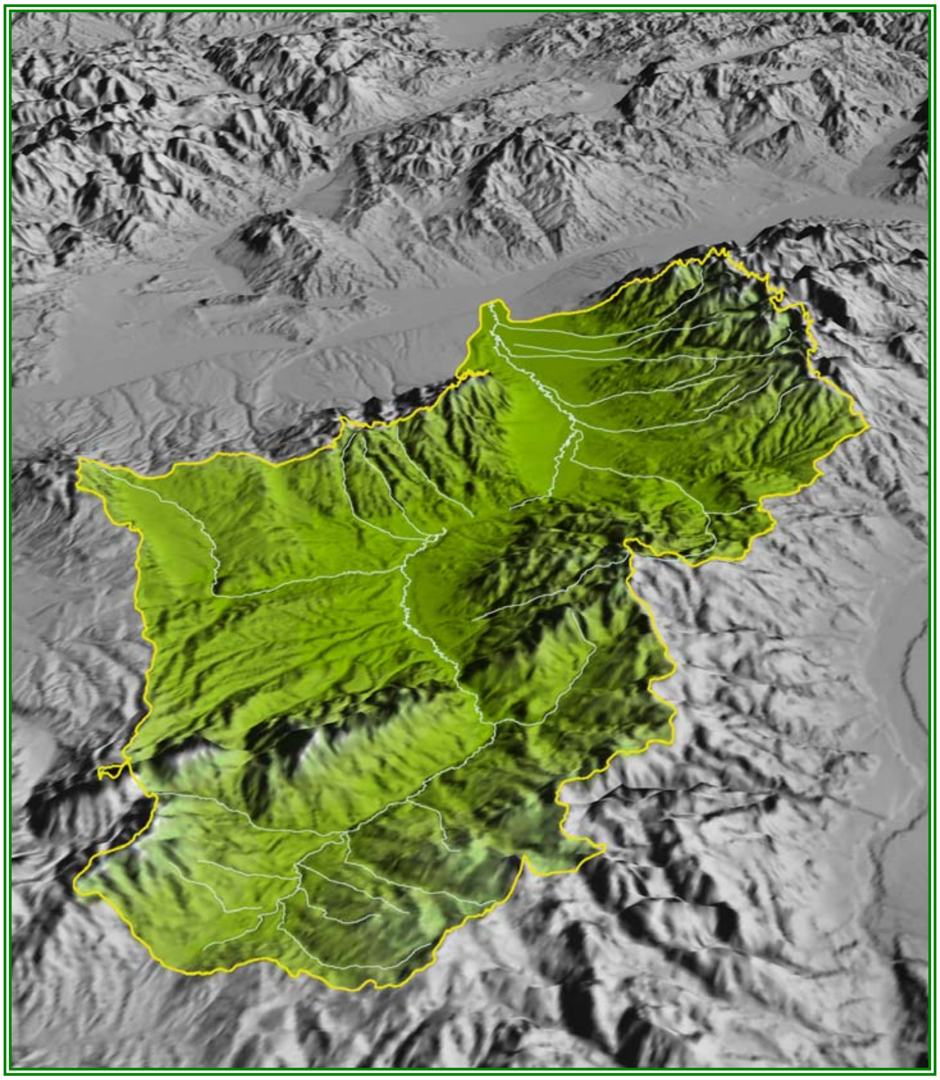
RUBY RIVER WATERSHED
TOTAL MAXIMUM DAILY LOADS AND FRAMEWORK FOR A WATER QUALITY RESTORATION PLAN



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EXECUTIVE SUMMARY

This document is a water quality and habitat restoration plan (WQHRP) that includes total maximum daily loads (TMDL). This document focuses on sediment, temperature, habitat, metals and nutrient related water quality impairments in the Ruby TMDL Planning Area. 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 will provide conditions that can support all identified uses. Fishery and associated aquatic life, recreation or drinking water uses are usually the most sensitive considerations in the Ruby watershed when developing TMDLs. This document combines an overall watershed restoration strategy along with creation of 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 (MDEQ).

The whole length of the Ruby River, from the confluence of the thee forks of the Ruby to the confluence with Beaverhead River, is identified as impaired on Montana's 303(d) list. In addition, 23 tributaries were listed in 1996, 18 of which are still considered impaired. The Ruby Reservoir was also listed in 1996, but is no longer considered impaired after more recent data was considered.

The Ruby River watershed encompasses approximately 623,000 acres in Madison County in southwest Montana. The Ruby Watershed drains portions of 5 mountain ranges. The southern portion of the Ruby River drainage originates in the Gravelly, Snowcrest, Greenhorn, and the southern portion of the Ruby Range. The Tobacco Root Mountains and the Ruby Range flank the east and west sides of the lower watershed. The Ruby Reservoir was constructed on the mainstem of the Ruby River in a canyon located approximately in the center of the watershed.

Source assessments identify agriculture, urban, mining and transportation activities as the primary sources of human caused pollutants in the Ruby Watershed. Restoration strategies for the Ruby River TPA focus on implementing agricultural and road management BMPs and other land, soil, and water conservation practices that relate to near stream channel and vegetation conditions. Restoring instream flow to dewatered stream segments of the Ruby River and several tributaries is another critical component to restoration of the Ruby Watershed. Priority abandoned mines are a source of metals contamination on several water bodies in the Ruby TPA and mine reclamation activities will be necessary on these streams to achieve water quality standards that will support conditions for a fully functioning aquatic ecosystem. The restoration process identified in this document is voluntary, cannot divest water rights or private property rights, and does not financially obligate identified stakeholders unless such measures are already a requirement under existing Federal, State, or Local regulations.

Restoration strategies identified in this document are intended to balance the varying uses of water while adhering to Montana's water quality and water use laws. This document should be considered dynamic, by providing an "adaptive management strategy" approach to restore water quality in the Ruby River Watershed. This water quality plan is intended to identify the knowledge we have at present and to identify a future path for water quality restoration. As more knowledge is gained through the restoration process and future monitoring, this plan may change to accommodate new science and information. Montana's water quality law provides an avenue for using the adaptive management process by providing for future TMDL reviews.

The state is required to support a voluntary program of reasonable land, soil and water conservation practices. MDEQ's approach to this program recognizes that the cumulative impacts from many nonpoint source activities are best addressed via voluntary measures with MDEQ and/or other agency or other forms of professional assistance. This often applies to agricultural situations or small landowner activities along or near streams. The State's voluntary program does not cover all nonpoint source activities since there are local, state and/or federal regulations that apply to certain nonpoint source activities within Montana. Examples where a non-voluntary approach is applicable due to existing regulations include but are not limited to streamside management zone requirements for timber production, minimum septic design and location requirements, local zoning requirements for riparian or streambank protection, and compliance with 310 Law.

The document structure provides specific sections that address TMDL components and watershed restoration. Sections 1.0 through 4.0 provide background information about the Ruby River watershed, Montana's water quality standards, and Montana's 303(d) listings. Sections 4.0 and 5.0 provide TMDL targets and impairment status reports by water body. Sections 6.0 through 9.0 review specific pollutant source assessments, TMDLs and allocations. A review of restoration and follow up monitoring strategies are provided in sections 10.0 and 11.0. Section 12.0 is a review of stakeholder and public involvement during the TMDL process. Many of the detailed technical analyses are provided in appendices. Table E-1 provides a very general summary of the water quality restoration plan and TMDL contents.

Table E-1 provides a summary of the water quality restoration plan and TMDL components discussed in this document.

Table E-1. Water Quality Plan and TMDL Summary Information.

Impaired Water Body Summary	• Of the 27 water bodies originally listed on the 1996 303(d) List, 22 water bodies are considered impaired and have TMDLs prepared in this document. Pollutants addressed by TMDLs include sediment, metals, nutrients, and thermal modification. The following TMDLs are included in this Water Quality Restoration Plan:
	  o Sediment – Alder, Basin, Burnt, California, Coal, Cottonwood, Currant, Garden, Indian, Mill, Mormon, Poison, Ramshorn, Shovel, Sweetwater, Warm Springs, and Wisconsin Creeks as well as Ruby River above and below the Ruby Reservoir, East Fork Ruby River, West Fork Ruby River and Middle Fork of the Ruby River.
	  o Temperature – Lower Ruby River, Mill Creek.
	  o Metals – Ramshorn Creek.
	  o Nutrients – Sweetwater Creek.

Impacted Uses	• Coldwater fishery and aquatic life beneficial uses are negatively impacted from loss of habitat, nutrients, sedimentation, irrigation returns and dewatering. • Fish consumption should be limited due to mercury conditions in Alder Creek. Coldwater fishery and aquatic life beneficial uses are impacted by lead in a few streams.
Pollutant Source Categories	• Agriculture: Grazing, cultivation, and irrigation. Historic channelization and stream encroachment from agricultural clearing. • Urban Activities: Urban runoff near Sheridan. Riparian disturbances (clearing, landscaping, other disturbance); stream encroachment from structures; historical channelization for land development; private roads; storm water runoff. • Public Roads: Forest and county unpaved roads. • Mining: Abandoned mine sites. Active mill site.

TMDL Target Development Focus	• Sediment
	  o Fine sediment in riffles and spawning substrate compared to reference condition.
	  o Channel conditions that affect sediment transport compared to reference condition.
	  o Bank erosion compared to reference condition.
	  o Biological indicators compared to reference condition.
	  o Streambank vegetation comparable to reference condition.
	  o Presence of significant human caused sources.
	• Nutrients
	  o Concentration in the water column.
	  o Benthic algal chlorophyll *a*.
	• Temperature
	  o Temperature conditions compared to natural conditions or;
	  o Canopy density, instream flow, channel width/depth ratio conditions compared to natural conditions and no irrigation returns that will cause standards to be exceeded.
	• Metals
	  o Water chemistry numeric standards.
	  o Sediment metal chemistry targets and toxicity metric used in combination.

Other Use Support Objectives (non-pollutant & non-TMDL)	• Improve native riparian vegetation cover. • Improve instream flow. • Improve instream fishery habitat. • Eliminate unnatural fish passage barriers based on fishery goals. • Improve all irrigation headgates, diversions, and crossing structures to minimize leakage and erosion.

Table E-1. Water Quality Plan and TMDL Summary Information.

Sediment TMDL Summary	• Based on an overall percent sediment load reduction based on individual percent reduction allocations to specific agricultural practices, unpaved roads, and placer mining. Reductions are based on estimates of BMP performance.
Sediment Load Allocation Strategy	• Grazing: 51% reduction in sediment loads from grazing-related bank erosion through implementation of BMPs and other reasonable land, soil and water conservation practices. • Roads: 60% reduction in sediment loading from road related surface erosion achieved by BMP implementation. • Urban and other near stream impacts: Allocation varies by circumstance and considers restoration costs and severity of the source. • Placer Mining and other historic channel manipulations: Allocation varies by circumstance and considers restoration costs and severity of the source. • Future Sources: Continue with BMPs and other reasonable land, soil and water conservation practices to prevent sediment loading from future mining, development, forestry, urban, transportation and agricultural activities. • Develop and implement storm water BMPs for the City of Sheridan. • Comply with MPDES permit requirements. • Manage the stream corridor to facilitate transport of excess historical sediment loads through the system (not a "formal" TMDL load allocation but an important load consideration).
Sediment Restoration and Implementation Strategy	• The restoration strategy ranks assessed sources and provides avenue to include other significant sources with like attributes in future adaptive planning efforts. Addressing the sources in the restoration strategy will likely achieve TMDLs. • The implementation strategy builds on the restoration strategy and further prioritizes restoration site potential by also considering if landowners or stakeholders have interest in restoration.
Metals TMDL Summary	• The TMDL is an equation based on water hardness and stream flow variables. • The only metal TMDL needed was for lead in Ramshorn Creek watershed.
Metals Load Allocation Strategy	• Percent based road and grazing reductions are founded on sediment TMDL allocations. • The remainder of the TMDL is allocated to naturally occurring loads and loads from abandoned mines.
Metals Restoration Strategy	• The sediment TMDLs provide road and grazing restoration approaches for Currant and Ramshorn Creek. • Abandoned mines that need reclamation work are identified; further mining source delineation is needed before restoration work occurs in Ramshorn Creek above the confluence with Currant Creek.
Temperature TMDL and Allocation Summary	• Based on percent reduction of surrogate measures for stream temperature, including increased stream flow, increased canopy cover, and reduction in warming from irrigation returns.
Temperature Reduction Strategy	• Continue agricultural BMPs and other reasonable land, soil and water conservation practices to increase riparian vegetation. • Implement urban BMPs to reduce riparian clearing and increase native vegetation in riparian areas. • Improve irrigation efficiency in conjunction with securing instream flows and reducing irrigation returns.
Nutrients TMDL and Allocation Summary	• The TMDL is an equation based on nutrient targets and average daily instream flow conditions. • Nutrient TMDLs are provided for only one stream, Sweetwater Creek. The allocation indicates that the TMDLs are allocated fully to natural and agricultural sources in combination.

Table E-1. Water Quality Plan and TMDL Summary Information.

Nutrient Load Reduction Strategy	• Continue and expand agricultural BMPs including grazing, corral, irrigation and crop management activities. • Nutrient allocations will be achieved in part through implementation of restoration practices outlined for sediment TMDLs.
Nutrient Restoration Strategy	• The restoration strategy indicates stream segments that were identified as sediment sources also contribute nutrients from grazing activities. A corral was identified as a restoration priority. Only a small portion of the watershed is managed for irrigated crop production but this area is identified as a restoration priority.
Other Restoration Objectives	• Improve streambank stability and instream fish habitat through protection of riparian areas on all lands. • Protect riparian habitat and study feasibility of expanding beaver activity in headwaters. • Pursue cooperative approaches to improve flow conditions during low flow periods in lower Ruby River, Mill Creek, Sweetwater Creek, California Creek, Ramshorn Creek, Indian Creek, and Wisconsin Creek. • Complete mine site restoration at priority abandoned mines in the Browns Gulch, Mill Gulch (Alder drainage) and Middle Fork Mill Creek drainages.

