applicable water quality sampling methods and therefore represents no measureable improvement in Boulder River lead concentrations at the flows of concern.

D.6 Evaluation of Low Flow Conditions

Low flow TMDL information is provided within **Table 5.5** of the 2009 document. This information is not included in this appendix since there are no low flow impairment problems identified in the Boulder River and therefore no loading reductions are required to satisfy the metals TMDLs. Water quality data for the Boulder River suggest that water quality standards are met after complete mixing below the City of Big Timber wastewater discharge. Nevertheless, this conclusion is based on a completely mixed condition and does not address the possibility of an unacceptable toxic condition within the treatment lagoon discharge mixing zone. This mixing zone condition is not evaluated as part of the TMDL development process and is instead addressed during routine DEQ MPDES permit development. If during permit development, DEQ identifies a need for mixing zone related discharge limits for copper, lead, or iron, then these limits would be in addition to any limits identified via the TMDL development process.

D.7 Staged Implementation for the City of Big Timber Wasteload Allocations

The TMDL document does not include a timeline for implementing the City of Big Timber WLAs. Meeting the City of Big Timber copper and lead WLAs can be staged during multiple permit cycles, with the first cycle representing the collection of wastewater discharge data as suggested within the 2009 document and summarized within this appendix. This staged WLA implementation approach is based on consideration of the following information.

- As defined above, the City of Big Timber wastewater discharge represents insignificant increases in copper and lead loading to the Boulder River during the high flow conditions for which impairment conditions exist. Reducing the copper and lead concentrations to meet the WLAs would probably result in no measurable improvement to water quality in the Boulder River when impairment conditions exist.
- As discussed within the 2009 document, the sources of elevated metals are likely linked to abandoned mines within the headwaters of the Boulder River watershed, where future remediation activities have the potential to result in significant water quality improvement under high flow conditions.

The staged approach to meeting the WLAs will allow for additional evaluation of the sources of elevated copper and lead, along with the development of potential solutions to address these sources. The ultimate objective of this staged approach is for the City of Big Timber to meet the copper and lead WLAs. The City of Big Timber is currently meeting the iron WLA.