SECTION 1.0
INTRODUCTION

1.1 Document Description

This document is a framework water quality and habitat restoration plan (WQHRP) that includes total maximum daily loads (TMDL). This document focuses on sediment, habitat, metals and nutrient related water quality impairments in the Ruby TMDL Planning Area. The primary objective is to develop an approach to restore and maintain the physical, chemical, and biological integrity of streams in the sub-basin. Clean Water Act objectives include restoration and maintenance of these watershed attributes, which also requires the development of TMDLs. This document combines a framework watershed restoration strategy along with creation of TMDLs.

TMDL development and water quality restoration planning is essentially a problem-solving process. The first steps include assessment of the health of 303(d)-listed streams and identification of causal mechanisms responsible for impairment. Numerical reference parameters provide the basis for TMDL target development and for determining the degree to which stream conditions depart from desired conditions. This deviation from desired conditions provides much of the basis for validating impairment conditions. Where impairment is validated, restoration objectives are developed to define conditions that, if implemented, would result in meeting the restoration objectives that lead to full support of beneficial uses.

Montana’s water quality standards include consideration of many water uses including fishery and aquatic life, agricultural, industrial, drinking water, and wildlife uses. Montana State law defines an impaired water as a water or stream segment for which sufficient, credible data indicate that the water or stream is failing to achieve compliance with applicable water quality standards (Montana Water Quality Act, Section 75-5-103). Compilation of this list by states is a requirement of section 303(d) of the Federal Clean Water Act. Both Montana State Law (Montana Water Quality Act; Section 75-5-703) and the Clean Water Act require development of TMDLs for waters on this list where a pollutant results in impairment. In a number of cases pollutants are not always the most limiting factor for instream beneficial use, and therefore, if implemented without other restoration approaches the TMDL itself will not fully restore uses. For example, sediment sources may be reduced to acceptable levels in a watershed, but fish habitat such as lack of pools and lack of holding cover may still limit the fishery. This plan also includes restoration strategies where habitat or other conditions impair a beneficial use but a clear link between the habitat condition and an excess pollutant load is lacking.

The Ruby River watershed encompasses approximately 623,000 acres in Madison County in southwest Montana. The whole length of the Ruby River, from the confluence of the thee forks of the Ruby to the confluence with Beaverhead River, is identified as impaired on Montana’s 303(d) list. In addition, 23 tributaries were listed in 1996, 18 of which are still considered impaired. The Ruby Reservoir was also listed in 1996, but is no longer considered impaired after more recent data was considered. There are also other streams in this watershed that may be impaired, but have not been assessed to a degree that provides enough information for Clean Water Act objectives. Stream that are identified in this document for future 303(d) monitoring include Rob and Ledford Creek. Some of these streams are identified in this document as needing future assessment if there are indications that a stream may be impaired. Water bodies identified on Montana's impaired water list that are addressed in this report include:

- Alder Creek
- Basin Creek
- Burnt Creek
- California Creek
- Coal Creek
- Cottonwood
- Currant
- East Fork Ruby River
- Garden Creek
- Harris
- Hawkeye Creek
- Indian Creek
- Middle Fork Ruby River
- Mill Creek
- Mill Gulch
- Mormon Creek
- North Fork Greenhorn Creek
- Poison Creek
- Ramshorn Creek
- Ruby River
- Ruby River Reservoir
- Shovel Creek
- Sweet Water Creek
- Warm Spring Creek
- West Fork Ruby River
- Wisconsin Creek

Based on these analyses, watershed planners, in collaboration with stakeholders, can develop a specific strategy or set of solutions to meet the restoration objectives and remedy the identified problems. This results in a comprehensive plan to restore the bodies of water to a condition that meets Montana's water quality standards and supports designated beneficial uses.

1.2 Document Organization

This plan is organized as follows:

- This section (Section 1.0) provides an introduction.
- Section 2.0 provides a summary of watershed characteristics.
- Section 3.0 provides additional detail on the 303(d) list, the TMDL development process and Montana Water Quality Standards.
- Section 4.0 provides development rationale for water quality targets which are based on reference values, water quality standards and beneficial use support objectives.
- Section 5.0 compares the existing conditions of each water body to the water quality targets developed in Section 5.0.
- Section 6.0 provides a temperature (thermal loading) source assessment, TMDLs, allocations, margin of safety, seasonal considerations and a restoration approach for thermally impaired streams in the Ruby Watershed.
- Section 7.0 provides a sediment source assessment, TMDLs, allocations, margin of safety, seasonal considerations and a restoration approach for streams in need of sediment TMDL.
- Section 8.0 provides a nutrient source assessment, TMDLs, allocations, margin of safety, seasonal considerations and a restoration approach for streams in need of nutrient TMDLs.
- Section 9.0 provides a metals source assessment, TMDLs, allocations, margin of safety, seasonal considerations and a restoration approach for streams in need of nutrient TMDLs.
- Section 10.0 provides an integrated summary of restoration approaches for all pollutants in the Ruby Watershed.
- Section 11.0 provides an integrated monitoring guidance for future efforts.
- Section 12.0 is a public outreach and stakeholder involvement section.
- Section 13.0 includes the references.

SECTION 2.0
WATERSHED CHARACTERIZATION

This watershed characterization provides an overview of watershed characteristics in the Ruby River Planning Area (TPA). It is intended to provide a general understanding of physical, climatic, hydrologic, and other ecological features within the planning area, and serve as foundational support for TMDL planning and implementation.

2.1 Physical Characteristics

The Ruby River watershed is located in Madison County in southwestern Montana. The Ruby Planning Area comprises the entire Ruby 4th field HUC sub-basin (watershed), and contains five 5th field and thirty 6th field HUCs sub basins (Table 2-1 and Appendix A – Map 1).

Table 2-1. Ruby River Watershed 5th Level Subbasins.

Subbasin	Hydrologic Unit Identifiers (5th field HUC)
Upper Ruby	1002003010
Sweetwater Creek	1002003020
Middle Ruby	1002003030
Alder Gulch	1002003040
Lower Ruby	1002003050

2.1.1 Climate

The most detailed climatological station in the watershed is Cooperative Observer (COOP) station number 240110-2 (Alder 17S), maintained by the National Weather Service (NWS). It is located 17 miles south of Alder, Montana at an elevation of 5,800 feet.

Average annual precipitation in the Ruby River watershed is 18 inches, mostly falling in the months of May and June. Figure 2-1 illustrates monthly average precipitation levels.

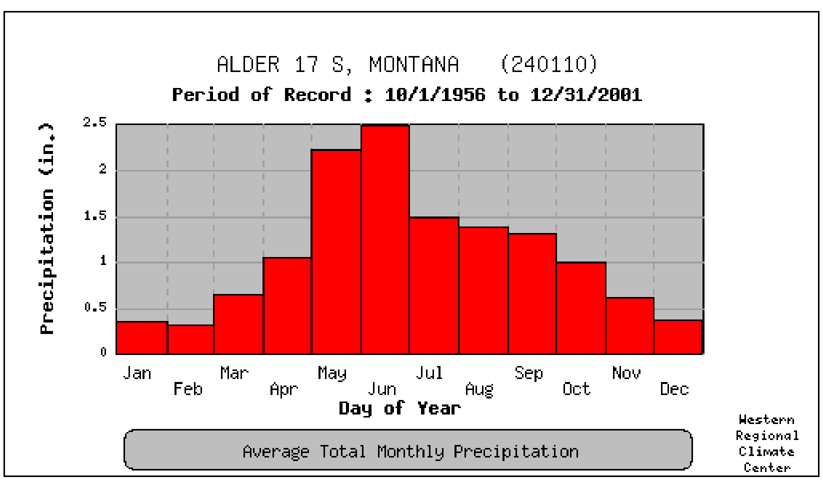

Figure 2-1. Average Total Monthly Precipitation at Alder, MT (WRCC, 2002).

Precipitation in the area occurs as both rainfall and snowfall. Mean annual precipitation as rain is 13.3 inches. Rainfall in the area generally is not flashy. For example, a 2-year event will yield only 0.7 inches in 6 hours or 1.3 inches in 24 hours (Table 2-2).

Table 2-2. Rainfall Precipitation Frequency Interval Table for Study Area (RWRP, 2001).

6 Hour Duration		24 Hour Duration	
Interval	Precipitation (inches)	Interval	Precipitation (inches)
2 year	0.7	2 year	1.3
5 year	0.9	5 year	1.6
10 year	1.1	10 year	1.8
25 year	1.4	25 year	2.2
50 year	1.5	50 year	2.6
100 year	1.6	100 year	2.8

The mean annual snowfall is 50.6 inches at this site, most occurring from November to April (Figure 2-2). High flows on the Ruby River in May and peak flows in June result from melting of the snowpack.

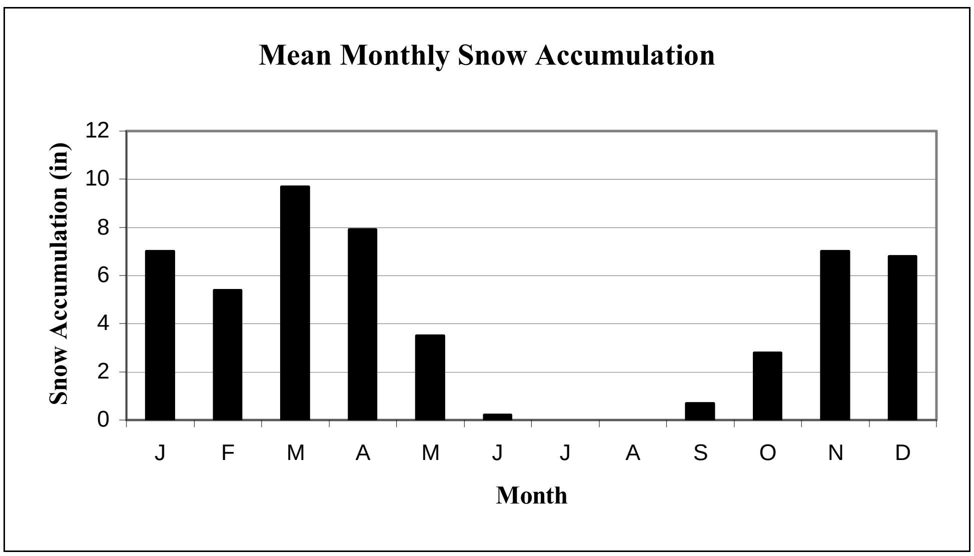

Figure 2-2. Mean Monthly Snowfall in the Study Area.

The mean annual air temperature as recorded by the Alder 17S weather station is 41.5 degrees Fahrenheit (WRCC, 2002). The highest temperatures occur in July, with a mean daily temperature of 62.7 degrees Fahrenheit. The lowest temperatures occur in January, with a mean temperature of 22.2 degrees Fahrenheit (Figure 2-3).

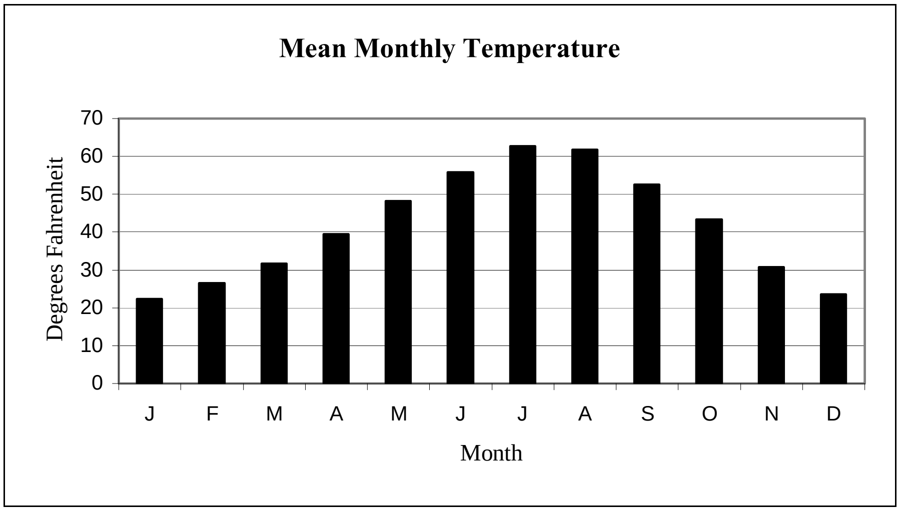

Figure 2-3. Mean Monthly Temperatures at Alder 17S, Average of 1956-2004 (WRCC, 2004).

2.1.2 Hydrology

2.1.2.1 Hydrography

The Ruby Watershed drains portions of 5 mountain ranges. The southern portion of the Ruby River drainage originates in the Gravelly, Snowcrest, Greenhorn, and the southern portion of the Ruby Range. The Tobacco Root Mountains and the Ruby Range flank the east and west sides of the lower watershed (Appendix A – Map 1). These southern headwater areas are within the Middle Rockies – Southwest Montana Barren Mountains ecoregion and the northeast headwaters are in the Northern Rockies - Tobacco Root Mountains ecoregion (Woods et al., 1999). The watersheds transition into the Montana Valley and Foothill Prairies – Dry Gneissic-Schistose-Volcanic Hills and then into the Dry Intermontane Sagebrush Hills ecoregions near the confluence of the Ruby River with the Beaverhead River just upstream of Twin Bridges, MT. The Ruby River flows roughly 80 miles north and east from its headwaters to the mouth (Bahls, 2001).

2.1.2.2 Ruby River Reservoir

The Ruby River Reservoir is a 38,000 acre-foot impoundment located on the Ruby River six miles south of Alder, Montana (MFWP, 1989). The reservoir, which was constructed in 1938, is managed by the Montana Department of Natural Resources and the Ruby River Water Users Association. The reservoir is used primarily for irrigation water storage and flood control. Most of the stream flow just below the reservoir is diverted for irrigation through the Vigilante and West Bench Canals. The West Bench Canal is roughly 12 miles long and is able to transport a flow of 173 cfs (Ruby River Reservoir Task Force, 1995). The Vigilante Canal is approximately 26 miles long and has a capacity of 182 cfs (Ruby River Reservoir Task Force, 1995).

2.1.2.3 Flow

Two USGS gauging stations above and below the reservoir have been in operation on the Ruby River from 1938 to present. Other stations located on the mainstem and some tributaries were in operation for short or intermittent duration (Table 2-3 and Appendix A – Map 2).

Table 2-3. USGS Gauge Station Site Locations and Data Availability.

Station Number	Station Name	Period of Record	Lat	Long
6019000	Ruby River above Warm Springs Creek, near Alder	1948-53	44 59 40	111 57 50
6019400	Sweetwater Creek, near Alder	1974-91 (Peak flow only)	45 04 39	112 13 32
6019500	**Ruby River above Reservoir, near Alder**	**1938-present**	45 11 33	112 08 30
6019800	Idaho Creek near Alder	1960-85 (Peak flow only)	45 12 00	112 08 00
6020000	Ruby River at dam site, near Alder	1911-1914; 135-1937	45 14 00	112 07 00
6020600	**Ruby River below reservoir near Alder**	**1962-present**	45 14 32	112 06 36
6021000	Ruby River near Alder	1929-39; 1946-61	45 17 30	112 06 00
6021500	Ruby River at Laurin	1946-61	45 21 00	112 07 00
6022000	Ruby River below Ramshorn Creek near Sheridan	1946-53	45 25 00	112 12 00
6022500	Ruby River near Sheridan	1946-51	45 26 00	112 15 00
6023000	Ruby River near Twin Bridges	1940-43; 1946-65; 1979-81	45 30 28	112 19 48

Daily mean streamflow on the Ruby River above the reservoir for the period of record (1938-2001) shows a general increase in both peak and base flow from 1938 through 1984, then leveling off after the peak flow of record in 1984 (nearly 4000 cfs) (Figures 2-4 and 2-5). These figures represent flow patterns on the Ruby River above controlled flow conditions. Flow at the station below the reservoir is not included because major diversions drastically reduce the stream flow approximately 3 miles downstream. The streamflow data from this site does not represent most of the Ruby River below the dam. The high flow in 1984 severely eroded streambanks in many areas of the Ruby River. Streambank vegetation removal appears to have contributed to the effects of the flood.

Below the reservoir, daily mean and peak streamflow data do not show any obvious trends, as reservoir storage tends to even out the extremes of flow patterns to meet irrigation demands. According to Ruby Reservoir Operating Guidelines (DNRC and RRWUA, 2001) peak irrigation demand is typically 20,000 to 25,000 miner's inches (500 to 625 cfs). In mid-July irrigation demands decrease to 12,000 to 15,000 miner's inches (300 to 375 cfs).

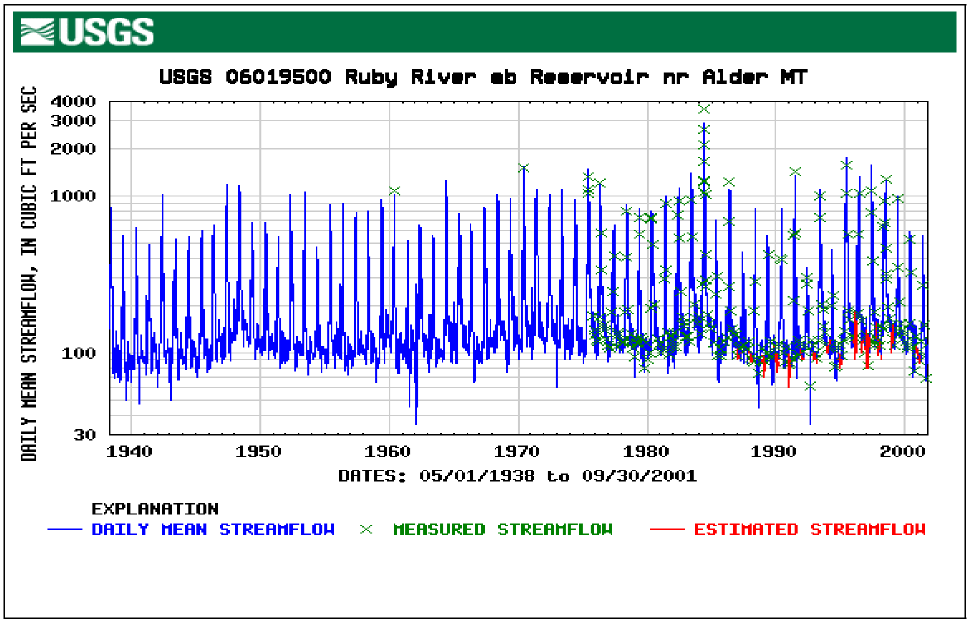

Figure 2-4. USGS Streamflow Data for Ruby River Above the Reservoir.

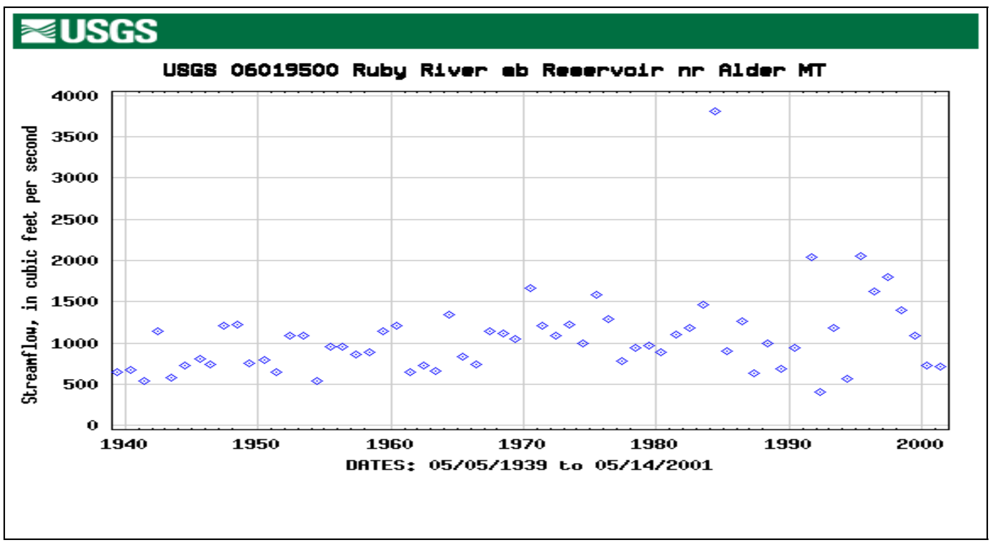

Figure 2-5. Peak Streamflow for Ruby River Above Ruby Reservoir, 1939-2001.

2.1.3 Stream Morphology/Geomorphology

Ruby River channel types have been assessed using the Rosgen Stream Classification System. This system provides a method for identifying streams according to morphological characteristics (Rosgen, 1996). The morphological characteristics include factors such as channel gradient, sinuosity, width/depth ratio, dominant particle size of bed and bank materials, channel entrenchment, and channel confinement. An automated GIS-based Rosgen level 1 stream type classification was developed for the Ruby River watershed using digital elevation models (DEMs) and a stream layer re-digitized from aerial photos. The computer model only reliably identifies A, B, C, and E stream types. These stream types were then confirmed and adjusted based on field data. Rosgen stream types are listed below in Tables 2-4 and 2-5.

Most of the Rosgen stream types are distributed along the dendritic channel network as expected, with E type channels lower down in the Ruby River floodplain and B and C type channels towards the headwaters. The Ea and Eb Rosgen types represent channels with A or B stream slope characteristics that are not entrenched. These stream types are generally due to a young geologic setting or high uplift rates and naturally well-armored channel beds resulting from inherited glacial substrate.

Table 2-4. Rosgen Stream Classifications for the Upper Ruby River.

Drainage Name	Total Stream (Miles)	Stream Type (Generally Downstream to Upstream)	Miles per Stream Type	Percent Total Stream Miles (%)
Upper Ruby River	23.1	C4	18.2	79
		F4	4.9	21
Middle Fork Ruby	13.9	E4	13.9	100
Coal Creek	7.0	F4	2.4	34
		C4b	2.9	41
		B4a	1.8	25
Basin Creek	2.3	E4b	1.5	65
		E4a	0.5	22
		B4a	0.3	13
Shovel Creek	1.3	E4	1.2	92
		E4a	0.1	8
Hawkeye Creek	2.1	E4	1.5	71
		E4b	0.6	29
Poison Creek	4.4	C5b	1.6	36
		B4	1.6	36
		B4a	1.2	27
East Fork Ruby	9.4	B4	1.7	18
		B4a	6.1	65
		E4a	1.6	17
Burnt Creek	4.5	B4	0.4	9
		E4a	2.8	62
		B4a	1.3	29
Sweetwater Creek	22.4	G5	5.2	23
		E5	11.2	50
		B5c	2.6	12
North Fork Sweetwater	3.4	E5	3.4	100
Warm Springs	8.5	E4	1.3	16
		C4	0.5	6
		E4b	0.6	7
		E5	2.5	30
		B4	3.6	42
Cottonwood Creek	6.1	E4b	1.2	20
		E4a	3.1	51
		E5a	1.8	29
Mormon Creek	3.0	E4b	1	33
		E4a	1.3	43
		E5b	0.7	23
Garden Creek	6.7	B4	1.7	25
		A4	1.5	22
		E4a	3.5	52

Table 2-5. Rosgen Stream Classifications for the Lower Ruby River.

Drainage Name	Total Assessed Stream (Miles)	Stream Type (Generally Downstream to Upstream)	Miles per Stream Type	Percent Total Stream Miles (%)
Lower Ruby River	24.2	E4	4.8	20
		F4b	1.1	5
		C4	16.3	67
		B	0.4	2
		F4	1.6	7
Mill Creek	8.7	B4c	3.0	34
		B4	1.3	15
		E4	0.5	6
		C4b	0.1	1
		B3	3.2	37
		B3a	0.6	7
Wisconsin Creek	10.5	B4	6.7	64
		E4b	0.6	6
		C4b	1.1	10
		C3a	1.2	11
		E4a	0.9	9
Indian Creek	7.8	F4b	0.5	6
		B4	0.8	10
		C4a	1.6	21
		C3a	2.3	29
		B3a	1.2	15
		A3	1.4	18
Alder Creek	4.7	C5	0.5	11
		C4	2.2	47
		B4	1.9	40
Clear Creek	1.7	F	1.7	100
California Creek	1.4	E5	0.3	21
		B4	0.6	42
		C5b	0.2	14
		A4	0.3	21
Ramshorn Creek	5.9	A5e	0.6	10
		B4	0.6	10
		E3a	0.6	10
		E4a	4.1	70
Browns Gulch	2.4	A	2.4	100
Currant Creek	3.7	A4	3.7	100

2.1.3.1 Physical Bank Inventory

During the summer of 1998, the NRCS conducted a rapid inventory of the Upper Ruby River in cooperation with the Ruby Valley Conservation District. The inventory was conducted using GPS and GeoLink software while floating the upper section of the Ruby River (above Ruby Reservoir). Some of the channel physical condition data from the streambank inventory are summarized below (Table 2-6).

Sinuosity is the ratio between the channel length of a river and the straight-line distance of the valley through which the river flows. A greater sinuosity indicates that the river meanders to a greater extent. Generally speaking, sinuosity of the upper Ruby River increased from 1961 to 1998 (Alvin, 1998). Section 1 is at the lower end of the upper reach of the Ruby River, near the dam. Section 2 is in the middle of the reach. Section 3 is at the upstream end of the upper reach of the Ruby River.

Table 2-7 summarizes the lengths of erosion, riprap, and vegetative fabric inventoried on the Ruby River upstream of the reservoir during the 1998 study. Bank erosion assessments were completed for the 2003 TMDL sediment source assessment and are summarized in the sediment source assessment section of this document (Section 7.0).

Table 2-6. Comparison of Sinuosity Between 1961 and 1998 (Modified from Alvin, 1998). All Lengths Are in Meters.

Site	1961 River Length	Valley Length	1961 Sinuosity	1998 River Length	Valley Length	1998 Sinuosity
1	9525	4754	**2.0**	11240	4754	**2.4**
2	10461	5982	**1.7**	13410	5982	**2.2**
3	5132	2900	**1.8**	5436	2900	**1.9**

Erosion and Bank Alterations:

Table 2-7. Linear Bank Features (modified from Alvin 1998).

Feature	Meters	Feet	Miles	% of Total
Total River	*62782*	*206519*	*39*	*100*
Erosion <5 Feet High	10964	35970	6.8	17
Erosion 5-10 Feet High	805	2641	0.5	1
Erosion >10 Feet High	221	725	0.2	0.5
Riprap	10996	36076	6.8	17
Vegetative Fabric	6303	20679	3.9	10

All areas of bank erosion were mapped but no assessment was made as to whether erosion is natural or management-induced. Results from the physical streambank assessment are illustrated in Map 3 of Appendix A. This information provides an overall view of potential problem areas.

The effects of channel manipulation on the Ruby River have been an issue for decades. An earlier stream inventory (SCS, 1976) found that 2.6% of the Ruby River from the reservoir down to the mouth had channel alterations, primarily as channel straightening. This study also documented 23,893 linear feet of riprap, which is equivalent to 4.5% of the streambank length inventoried. By 1976 riprap and rock jetties had already been used for "a great many years" (SCS, 1976). Channel straightening and armoring on the Ruby was used as a case study in a River Mechanics Seminar in 1972, in which the panel discussed the effects of channel manipulation on the system, including lateral erosion and vertical adjustments of the channel upstream and downstream of the altered area (Miller and Skinner, 1972).

Stream condition and streambank erosion were mapped during 2003 and 2004 on listed streams in the Ruby watershed. These data, as well as data from previous condition assessments conducted by USFS and BLM, are summarized for each stream in the Impairment Determination (Section 4.0).

2.1.4 Topography

The headwaters of the Ruby River originate in the Gravelly Range to the east and the Snowcrest Range to the west. The highest point in the watershed is 10,655 feet elevation at Hogback Mountain (Holsman, 1997). Several other peaks in the Gravelly and Snowcrest Ranges are also greater than 10,000 feet. The Ruby River Reservoir is at 5,400 feet above sea level (USDA Forest Service, 1992), and the elevation at the mouth of the Ruby River is 4,360 feet (Holsman, 1997). The Gravelly Range has gently sloping topography, with long pediment slopes forming a more gradually sloping terrain to the east of the valley, while the Snowcrest range is characterized by sharp ridges and steep slopes, creating a more abrupt boundary to the valley on the west side. The Ruby Range and the Tobacco Root Mountains flank the lower Ruby Watershed below Ruby Reservoir. The aspect and topography of mountain ranges in the Ruby River valley can be seen in Map 1 of Appendix A.

2.1.5 Geology and Soils

Quaternary deposits in the Ruby valley consist of glacial deposits, alluvial fans and gravels, and landslide deposits. Tertiary shales and sandstones, and some volcanic rocks outcrop intermittently throughout the upper Ruby watershed (Appendix A – Map 4). The upper Ruby River flows south to north through the axial part of a broad, asymmetrical syncline composed primarily of Upper Cretaceous sediments of the Colorado Formation (shale member) (USDA Forest Service, 1992). The limbs of the syncline are composed primarily of Paleozoic and Mesozoic sediments. The Snowcrest Range is formed by the overturned west limb of the syncline, and the more gently sloping Gravelly Range is formed by the dipping east limb (Figure 2-6) (USDA Forest Service, 1992).

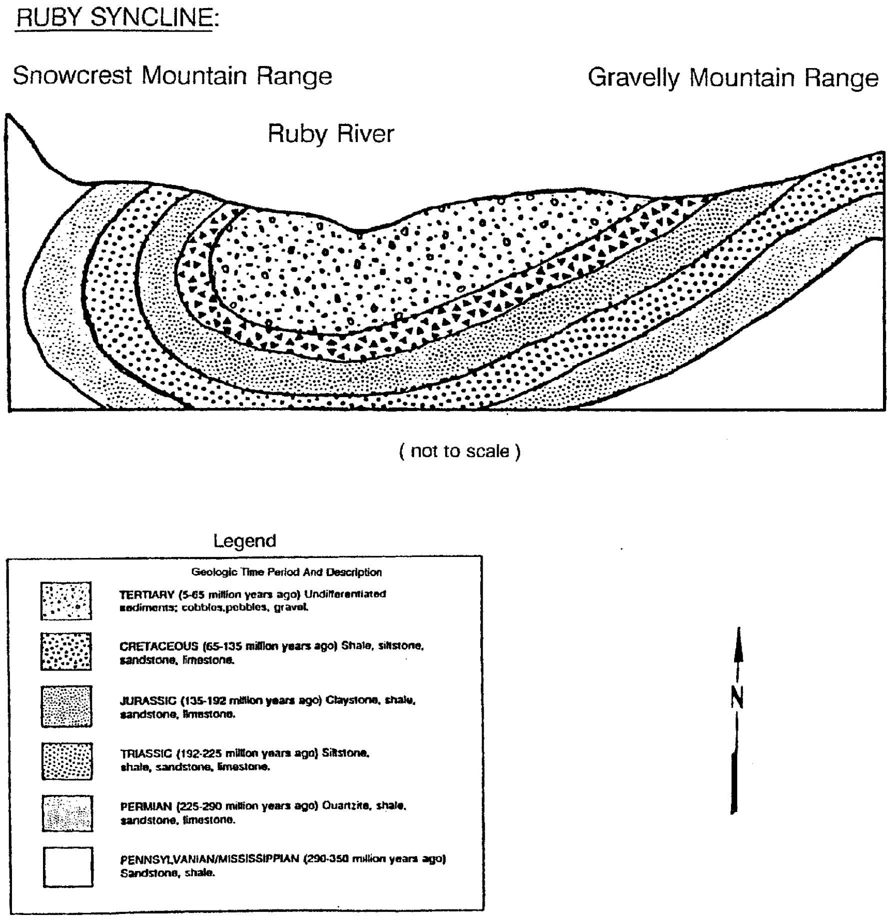

Figure 2-6. Schematic of Ruby River Syncline, as it Would be Seen Looking Downstream (USDA Forest Service, 1992).

The landscape of the upper Ruby River watershed is dominated by landslide deposits, which may range in age from Late Cretaceous (Beaverhead Conglomerate) to the present (active scarps in 1984 in Warm Springs and Spring Creek) (Ed Ruppel, pers. comm., 2002). These deposits occur on both the west (Snowcrest) and east (Gravelly) sides of the valley, but appear to be more prominent on the east side where Cretaceous black shale forms a dip-slope from the Gravelly Range toward the Ruby River.

The landscape of the Ruby Valley is slowly shifting due to the influence of tectonic uplift combined with the geologic structure. Within this landscape the upper Ruby River is cutting both laterally and vertically, and is as a result reactivating old landslides and creating new ones. The east side of the basin dips westward toward the Ruby River. As the Ruby River downcuts, the dipslope is continually destabilized, resulting in mass failures. Tributaries of the Ruby River adjust to the lowering of the main river channel by downcutting, destabilizing slopes along the tributaries as well (USDA Forest Service, 1992).

The three major series of soils present in the Ruby River Basin are the Musselshell, Trimad, and Amesha series. Upland soils fall mainly within the Bridger and Hanson series (RWRP, 2001).

Soils on the east side of the Ruby River are generally deep, moderately well to somewhat poorly-drained silty clay loams, silty clays, and clays. About half of the east side of the valley is characterized by slumps and glacial till (Page, 1978). On the west side of the valley, "heavy textured" grassland soils occur on alluvial bottoms and areas of relatively gentle topography, while sandy and gravelly loam soils occur on steeper slopes (Page, 1978). The most highly erodible (most easily eroded) soils are located in large floodplain areas along the Ruby River. Other sensitive areas are at the toe slope of the glacial outwash fan and pediment area at the base of the Tobacco Root mountains, in the gravelly mountains, and in the Sweetwater Creek drainage (Appendix A – Map 3).

2.2 Biological Characteristics

2.2.1 Vegetation

Vegetation is alpine tundra at the highest elevations, mixed conifer forest on upper slopes, and mixed grassland at lower elevations (Bahls, 2001). Forested areas of the Ruby River watershed are dominated by Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), whitebark pine (*Pinus albicaulis*), limber pine (*Pinus flexilis*), and quaking aspen (*Populus tremuloides*) (Page, 1978). Riparian areas are dominated by Geyer, Bebbs, and Booth willow (*Salix geyeriana*, *S. bebbiana*, and *S. boothii*, respectively) in lower areas and by buffaloberry (*Shepherdia argentea* and *S. canadensis*), silverberry (*Elaeagnus commutata*), and Wolf's willow (*Salix wolfii*) in the upper watershed. Some reaches of the upper Ruby River are currently dominated by Rocky Mountain Juniper (*Juniperus scopulorum*). The herbaceous layer along streams is dominated either by sedges or introduced pasture grasses. General vegetation cover types (i.e. forested, wetland, grassland) are illustrated on the Land Cover Type map (Appendix A – Map 4).

2.2.2 Fisheries

Most of the 3030(d) listed water bodies in the Ruby River watershed are considered impaired for support of aquatic life and coldwater fisheries. For the purpose of fisheries investigations the Ruby River Watershed can be examined as three systems; i.e., a lower river and an upper river environment separated by Ruby River Reservoir.

2.2.2.1 Ruby River Reservoir

The Ruby River Reservoir provides fisheries for rainbow, cutthroat, and brown trout and mountain whitefish. Rainbow and cutthroat trout have been stocked to augment wild populations in the past. Management goals include maintaining the reservoir as a wild self-sustaining fishery.

A drought period from 1988 through 1992 marked extremely low storage pools, dropping to a minimum of only 500 acre feet in 1992 (Oswald, 2002b). In early September 1994, the reservoir was nearly emptied. As a result, a channel was cut into the sediments at the upstream end of the reservoir, sending a large sediment pulse downstream and causing a large fish kill below the reservoir. Response to this event included the formation of the Governor's Ruby River Task Force, which implemented a minimal storage pool of 2,600 acre feet and fisheries target pools of

6,000 acre feet and 10,000 acre feet. In 1999, dry climatic conditions dropped the reservoir to the minimum fisheries target pool (Figure 2-7).

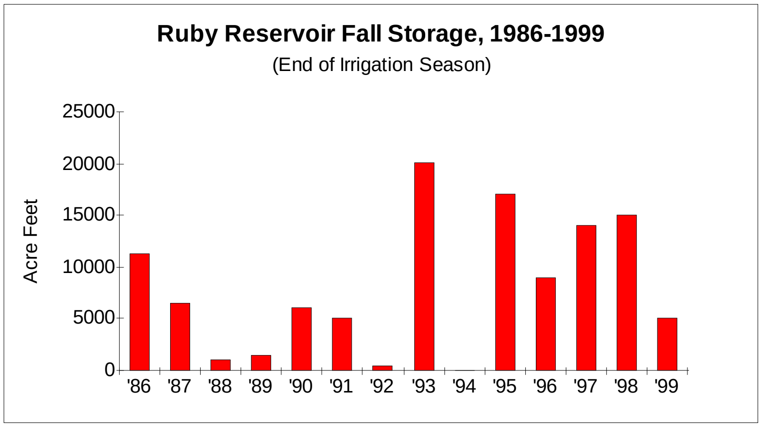

Figure 2-7. Fall Storage Levels in Ruby Reservoir, 1986 – 1999. Chart Recreated from Oswald (2002b). Numbers Best Approximated to Show Trends.

2.2.2.2 Lower Ruby River

In September 1994, Ruby Reservoir was inadvertently drained due to persistent drought conditions and high irrigation demand. Heavy sediment entrainment into the river, coupled with extremely low flow resulted in a complete deoxygenation in the uppermost river mile and a significant fish kill estimated at 10,000-15,000 fish, including brown and rainbow trout (Oswald, 2000a).

A number of river sections in this portion of the river have been analyzed by MDFWP in response to the dewatering of Ruby Reservoir in 1994 or in response to the establishment of more fishing access sites. According to Oswald (2000b), the lower Ruby River supports relatively abundant populations of brown trout. The size composition and abundance of these populations is dependant upon distance from the reservoir tailwater, dominant habitat type and conditions, and flow release regime from the dam. The rainbow trout population of the Ruby River tailwater is largely dependant upon the spill of Eagle Lake strain fish that have been stocked into Ruby Reservoir (Oswald, 2000a).

In 1995, *Myxobolus cerebralis*, the causative factor for whirling disease was found in the Ruby. Whirling disease has been considered the limiting factor for brown trout recruitment in the lower river. Generally brown trout are more resistant to whirling disease than other species but more than 100 years of wild brown trout recruitment in the absence of the disease in Montana may have resulted in a population composed of individuals naïve to the disease and a loss of some of the resistance (Oswald, 2000a). Angler survey data suggest that brown trout populations have maintained if not flourished under fishing pressure from increased pubic angling in recent years.

2.2.2.3 Upper Ruby River

The upper Ruby River fishery (i.e. Three Forks Section) is dominated by a hybridized group of rainbow trout and westslope cutthroat trout (Oswald, 2000a). Mountain whitefish also occur in this area of the river along with resident non-game species; mottled sculpin, longnose dace, and longnose and white suckers. Rainbow densities declined dramatically in 1989 and remained low throughout the drought-influenced period spanning from 1985 through 1994. During the 1997-1999 period, population density increased markedly under favorable flow regimes.

The lower portion of the upper river (Greenhorn Section) is dominated by brown trout and rainbow trout. Brown trout density and standing crop substantially exceeded that of rainbow trout in this section. Comparisons with the Three Forks Section indicate that the carrying capacity of the more productive habitat of the Greenhorn Section was strongly dominated by brown trout biomass (Oswald, 2002a).

Arctic fluvial grayling reintroduction efforts initiated in 1997 in the upper Ruby River have had limited success. The reintroduction effort is in response to the decline of fluvial arctic grayling to 4-5% of their historic range, primarily in a remnant population in 50 to 80 miles of the Big Hole River. Although stocked populations of grayling have demonstrated an affinity for the fluvial environment and maintained high population density throughout the stocked reach, they appear to be limited by winter survival. According to Oswald (2002a) the artificial placement of the large standing crop of fluvial arctic grayling into the apparently limited environment of the Three Forks Section has not resulted in deleterious affects on the wild RbxCT population density or condition. Oswald speculates that this may be indicative of ample habitat niche at high flows or may be due to differential niche occupation by the species. Grayling reproduction has been documented for the last two years, even if at low levels (Magee Pers. Comm., 2002).

2.2.2.4 Ruby River Tributaries

The tributaries to the Ruby River exhibit a diverse species composition. Pure genetic westslope cutthroat trout have been identified in 19 streams or stream segments (secondary tributaries) within the watershed (Appendix A – Map 5). These genetically pure populations of westslope cutthroat trout generally exist in streams where they have a sympatric relationship with the mottled sculpin or introduced brook trout. Where introduced rainbow trout (another *Oncorhynchus spp*.) have colonized a stream, genetic introgression has occurred. Stream barriers have precluded rainbow establishment in some reaches and have maintained pure westslope populations. Table 2-8 provides a summary of species composition and genetic purity of westslope cutthroat trout for tributaries of the Ruby River.

Table 2-8. Summary of Ruby River Drainage Tributary Data for Species Composition and Genetic Purity of Westslope Cutthroat Trout (Oswald, 2000a).

Stream	Year	Species	WCT Genetic Analysis
Greenhorn Mtns			
Idaho Creek	1994	WCT	100%
N.F. Greenhorn Creek	1994	WCTxRB, EB, MS	98%
Snowcrest Mtns			
Spring Creek	1995	None	NA
Ledford Creek	1994	LL, EB, MS	NA
Robb Creek	1994	WCT, EB, MS	98%
Ruby Mtns			
Sweetwater Creek	1992	RB, RBxCT, MS	NA
N.F. Sweetwater Creek	1994	WCT, MS	100%
N.F. Sweetwater Creek	1995	WCTxRB, MS	95%
W.F. Sweetwater Creek	1994	WCT, MS	100%
Cottonwood Creek	1992	CT, RB, RBxCT, EB, MS	75%
Garden Creek	1992	RB, MS	NA
Hinch Creek	1992	WCTxRBxYCT, MS	84%

RB-Rainbow trout
WCT-Westslope cutthroat trout
YCT-Yellowstone cutthroat trout
EB-Brook trout
MS-Mottled sculpin
LL-Brown trout
x-denotes hybridization

2.2.3 Species of Special Concern

This section provides a summary of species distribution and status concerning rare, threatened, or endangered aquatic species known to occur in the planning area. It should be noted however, that this is not intended to be an exhaustive presentation of issues relative to noted species.

Native fish species of special concern may influence the management of natural resources in the Ruby watershed. Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) are present in the Ruby Planning Area with populations occurring throughout the basin (Appendix A – Map 5). Westslope cutthroat trout is listed on the State of Montana's list of Animal Species of Special Concern (Carlson, 2003) with a state rank of S2. An “S2” rank is described as “imperiled because of rarity or because of other factors demonstrably making it very vulnerable to extinction throughout its range.” It is also listed as “sensitive” by the USFS (“animal species ... for which population viability is a concern as evidenced by significant downward trend in population or a significant downward trend in habitat capacity”) and “special status” by the BLM (“federally-listed Endangered, Threatened, or Candidate species or other rare or endemic species that occur on BLM lands) (Carlson, 2003). Section 2.2.2.4 above describes westslope cutthroat trout population distribution and purity in the Ruby River watershed.

Montana Arctic grayling (*Thymallus arcticus montanus*) has been introduced in the main stem of the Ruby River above Ruby River Reservoir. It is on the State of Montana's list of Animal

Species of Special Concern with a state rank of S1. An “S1” rank is described as “critically imperiled because of extreme rarity or because of some factor(s) of its biology making it especially vulnerable to extinction.” It is also listed as “sensitive” by the USFS (“animal species ... for which population viability is a concern as evidenced by significant downward trend in population or a significant downward trend in habitat capacity”) and is a candidate species for listing under the federal Endangered Species Act of 1973 (Carlson, 2003). Candidate species are described as those that the U.S. Fish and Wildlife Service has sufficient information on biological status and threats to propose to list them as threatened or endangered.

2.3 Cultural Characteristics

2.3.1 Historical Setting

Historically, the river now known as the Ruby River has been referred to by several different names. The Native Americans and early settlers of the Ruby Valley referred to the present day Ruby River as “Passamari.” This was derived from the Snake language and translated to "cottonwood grove by the water.” The Lewis and Clark expedition passed through the area of the confluence of the Ruby River with the Beaverhead and Big Hole Rivers in 1805. In honor of Thomas Jefferson’s virtues, they named the present-day Ruby River “Philanthropy.” By the time gold was discovered in Alder Gulch in 1836, however, the Ruby River had taken on a third name. By this time, apparently due to the smell of sulfur given off by its many springs, the river had become known as the Stinking Water River. Shortly thereafter, many miners settled the area and the river became known as the Ruby River named after the many ruby colored garnets found in the area (Madison County Historical Association, 1976).

The historical accounts of the Ruby River describe a river that is heavily dominated with willows and other shrubs and sparsely populated with scattered cottonwood groves. Plant species described in the valley include willow, currant, serviceberry, rose, birch, gooseberry and buffaloberry. Tall grasses are described as occupying the meadows of the valley (Phillips, 1940; Nell and Taylor, 1996; Perrault, 1997).

Structurally, the Ruby River was described as a low-banked river with easy access to its floodplain. Spring floods were described to be a foot deep on the floodplain, with the meadows becoming lakes of water. The mouth of the river was described by Lewis and Clark as being comprised of two channels. It is referenced as a system dominated by beaver dams and ponds with a stone and gravel bottom (Nell and Taylor, 1996; Perrault, 1997).

In terms of water quality characteristics, it was described as a turbid river that also had a naturally higher temperature in the upper portion due to inputs from Warm Springs Creek (Nell and Taylor, 1996).

2.3.2 Land Cover

Of the approximately 623,000 acres included in the Ruby River watershed, the majority of the land is brush or grass rangeland (55.7%). A significant area of the watershed is covered with evergreen forest (28.3%) as well. Table 2-9 summarizes the land cover in the watershed.

Table 2-9. Land Cover in the Ruby River Watershed.

Land Use	Acres	Percent of Total
Brush Rangeland	223,398	35.9%
Evergreen Forest	176,052	28.3%
Grass Rangeland	123,019	19.8%
Crop/Pasture	52,007	8.4%
Mixed Rangeland	17,823	2.9%
Shrub Tundra	11,229	1.8%
Wetland	2,304	0.37%
Mixed Forest	1,647	0.26%
Mine/Quarry	1,615	0.26%
Bare Tundra	1,347	0.22%
Reservoir	1,025	0.16%
Deciduous Forest	791	0.13%
Exposed Rock	363	0.058%
Residential	204	0.033%
Mixed Urban	185	0.030%
Mixed Tundra	44	< 0.01%
Lake	42	< 0.01%
Commercial	32	< 0.01%
Other Agriculture	13	< 0.01%

Table source NRIS (http://nris.state.mt.us).

2.3.3 Land Use

2.3.3.1 Historical Land Use

Beaver trapping, mining, grazing, and farming are historical uses that have occurred in the Ruby Valley. Prior to European settlement, much of the area of southwestern Montana was utilized by the Bannock, Flathead, and Shoshone tribes as a common hunting ground. After the Lewis and Clark expedition passed through the area in 1805, they were followed from 1810’s through 1830’s by fur trappers sent by the Missouri Fur Company and the American Fur Company. Native Americans and members of these fur companies heavily trapped beaver in the areas of the Upper Missouri River, including the Ruby River (Phillips, 1940). In pre-settlement times, American bison, Bighorn sheep, pronghorn, and grizzly bear used the native grasslands in the watershed.

Gold was discovered on Alder Gulch in 1835. Alder Gulch and many other tributaries of the Ruby River were subjected to impacts of placer mining by the multitude of miners that came into the region. Shortly thereafter, farmers and ranchers took up residence in the valley. In the ten years after the gold strike upwards of 30,000 people inhabited Virginia City and the surrounding community. The majority of farmers and ranchers settled near the Ruby River and its tributaries. Within a few years, other settlements established throughout the Ruby Valley (Madison County Historical Association, 1976). The development of farms and ranches in the valley led to reduction and removal of riparian vegetation along riverbanks (Perrault, 1997).

By the late 1800's, farming and ranching communities were well established in the Ruby Valley. Madison County had become world-famous for raising livestock including sheep, cattle, and horses. Heavy forest and prairie fires raged throughout the valley in the late 1880's and had a large impact on the cattle industry (Madison County Historical Association, 1976; Perrault, 1997). In addition, years of extensive drought (1917–1919) had a heavy impact on the agricultural communities of the Ruby Valley.

2.3.3.2 Current Land Use

The upper Ruby River watershed is under primarily agricultural land use, including limited timber harvest (USGS, 1996). There has not been a great deal of silvicultural use during the past twenty years. Most of the upper watershed is used for rangeland. The narrow floodplains of the major tributaries in the middle reach of the Ruby River are irrigated for hay production and pasture (USGS, 1996). By the late 1800's cattle and sheep grazing was widespread in the basin. Between 1870 and approximately 1940, the influence of heavy livestock grazing caused severe, adverse effects on riparian areas in the upper Ruby River basin (USFS, 1992). In subsequent years, grazing management changes reduced the duration and intensity of grazing. Presently, many areas appear to be in recovery from past overuse. Recent road improvements have enabled ranchers to truck cattle further up the watershed, decreasing the distance cattle are driven overland.

Other primary land uses in the basin consist of recreation, logging, and mining. The most intensive recreation use is fall big game hunting. Traffic levels associated with hunting are high: averages of 166 and 158 vehicles per day were tallied on the Centennial-Divide Road in the watershed during 36-day periods in the 1989 and 1990 hunting seasons (USFS, 1992). Visitor use is estimated at upwards of 15,000 recreation visitor days during the big game hunting season. Generally wet conditions during the big game hunting season make the potential high for road erosion impacts caused by visitor use (USFS, 1992). Fishing is also an important recreation use on the Ruby River.

Mining has been and is still an important land use in the basin and a potential source of impairment to water quality. There are 344 identified historic mining areas and 21 priority abandoned mine sites in the Ruby basin (Appendix A – Map 6). None of these have a NPDES permit because they are no longer in operation.

Roads directly affect a small portion of the land within the upper basin. The Centennial-Divide Road, which is partly paved and partly graveled, runs along the entire USDA Forest Service upper Ruby River allotment and continues north to Alder, Montana. For much of its length within the upper Ruby River allotment, the road is located in or adjacent to the riparian area of the main Ruby River. The Ledford and Sweetwater Roads are other major gravel roads in the upper basin, which run adjacent to Ledford Creek and Sweetwater Creek, respectively. Road density is much higher in the lower watershed, which is much more populous. There are approximately 80 miles of state maintained roads and 400 miles of county maintained roads within the watershed (Holsman, 1997), in addition to the many miles of public roads on Forest Service and BLM land. Road miles in major tributaries of the Ruby River were estimated using GIS. The sediment source assessment Section (7.0) of this document has more detailed information about roads as sources of sediment.

2.3.4 Land Ownership

Roughly half of the planning area is under federal management, nine percent is under state ownership (including surface waters), and about thirty-nine percent is in private ownership. Approximately the upper 25% of the watershed, mostly upstream from the Vigilante Guard Station, is under Forest Service management (Appendix A – Map 7, Table 2-10). In general, lower elevations in the Ruby valley are under federal (BLM) and private ownership. The Ruby River Reservoir is owned by the Department of Natural Resources and Conservation (DNRC) and operated by the Ruby River Water Users Association (RRWUA).

Table 2-10. Land Ownership in the Ruby River Watershed (NRIS).

Owner	Acres	Square Miles	% of Total
Private	240,682	376	38.6%
U.S. Forest Service	222,265	347	35.7%
Bureau of Land Management	91,504	143	14.7%
State Trust Land	56,623	89	9.1%
Other State Land	10,867	17	1.7%
Water	941	2	0.20%
TOTAL	622,883	973.3	

2.3.5 Population

The lower half of the Ruby watershed is far more populous than the upper watershed. Sheridan and Virginia City are the largest municipalities in the Ruby River watershed. Population info for lower Ruby Watershed is around 3,400 people (2000 census).

In the upper watershed (above the reservoir), there is no urban development and relatively few residences compared to the lower part of the valley. As of the 2000census, fewer than 100 people resided in the upper Ruby River watershed (2000 census).

2.3.6 Point Sources

There are six NPDES point sources in the watershed. Of the six point sources, two are industrial permits, three are storm water permits and one is a municipal wastewater permit (Appendix A – Map 9). All of the permits are related to mining or milling and refining of metals except for the town of Sheridan WWTP permit (Table 2-11). Receiving waters are Indian Creek, Alder Creek and California Creek. The storm water permits are not specifically addressed in source assessments because of lacking water quality runoff data, but the upland modeling will assess sediments from runoff from these sites if they were detected on the NLCD satellite images.

Table 2-11. NPDES Point Sources the Ruby River Watershed.

NPDES	Permit Name	Description	Receiving Water	Type
MT0022098	Sheridan (WWTP) 001	Wastewater Treatment Plant	Indian Creek	Municipal
MT0029971	Ruby Garnet 001	Discharge To Settling Ponds	Ground Water	Industrial
MT0030015	M & W Milling and Refining, Inc. 001	Impoundment Under Drain	Ground Water	Industrial
MTR300139	M & W Milling & Refining, Inc 002	Storm Water - Mining And Oil	Tributary to Alder Gulch	Storm Water

SECTION 3.0
TMDL REGULATORY FRAMEWORK

3.1 TMDL Development Requirements

Section 303(d) of the Federal Clean Water Act (CWA) requires states to identify water bodies within its boundaries that do not meet water quality standards. States track these impaired or threatened water bodies with a 303(d) list. Recently the name for the 303(d) list has changed to 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: (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 TMDLs for impaired or threatened water bodies.

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 need to incorporate a margin of safety and consider seasonality. In Montana, TMDL development is often accomplished in the context of an overall water quality plan. The water quality plan includes not only the actual TMDL, but also includes information that can be used to effectively restore beneficial water uses that have only been affected by pollution, such as habitat degradation or flow modification that are not covered by the TMDL program.

To satisfy the Federal Clean Water Act and Montana State Law, TMDLs are developed for each water body-pollutant combination identified on the states list of impaired or threatened waters and are often presented within the context of a water quality restoration or protection plan. State Law (Administrative Rules of Montana 75-5-703(8)) also directs MDEQ 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. Montana TMDL laws provide a 5-year review process to allow for an adaptive management approach to update the TMDL and water quality restoration plan.

3.2 Water Bodies and Pollutants of Concern

Recently, a court ruling and subsequent settlements have obligated the U.S. EPA and the State of Montana to use pollutant/water body combinations from the Montana's 1996 List of impaired waters. State and federal guidance indicates that the most recent list be used for determining the need for TMDLs. Therefore, both lists are addressed in this document. A total of 27 water bodies in the Ruby River TPA appeared on the 1996 or 2004 lists. All pollutants that have appeared on the 1996 list are addressed in the impairment status review, TMDLs, or watershed restoration plans presented in this document. Most pollutants identified on the 2004 list are addressed, however a few of them are not addressed at this time due to project budget and time constraints. These listings will be identified in a follow up monitoring strategy and addressed within a timeframe identified in Montana's law (*Montana Code Annotated 75-5-703*). However, TMDLs were not prepared for impairments where additional information suggests that the initial listings were inaccurate, or where conditions had improved sufficiently since the listing to an extent that the pollutant no longer impairs a beneficial use. Where a pollutant is recommended for removal from the list, justification is provided in the sections that follow. Tables 3-1 and 3-2 provide a summary of water body listings for the 1996 and 2004 303(d) Lists for the Ruby River TPA.

Table 3-1. Water Bodies on Montana's 303(d) List of Impaired Waters and Their Associated Level of Beneficial Use Support.

Water Body & Stream Description	Water Body #	Use Class	Trophic Level	Year	Aquatic Life	Fisheries - Cold	Drinking Water	Swimmable (Recreation)	Agriculture	Industry
Alder Gulch, From headwaters to mouth (Ruby R)	MT41C002_040	B-1		1996	P	P	T	T	X	X
				2004	N	N	N	P	F	F
Basin Creek, Headwaters to mouth (Middle Fork Ruby R)	MT41C003_120	B-1		1996	P	P	X	X	X	X
				2004	P	P	F	F	F	F
Burnt Creek, Headwaters to mouth (Ruby R)	MT41C003_130	B-1		1996	P	P	X	X	X	X
				2004	P	P	F	F	F	F
California Creek, Tributary of Ruby R	MT41C002_090	B-1		1996	P	P	T	T	X	X
				2004	P	P	F	F	F	F
Coal Creek, From headwaters to mouth (Middle Fork Ruby R)	MT41C003_020	B-1		1996		T	X	X	X	X
				2004	P	P	F	F	F	F
Cottonwood Creek, From headwaters to mouth (Ruby R)	MT41C003_030	B-1		1996	P	P	X	X	X	X
				2004	P	P	F	F	F	F
Currant Creek, Headwaters to mouth (Ramshorn Cr)	MT41C002_060	B-1		1996	P	P	X	X	X	X
				2004	F	F	F	F	F	F
East Fork Ruby River, From headwaters to mouth (Ruby R)	MT41C003_040	B-1		1996	N	N	X	X	X	X
				2004	P	P	F	F	F	F
Garden Creek, Headwaters to mouth at Ruby Reservoir	MT41C002_100	B-1		1996	P	P	X	P	X	X
				2004	P	P	F	F	F	F
Harris Creek, Tributary to California Cr from Forest Boundary to Headwaters	MT41C002_120	B-1		1996	P	P	X	X	X	X
				2004	F	F	F	F	F	F

Table 3-1. Water Bodies on Montana's 303(d) List of Impaired Waters and Their Associated Level of Beneficial Use Support.

Water Body & Stream Description	Water Body #	Use Class	Trophic Level	Year	Aquatic Life	Fisheries - Cold	Drinking Water	Swimmable (Recreation)	Agriculture	Industry
Hawkeye Creek, Tributary to Ruby R (Middle Fork)	MT41C003_140	B-1		1996	P	P	X	X	X	X
				2004	F	F	F	F	F	F
Indian Creek, From headwaters to mouth (Mill Cr-Ruby R)	MT41C002_030	A-1		1996	P	P	T	T	X	X
				2004	P	P	F	F	F	F
Middle Fork Ruby River, From Divide Cr to mouth (Ruby R)	MT41C003_090	B-1		1996	N	N	X	X	X	X
				2004	P	P	F	F	F	F
Mill Creek, From headwaters to mouth (Ruby R)	MT41C002_020	B-1		1996	P	P	T	T	X	X
				2004	P	P	F	P	F	F
Mill Gulch, Tributary to Granite Cr-Alder Cr from Forest Boundary to Headwaters	MT41C002_070	B-1		1996	P	P	X	X	X	X
				2004	F	F	F	F	F	F
Mormon Creek, Headwaters to mouth (Upper end of Ruby R. Reservoir)	MT41C002_110	B-1		1996	P	X	X	X	X	X
				2004	P	P	F	F	F	F
North Fk Greenhorn Creek, From headwaters to confluence with South Fk	MT41C003_070	B-1		1996	X	T	X	X	X	X
				2004	F	F	F	F	F	F
Poison Creek, Headwaters to mouth (Ruby R)	MT41C003_110	B-1		1996	P	P	X	X	X	X
				2004	P	P	F	F	F	F
Ramshorn Creek, From headwaters to mouth (Ruby R)	MT41C002_050	B-1		1996	P	P	T	X	X	X
				2004	P	P	F	F	F	F
Ruby River, From Ruby Dam to the mouth (Beaverhead R)	MT41C001_010	B-1		1996	P	P	T	P	X	X
				2004	P	P	F	P	F	F
Ruby River, From the East and West Forks to Ruby Reservoir	MT41C001_020	B-1		1996	N	N	T	X	X	X
				2004	P	P	F	F	F	F
Ruby River Reservoir	MT41C004_010	B-1	M	1996	P	P	X	X	X	X
				2004	X	X	X	X	X	X
Shovel Creek, Headwaters to mouth (Cabin Cr-Middle Fork Ruby R)	MT41C003_150	B-1		1996	P	P	X	X	X	X
				2004	F	F	F	F	F	F
Sweetwater Creek, From headwaters to mouth (Ruby R)	MT41C003_060	B-1		1996	X	T	X	X	X	X
				2004	P	P	F	P	F	F
Warm Springs Creek, From headwaters to mouth (Ruby R)	MT41C003_050	B-1		1996	P	P	X	X	X	X
				2004	P	P	F	F	F	F
West Fork Ruby River, From headwaters to mouth (Ruby R)	MT41C003_080	B-1		1996	N	N	X	X	X	X
				2004	F	F	F	F	F	F
Wisconsin Creek, From headwaters to mouth (Leonard Slough)	MT41C002_010	B-1		1996	P	P	T	T	X	X
				2004	P	P	F	P	F	F

Legend
F= Full Support; **P**= Partial Support; **N**= Not Supported; **T**= Threatened; **X**= Not Assessed (Insufficient Credible Data); **M**= Mesotrophic

Table 3-2 lists the water bodies on the 1996 and 2004 303(d) Lists of impaired waters. Probable causes of impairment, as identified on the 1996 and 2004 lists, include sediment related listings (siltation, suspended solids, turbidity, bank erosion), metals (cadmium, copper, lead, mercury, and zinc), thermal modification, nutrients, riparian and fish habitat degradation, habitat alteration, habitat modification, channel incisement, and flow alteration (dewatering). Metals, temperature, nutrients and sediment TMDLs are needed for specific water bodies in this TPA. Habitat and flow related listings are pollution and will likely be addressed as sources of pollutants in this document.

Table 3-2. Probable Cause(s) and Source(s) for 1996 and 2004 Impaired Waters Lists.

Water Body	1996 Causes	1996 Sources	2004 Causes	2004 Sources
Alder Gulch, From headwaters to mouth (Ruby R)	Habitat Alterations Siltation	Agriculture Channelization Dredge Mining Flow Regulation/ Modification Natural Sources Resource Extraction	Copper Fish Habitat Degradation Mercury Metals Other Habitat Alterations Riparian Degradation Siltation	Silviculture Resource Extraction Placer Mining Mine Tailings Acid Mine Drainage Abandoned mining Hydromodification Channelization Highway Maintenance and Runoff Unpaved Road Runoff
Basin Creek, Headwaters to mouth (Middle Fork Ruby R)	Habitat Alterations Siltation	Agriculture	Bank Erosion Other Habitat Alterations Riparian Degradation Siltation	Habitat Modification (Other than Hydromodification) Bank or Shoreline Modification/Destabilization Highway Maintenance and Runoff Unpaved Road Runoff
Burnt Creek, Headwaters to mouth (Ruby R)	Habitat Alterations Siltation	Agriculture	Bank Erosion Other Habitat Alterations Siltation	Agriculture Grazing Related Sources Highway Maintenance and Runoff Unpaved Road Runoff
California Creek, Tributary of Ruby R	Siltation Turbidity	Harvesting, Restoration, Residue Management Highway/Road/Bridge Construction Pasture Land Resource Extraction	Bank Erosion Other Habitat Alterations Siltation	Resource Extraction Dredge Mining Erosion from Derelict Land
Coal Creek, From headwaters to mouth (Middle Fork Ruby R**)**	Habitat Alterations	Agriculture Natural Sources Range Land	Bank Erosion Other Habitat Alterations Riparian Degradation Thermal Modifications	Agriculture Grazing Related Sources
Cottonwood Creek, From headwaters to mouth (Ruby R)	Habitat Alterations Siltation	Agriculture Range Land Removal of Riparian Vegetation Streambank Modification/ Destabilization	Dewatering Flow Alteration Other Habitat Alterations Riparian Degradation Siltation	Agriculture Crop-Related Sources Grazing Related Sources Highway Maintenance and Runoff Unpaved Road Runoff
Currant Creek, Headwaters to mouth (Ramshorn Cr)	Siltation	Silviculture	Fully-Supporting All Beneficial Uses	Fully-Supporting All Beneficial Uses

Table 3-2. Probable Cause(s) and Source(s) for 1996 and 2004 Impaired Waters Lists.

Water Body	1996 Causes	1996 Sources	2004 Causes	2004 Sources
East Fork Ruby River, From headwaters to mouth (Ruby R)	Flow Alteration Habitat Alterations	Agriculture Natural Sources Range Land Streambank Modification/ Destabilization	Bank Erosion Fish Habitat Degradation Other Habitat Alterations Riparian Degradation	Agriculture Grazing Related Sources
Garden Creek, Headwaters to mouth at Ruby Reservoir	Flow Alteration Habitat Alterations Siltation	Agriculture Range Land Silviculture	Bank Erosion Other Habitat Alterations Riparian Degradation	Agriculture Grazing Related Sources
Harris Creek, Tributary to California Cr from Forest Boundary to Headwaters	Siltation	Agriculture	Fully-Supporting All Beneficial Uses	Fully-Supporting All Beneficial Uses
Hawkeye Creek, Tributary to Ruby R (Middle Fork)	Habitat Alterations Siltation	Agriculture	Fully-Supporting All Beneficial Uses	Fully-Supporting All Beneficial Uses
Indian Creek, From headwaters to mouth (Mill Cr-Ruby R)	Flow Alteration	Agriculture	Dewatering Fish Habitat Degradation Flow Alteration Other Habitat Alterations Riparian Degradation	Agriculture Grazing Related Sources
Middle Fork Ruby River, From Divide Cr to mouth (Ruby R)	Habitat Alterations Siltation	Agriculture Natural Sources Range Land Streambank Modification/ Destabilization	Bank Erosion Fish Habitat Degradation Other Habitat Alterations Riparian Degradation Siltation	Agriculture Grazing Related Sources Highway Maintenance and Runoff Unpaved Road Runoff
Mill Creek, From headwaters to mouth (Ruby R)	Flow Alteration Siltation Thermal Modifications	Agriculture Channelization Flow Regulation/ Modification Highway Maintenance and Runoff Resource Extraction	Dewatering Flow Alteration Lead Metals Other Habitat Alterations Riparian Degradation Zinc	Agriculture Crop-Related Sources Resource Extraction Acid Mine Drainage Abandoned mining Habitat Modification (Other than Hydromodification) Removal of Riparian Vegetation

Table 3-2. Probable Cause(s) and Source(s) for 1996 and 2004 Impaired Waters Lists.

Water Body	1996 Causes	1996 Sources	2004 Causes	2004 Sources
Mill Gulch, Tributary to Granite Cr-Alder Cr from Forest Boundary to Headwaters	Siltation	Silviculture	Fully-Supporting All Beneficial Uses	Fully-Supporting All Beneficial Uses
Mormon Creek, Headwaters to mouth (Upper end of Ruby R. Reservoir)	Flow Alteration Habitat Alterations Siltation	Agriculture Range Land	Other Habitat Alterations Siltation	Agriculture Grazing Related Sources
North Fk Greenhorn Creek, From headwaters to confluence with South Fk	Habitat Alterations	Agriculture Placer Mining Resource Extraction Range Land	Fully-Supporting All Beneficial Uses	Fully-Supporting All Beneficial Uses
Poison Creek, Headwaters to mouth (Ruby R)	Habitat Alterations Siltation	Agriculture	Bank Erosion Other Habitat Alterations Riparian Degradation Siltation	Agriculture Grazing Related Sources
Ramshorn Creek, From headwaters to mouth (Ruby R)	Metals	Resource Extraction	Dewatering Flow Alteration Lead Metals Siltation	Agriculture Crop-Related Sources Resource Extraction Mine Tailings Highway Maintenance and Runoff Unpaved Road Runoff
Ruby River, From Ruby Dam to the mouth (Beaverhead R)	Flow Alteration Metals Siltation Suspended Solids	Agriculture Flow Regulation/ Modification Highway Maintenance and Runoff Natural Sources Pasture Land Resource Extraction Streambank Modification/ Destabilization	Channel Incisement Dewatering Fish Habitat Degradation Flow Alteration Other Habitat Alterations Riparian Degradation Siltation Thermal Modifications	Agriculture Crop-Related Sources Grazing Related Sources Hydromodification Flow Regulation/Modification Habitat Modification (Other than Hydromodification) Removal of Riparian Vegetation Bank or Shoreline Modification/Destabilization

Table 3-2. Probable Cause(s) and Source(s) for 1996 and 2004 Impaired Waters Lists.

Water Body	1996 Causes	1996 Sources	2004 Causes	2004 Sources
Ruby River, From the East and West Forks to Ruby Reservoir	Flow Alteration Metals Habitat Alterations Siltation Suspended Solids	Agriculture Channelization Flow Regulation/ Modification Natural Sources Range Land Removal of Riparian Vegetation Streambank Modification/ Destabilization	Bank Erosion Channel Incisement Fish Habitat Degradation Other Habitat Alterations Riparian Degradation Siltation	Agriculture Grazing Related Sources Habitat Modification (Other than Hydromodification) Removal of Riparian Vegetation Bank or Shoreline Modification/Destabilization Highway Maintenance and Runoff
Ruby River Reservoir	Siltation	Agriculture Domestic Wastewater Lagoon Range Land	*(Did not meet SCD)*	*(Did not meet SCD)*
Shovel Creek, Headwaters to mouth (Cabin Cr-Middle Fork Ruby R)	Habitat Alterations Siltation	Agriculture	Fully-Supporting All Beneficial Uses	Fully-Supporting All Beneficial Uses
Sweetwater Creek, From headwaters to mouth (Ruby R)	Flow Alteration Siltation	Agriculture Hydromodification Natural Sources	Bank Erosion Dewatering Fish Habitat Degradation Flow Alteration Nutrients Other Habitat Alterations Riparian Degradation Siltation	Agriculture Grazing Related Sources
Warm Springs Creek, From headwaters to mouth (Ruby R)	Flow Alteration Habitat Alterations Siltation	Agriculture Flow Regulation/ Modification Highway Maintenance and Runoff Removal of Riparian Vegetation Streambank Modification/ Destabilization	Bank Erosion Other Habitat Alterations Riparian Degradation Siltation	Agriculture Grazing Related Sources Pasture Grazing - Riparian Highway Maintenance and Runoff Unpaved Road Runoff
West Fork Ruby River, From headwaters to mouth (Ruby R)	Habitat Alterations Siltation Suspended Solids	Agriculture Natural Sources Range Land	Fully-Supporting All Beneficial Uses	Fully-Supporting All Beneficial Uses

Table 3-2. Probable Cause(s) and Source(s) for 1996 and 2004 Impaired Waters Lists.

Water Body	1996 Causes	1996 Sources	2004 Causes	2004 Sources
Wisconsin Creek, From headwaters to mouth (Leonard Slough)	Flow Alteration Habitat Alterations Siltation	Agriculture Channelization Flow Regulation/ Modification Highway Maintenance and Runoff Streambank Modification/ Destabilization	Arsenic Dewatering Fish Habitat Degradation Flow Alteration Lead Metals Other Habitat Alterations Riparian Degradation Siltation	Agriculture Resource Extraction Mine Tailings Hydromodification Channelization Flow Regulation/Modification Bridge Construction

Impairment status and impairment list reviews will also be provided for each water body in Section 5.0 of this document in text form.

Seven streams were reassessed using MDEQ's formal Sufficient and Credible Data, Beneficial Use Determination (SCD/BUD) process (citation) and subsequently found to be fully supporting their beneficial uses between the 1996 and 2004 listing cycles. To be conservative, and ensure beneficial uses were still being supported, the TMDL project team reevaluated these streams. The TMDL team initially utilized field reconnaissance as a means for reevaluation. The field reconnaissance effort utilized a review of the existing environmental data, visual observation of sediment sources in the field, and visual observation of the sediment and riparian habitat conditions. These streams included Shovel, Hawkeye, North Fork Greenhorn, Mill Gulch, Current, and Harris Creeks, along with West Fork Ruby River.

For Mill Gulch, Harris and North Fork Greenhorn Creek the project team agreed on the previous fully supporting determinations, good cause was met for delisting, and therefore, no more monitoring was conducted in these areas.

After field reconnaissance, the project team agreed to complete further monitoring on Currant, Shovel, Hawkeye Creeks and West Fork Ruby River to provide a higher level of certainty. Instream surveys and sediment source assessments employed for other streams in the Ruby Watershed in need of TMDLs were used to assess these streams. See Appendix E for a discussion of methods.

After further monitoring was completed on these four streams the source assessment information, physical, chemical and biological data was assessed together. The assessments are provided in Section 5.0 of this document. The newly acquired, more robust data indicated that a sediment TMDL was needed for Currant and Shovel Creeks as well as West Fork of the Ruby River. These streams should be identified as impaired due to sediment on the 2006 303d list. The other streams either did not show impairment to uses or the impairment was attributed to large natural sediment sources and sufficient information was available for good cause delisting. See Section 5.0 for discussion about each of these streams.

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 high quality of a water body. The ultimate goal of this water quality restoration plan, once implemented, is to ensure that all designated beneficial uses are fully supported and all standards are met. Water quality standards form the basis for the targets described in Section 3.3. Pollutants addressed in this Water Quality Restoration Plan include: nutrients, sediment, metals, and thermal modification. This section 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 include 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 nonpoint 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 U.S. 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 or made less stringent.

Descriptions of Montana's surface water classifications and designated beneficial uses are presented in Table 3-3. All water bodies within the Ruby TPA are classified as B-1 except Indian Creek, which is classified as A-1.

Table 3-3. Montana Surface Water Classifications and Designated Beneficial Uses Applicable to the Ruby Watershed.

Classification	Designated Uses
A-1 CLASSIFICATION:	Waters classified A-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment for removal of naturally present impurities. Water quality must be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
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 WQB-7 (MDEQ, January 2004). 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) exposure by water consumption, 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 that include 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.

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 Ruby TPA are summarized, one-by-one, below.

Sediment

Sediment (i.e., coarse and fine bed sediment) and suspended sediment are addressed via the narrative criteria identified in Table 3-4. The relevant narrative criteria do 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 reference condition that reflects a water body's greatest potential for water quality given current and historic land use activities where all reasonable land, soil, and water conservation practices have been applied and resulting conditions are not harmful, detrimental or injurious to beneficial uses (see definitions in Table 3-4).

Table 3-4. 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.

Metals

Numeric standards for water column metals in Montana include specific standards for the protection of both aquatic life and human health. 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 applicable numeric metals standards (guidelines for aquatic life) for the specific metals of concern in the Ruby TPA are presented in Table 3-5. Actual standards for aquatic life at any given hardness are calculated using Equation 3-1 and Table 3-6. The actual standards are used to determine standards exceedences in this document, not the guidance from Table 3-5. Existing data indicates that other metals are below water quality standards.

It should be noted that recent studies have indicated in some streams metals concentrations may vary through out the day because of diel pH and alkalinity changes. In some cases the variation can cross the standard threshold (both ways) for a metal. Montana water quality standards are not time of day dependent.

Table 3-5. Montana Numeric Surface Water Quality Standards Guide for Metals.

Parameter	Aquatic Life (acute) (µL)[a]	Aquatic Life (chronic) (µL)[b]	Human Health (µL)[a]
Cadmium (TR)	1.05 @ 50 mg/L hardness[c]	0.16 @ 50 mg/L hardness[c]	5
Copper (TR)	7.3 @ 50 mg/L hardness[c]	5.2 @ 50 mg/L hardness[c]	1,300
Lead (TR)	82 @ 100 mg/L hardness[c]	3.2 @ 100 mg/L hardness[c]	15
Mercury (TR)	1.7	0.91	0.05
Zinc (TR)	67 @ 50 mg/L hardness[c]	67 @ 50 mg/L hardness[c]	2,000

[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) (see Table 3-6 for the coefficients to calculate the standard).
Note: TR – total recoverable.

Hardness-based standards for aquatic criteria are calculated using the following equation and are used for determining impairment:

Equation 3-1.

Chronic = exp.{mc[ln(hardness)]+bc} where mc and bc are values from Table 3-6

Table 3-6. Coefficients for Calculating Metals Freshwater Aquatic Life Standards (MDEQ 2002).

Parameter	ba (acute)	bc (chronic)
Cadmium	-3.924	-4.719
Copper	-1.700	-1.702
Lead	-1.46	-4.705
Zinc	0.884	0.884

Note: If hardness is <25 mg/L as CaCO3, the number 25 must be used in the calculation. If hardness is equal or greater than 400 mg/L as CaCO3, 400 mg/L must be used for the hardness value in the calculation.

Montana also has a narrative standard that pertains to metals in sediment. No increases are allowed above naturally occurring concentrations of sediment or suspended sediment (except as 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 (ARM 17.30.623(2)(f)). This narrative standard includes metals laden sediment.

Temperature

Montana's temperature standards address a maximum allowable increase above "naturally occurring" temperatures to protect the existing temperature regime for fish and aquatic life. Additionally, Montana's temperature standards address the maximum allowable rate at which temperature changes (i.e., above or below naturally occurring) can occur to avoid fish and aquatic life temperature shock.

For waters classified as A-1, or B-1 the maximum allowable increase over naturally occurring temperature (if the naturally occurring temperature is less than 67º Fahrenheit) is 1° (F) and the rate of change cannot exceed 2°F per hour. If the natural occurring temperature is greater than 67ºF, the maximum allowable increase is 0.5ºF (ARM 17.30.622(e), ARM 17.30.623(e)).

Nutrients

There are no statewide numeric Aquatic Life standards for nutrients. Numeric human health standards exist for nitrates. Human health standards for nitrogen are listed in Table 3-7.

Table 3-7. Human Health Standards for Nitrogen for the State of Montana.

Parameter	Human Health Standard (µL)[1]
Nitrate as Nitrogen (NO_3-N)	10,000
Nitrite as Nitrogen (NO_2-N)	1,000
Nitrate plus Nitrite as N	10,000

[1]Maximum Allowable Concentration.

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 µg/L) and total phosphorus (20 µg/L upstream of the confluence with the Blackfoot River and 39 µg/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.

The narrative standards applicable to nutrients that protect all uses 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.

3.3.3 Reference Approach for Narrative Standards

When possible, a reference site approach is used to determine the difference between an impacted area and a "natural" or least impacted water body. The reference site approach is the preferred method to determine natural conditions, but when appropriate reference sites are not easily found, modeling, or regional reference literature values are used. The approach for using reference sites for the Ruby River system is included in Appendix B.

SECTION 4.0
WATER QUALITY TARGETS

The water quality targets presented in this section are based on the best available science and information available at the time this document was written. TMDL targets are not stagnant components of this plan. Targets will be assessed during future TMDL reviews for their validity when new information may provide a better understanding of reference conditions.

4.1 Metals

4.1.1 Linking Metals to a Use Impairment

Assessing the presence of human caused sources is a necessary first step prior to linking metals to use impairment. If no human caused sources are identified along with metals standard exceedences, standards revision for the water body will be considered. If human caused sources are present along with standard exceedences, a source assessment is needed. The following sections describe a decision pathway to determine if a particular metal is affecting a stream's beneficial uses within this TMDL document. From this point forward in Section 4.1, it is assumed that human caused metals sources are present unless otherwise noted.

Budget constraints and project deadlines have contributed to water chemistry datasets that may not represent a broad spectrum of instream conditions. Also, Montana's narrative standards apply to metals that are adsorbed to instream sediments. Therefore, sediment metal concentrations and biological toxicity metrics are used as supporting evidence of impairment along with water chemistry.

A group of targets are used to determine beneficial use impairment from metals. Not all targets need to be met, but a decision process based on the targets will be followed. The decision criteria provided in the following sections will be completed for each metal/stream combination found on either the 1996 or 2004 lists of impaired water bodies. The amount of data needed for each data category may very by the severity of metals concentration found or the effects on biology, instream data proximity to sources, and the desired certainty of analysis. The amount of data used to link metals to impaired use will vary by water body. The following process is provided for a general framework for the decision processes presented in the impairment status section of this document.

4.1.2 Interpreting Water Quality Data

Numeric water quality standards for human health and aquatic life support are used for the first step of the decision process (Figure 3-1). The aquatic life standards for several metals (i.e., copper, cadmium, lead, zinc) are a function of water hardness, as described in Section 3.2.2. As hardness decreases (i.e., calcium and magnesium concentrations decline), the applicable numeric standard also decreases (becomes more stringent). In most cases, stream water hardness decreases with increasing flow during spring runoff, resulting in lower applicable aquatic life standards during spring runoff periods. Runoff's affect on metals concentrations can vary, as spring runoff may dilute metals sources that enter the stream though ground water or may increase erosion and erode soils containing metals. Mines may exude metals through ground water discharge and may therefore cause high metals concentrations during low flow. Examining water quality data under various hydrologic conditions is necessary to characterize water chemistry metal conditions. Therefore, monitoring both spring runoff and summer low flow conditions was conducted in the Ruby TPA.

If human health standards or acute aquatic life standards are exceeded, a TMDL for the specific metal in question is required. Montana's chronic metals standards are set for a 96-hour average. Budget constraints for this project prohibited intensive sampling during a 96-hour timeframe. The application of the chronic criteria is based on the assumption that any one sample is representative of the previous 48 hours and the following 48 hours. Also, because current data sets for the water bodies (streams) in the Ruby TPA are small, any one exceedence of a chronic aquatic life standard in recent sampling will require formation of a TMDL. This may not be the case for other metal TMDLs in Montana that use a larger water quality data set to provide more certainty of accurately representing ambient instream metals conditions.

4.1.3 Interpreting Sediment Chemistry Data

Water column metal standard exceedences may only occur infrequently in response to environmental conditions. Temporally limited water quality monitoring may not identify toxic conditions. Similarly, elevated metals concentrations in stream sediments can negatively impact aquatic life in surface water, and thus may contribute to water quality impairment according to Montana's **narrative** standards. Elevated metals concentrations of stream sediments can also be an indicator of more severe water quality impacts further upstream. Therefore, stream sediment metal chemistry concentrations are also used to determine impairment by a metal. Fine sediment (<63 micron) that is likely to be periodically suspended in the water column is sampled from the streambed and then analyzed using a total recoverable digestion.

Montana provides guidance on use of reference conditions in Appendix A of the 2004 Water Quality Integrated Report. The use of literature values is an approved method for determining reference condition. Additionally, specific conditions within the sediment at a given site provide different oxygen, pH, and organic carbon conditions that affect the availability and toxicity of the metals found in sediment. The guidance provided for criteria in this document does not consider these site specific variables. Because this reference method has low certainty and sediment related metals standards are narrative, sediment metals data are used in conjunction with biological toxicity information.

Unlike surface waters, no numeric standards currently exist specifying allowable metals concentrations in sediments, although there are published guidance values denoting potentially harmful conditions for aquatic biota (USEPA, 2001; Maret and Skinner, 2000; Buchman, 1999). Sediment metal concentration values created for the Ruby Watershed using guidance from these three sources are listed in Table 4-1. Additive or synergistic affects of multiple metals are considered by best professional judgment when more than one metal is found at levels approaching the sediment guidelines.

Table 4-1. Guidelines for Metals Concentrations in Sediment to Protect Aquatic Life.

Parameter	Concentration (mg/kg)
Copper	78
Lead	62
Cadmium	3.9
Mercury	0.2
Zinc	150
Arsenic	33

4.1.4 Interpreting Biological Toxicity Metrics

Biological toxicity metrics are used as impairment indicators. The biological toxicity indicator used for this assessment is the percent of abnormal diatoms found living on the stream bottom. If more than 3% of diatoms are deformed, it is likely a response to toxic conditions (Bahls, 2003). There are uncertainties in using this biological metric. The deformities can be caused by a number of environmental conditions, metals toxicity being only one of them. Therefore, the biological indicators are used only in conjunction with sediment metal concentration data. If abnormal diatoms are over guidance criteria, but high metal concentrations were not found in stream sediments, no metal TMDL is needed. On the other hand, if sediment metals concentrations and a toxic response is found, it is likely that metals detected in the sediment are producing a toxic response.

4.1.5 Summary of the Decision Process Used to Determine How a Metal Affects Beneficial Uses

Figure 4-1 identifies the decision process used to determine if metals are impacting uses in the Ruby TPA. If water quality data exceed water quality standards, a TMDL for the specific metal will be written. Where limited water quality samples do not exceed standards but a sediment metal concentration is above a guidance level, biological responses are considered. If there is a toxicological response in a biological community and a high sediment metal concentration, the Department will develop a metal TMDL or provide a follow up monitoring water column monitoring strategy that could lead to a TMDL. If the water column chemistry (both high and low flow conditions) and biological results (both periphyton and macroinvertebrate) do not indicate an impairment condition, then it can be concluded that beneficial uses are not impaired due to metals even if sediment chemistry metal is greater than guidance values.

There are a few exceptions to the general decision process. The first is where sediment chemistry metals are greater than published guidance values and upstream human caused metals sources indicate the possibility of impairment conditions further upstream in the watershed. Under this scenario, a follow up monitoring plan will be provided. The amount of additional sampling needed in this circumstance will be based on the individual situation.

The second exception is when the metal has low toxic effects on aquatic life but a high bioconcentration factor that is likely to influence human health through fish consumption, as is the case with mercury. In this case, high concentrations of mercury found in sediment without a toxic effect are sufficient information to trigger TMDL formation. This is especially true if fish tissue analysis data is available and indicates bioconcentrating effects.

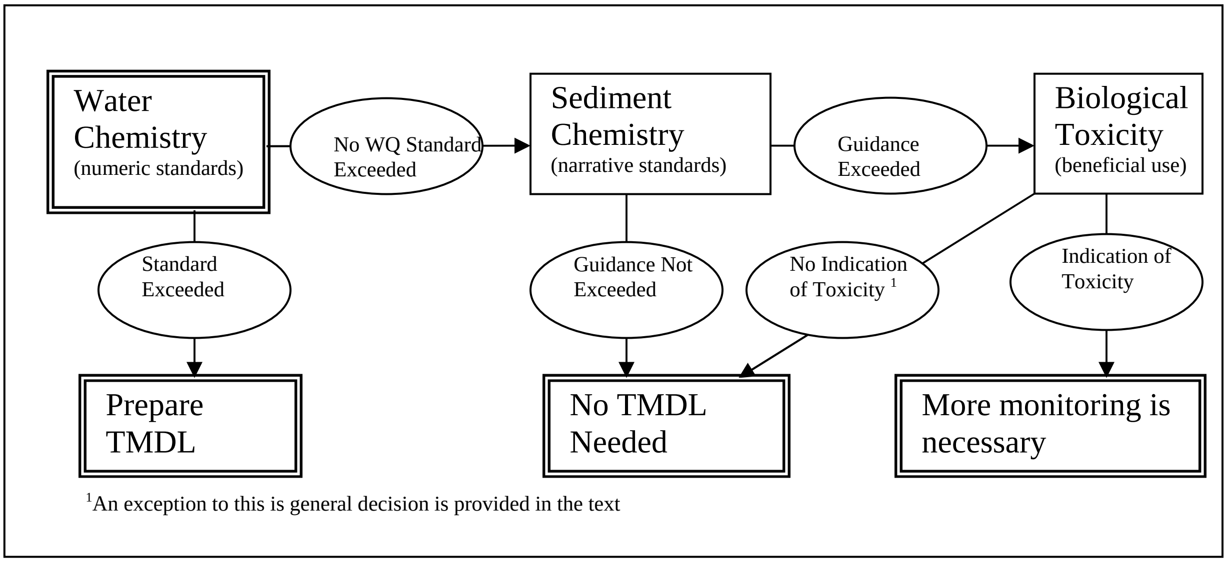

Figure 4-1. Decision Process to Determine if a Specific Metal is Impacting a Use.

4.2 Temperature

Narrative water quality standards for temperature are based on allowable temperature increases over the natural condition. Narrative water quality standards for temperature are detailed in Section 3.3.2. To relate temperature targets directly to Montana's narrative temperature standards, natural conditions need to be defined. This can be completed in two ways. The preferred methodology is to define reference condition and compare the impacted stream to the reference stream reach. In many cases this is difficult to accomplish because the reference approach for temperature would need to match ground water, instream flow, water use, stream aspect, riparian canopy, and stream channel conditions at a watershed scale. Finding a reference watershed with similar conditions is very difficult. On larger streams in Montana, finding temperature reference condition along a stream continuum is almost impossible. If a reference stream cannot be found, a modeling approach to determine natural conditions for the stream can be completed.

The SNTEMP temperature model is used to determine if temperature standards are likely to be exceeded in the lower Ruby River and in Mill Creek. The SNTEMP model uses measured water temperature data for calibration to existing conditions that reflect current land and water use. Once calibrated, the model assesses scenarios of future reasonable land, soil and water conservation practices that influence instream temperature. The scenarios are run with increased canopy cover and increased instream flow that are based on reasonable land, soil, and water conservation practices. Details of the modeling methods are included in Appendix C. Modeling allows estimation of actual increases in water temperature due to specific influences, and is also used for TMDL allocation.

4.2.1 Instream Temperature Targets

Instream temperatures are affected by a number of physical factors. The relationship between channel geometry, riparian shading, and flow volumes in maintaining cool temperatures is complex and not intuitive. But, each of these factors has a general correlation with instream water temperature. More shade equates to less solar radiation entering the stream. A narrow stream channel has less water surface area to transfer heat and promotes shading. Finally, more water in the stream creates a larger thermal inertia that resists changes in temperature.

Riparian canopy density targets are based on internal reference areas. Targets for canopy density vary depending upon the different vegetative zones each impaired stream flows through. Canopy density targets for shrub and tree-dominated areas are each set at different levels, and are based on riparian areas that have reasonable land and soil conservation practices.

Instream temperatures are influenced by flows to the river, including tributaries and return flow related to irrigation, as well as by flow dynamics related to dam releases and irrigation withdrawals. These dynamics are discussed in the source characterization discussion in Section 6.0. Flow relates strongly to temperature as reduced flow volumes have less thermal inertia, and therefore, heat more rapidly.

Instream flow targets that relate to irrigation efficiency savings estimates are provided in Table 4-2 and Appendix C. Stream flow targets are also partially based on a water budget analysis that was completed prior to the TMDL monitoring (Payne, 2004). The target assumes that water saved through reasonable irrigation water-saving activities applied in delivery systems and on farms can be salvaged and leased for instream use through a locally lead effort. The SNTEMP model was used to assess the affects of irrigation water savings to instream temperature (Appendix C).

A few reaches of temperature-listed stream segments in the Ruby watershed are over widened. Width/depth ratio is used as an indirect indicator for temperature because overwidened or aggraded channels allow larger daily water temperature fluctuations and provide fewer deep coldwater refugia for aquatic species. Width/depth ratio is derived from channel bankfull width and average bankfull depth. Targets are based on reference values for width/depth ratio developed by the Beaverhead-Deerlodge National Forest, which are based on surveys of reference reaches throughout southwest Montana. Targets based on width/depth ratio are discussed in Section 4.4, *Sediment*. Reference values are determined by Rosgen level 1 stream type.

Table 4-2. Temperature Targets.

Targets	Proposed Criterion
Maximum Allowable Increase Over Naturally Occurring Temperature	For waters classified as A-1 or B-1, a 1ºF maximum increase above naturally occurring water temperature is allowed within the range of 32ºF to 66ºF; within the naturally occurring range of 66ºF to 66.5ºF, no discharge is allowed which will cause the water temperature to exceed 67ºF; and where the naturally occurring water temperature is 66.5ºF or greater, the maximum allowable increase in water temperature is 0.5ºF.
Meet the Water Temperature Target Above or Meet All of Targets Below.	
Stream Diversions	Apply irrigation water savings to instream use during warmest months (Apr.-Oct). Details are provided in Appendix C.
Inflows to Stream	No human caused surface water inflow, in single or combination, will increase temperatures above standards.
Canopy Density Over the Stream	Comparable with reference sites. Details are provided in Appendices B and C.
Width/Depth Ratio	Target values for stream type as defined for sediment targets (Table 4-7)

4.3 Nutrients

4.3.1 Basis for Ruby TPA Nutrient Criteria

Montana's narrative standards pertaining to nutrients specify *"surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will: create conditions which produce undesirable aquatic life" (ARM 17.30.637{e})*. Nitrogen and phosphorous are essential components of aquatic ecosystems, but excessive amounts of these nutrients can stimulate the growth of nuisance levels of algae. In excess amounts, algae can produce unpleasant tastes and odors in drinking water, taint the taste of fish flesh, produce allergic reactions in humans, clog and corrode water supply and irrigation equipment, alter the composition of macroinvertebrate and fish communities, and interfere with aesthetic and recreational uses of rivers and streams (Nordin, 1985). In shallow streams and rivers, the benthic chlorophyll *a* concentration is commonly used to measure the amount of aquatic plant growth on the stream bottom. TMDL targets are intended to prevent excess algae growth, which can be measured as benthic algal chlorophyll *a*, and are based on nutrient levels that will prevent excessive growth of benthic algae.

Plants require a balance of nutrients for growth. Most aquatic algae contain nitrogen, phosphorus and carbon in a ratio by weight of 41/7/1 (Redfield, 1958; Chapra, 1997). Increases in plant production may occur if the limiting nutrient is elevated. Most aquatic plants are not limited by carbon, however, nitrogen or phosphorus usually limits growth. A nitrogen to phosphorus (N/P) ratio of around 7 is generally thought to be optimal for algae growth. Therefore if a N/P ratio is substantially lower than 7 the stream is most likely limited by nitrogen, if the ratio is substantially higher than 7 it is most likely to be limited by phosphorus. Conditions may change in streams daily or seasonally that affect the nitrogen to phosphorus ratio, and either nutrient may be limiting at times. The N/P ratio can be used as a general indicator of which nutrient is most likely limiting algae growth in a stream.

Sweetwater Creek is the only water body in the Ruby River watershed listed for nutrients. The existing body of data is not comprehensive enough to determine which of the nutrients is limiting on Sweetwater Creek. Therefore, targets are set for both nitrogen and phosphorus. With only limited nutrient data from the Ruby watershed, it is necessary to refer to other regional studies for target values.

Total nitrogen, nitrate+nitrite, and total phosphorus are used as targets for Sweetwater Creek. Studies have compared nutrient levels to reference conditions for other areas within the same ecoregions. These include the Clark Fork River nutrient standards and a review of existing data conducted by U.S. EPA to determine reference conditions for level III ecoregions (U.S. EPA, 2001; 2000a). U.S. EPA "Reference" conditions are estimated by taking the 25^{th} percentile concentrations of samples taken from each ecoregion. Narrative standards are written in terms of increase over natural conditions, which can be approximated using the best available conditions in a region. Numeric values for Clark Fork River (CFR) standards and U.S. EPA nutrient guidelines for the level III ecoregions pertaining to the Ruby watershed are presented in Table 4-3. The guidance criteria in Table 4-3 should not be taken as targets for Sweetwater Creek, but are provided as a basis for target development.

Most of the lower Ruby River drainage lies within the *Montana Valley and Foothill Prairies* ecoregion. The southern headwaters originate within the *Middle Rockies* – Southwest Montana Barren Mountains ecoregion and the northeast headwaters are in the *Northern Rockies* - Tobacco Root Mountains ecoregion (U.S. EPA, 2000b). All of these ecoregions are based on outdated ecoregion areas because U.S. EPA based their latest nutrient ecoregion analysis on a vintage ecoregion plan. Subsequently new ecoregions have been delineated. Nutrient levels within the upper watershed can be compared to nutrient guidelines for the *Middle Rockies* ecoregion as well as to the *Montana Valley and Foothill Prairies* nutrient guidelines (U.S. EPA, 2000a). Proposed targets for total phosphorus and total nitrogen have been accepted as standards for the upper Clark Fork River watershed, which lies partially in the *Montana Valley and Foothill Prairies* ecoregion. However, parts of the Ruby River system may actually be more comparable to plains systems. For comparison with plains systems, guideline levels from *Northwestern Great Plains* ecoregion are included in Table 4-3.

Table 4-3. Nutrient and Chlorophyll *a* Summer Guideline Values Based on Regional References.

Location	**Criteria**	**TP (µg/L)**	**TN (µg/L)**	**NO_2+NO_3 (µg/L)**	**Benthic Chlor *a* (mg/m^2)**
Upper Clark Fork River [1]	Standards	20	300	---	100 avg. 150 max
Preliminary SW Montana Valley Foothill Reference Site Data[2]	75th percentile	15.5	116	10	16
Montana Valley and Foothill Prairies [3]	25th percentile of average summer concentration	10	250	30	---
Middle Rockies[3]	25th percentile of average summer concentration	12	310	20	---
Northwestern Great Plains[3]	25th percentile of average all season concentration	45	700	20	---
British Columbia Ministry[4]	Recommended criterion for recreation and aesthetics in high mountain streams	---	---	---	50
	Recommended criterion for aquatic life in high mountain streams	---	---	---	100

[1] Montana's Clark Fork Nutrient Standards
[2] Unpublished Data MDEQ, 2005
[3] U.S. EPA, 2000b and U.S. EPA, 2001a
[4] Water Quality Criteria for Nutrients and Algae, British Columbia Ministry of Environment, Water Management Division (Nordin et al., 1985)

4.3.2 Nutrient Chemistry Targets

The CFR standards for TN and TP will be used as water quality targets for the Ruby TPA. The CFR standards fall near median TN and TP concentrations of existing regional nutrient reference guidance provided in Table 4-4. A nitrate+nitrite target of 20 mg/L is constructed by using the median of the criteria in Table 4-4. Future TMDL reviews may add dissolved oxygen as a target.

Chlorophyll *a*

Benthic algal chlorophyll *a* concentrations indicate how much attached algal growth occurs in a stream. Guidance from the Clark Fork Nutrient Standards and SW Montana reference sites are used to derive Chlorophyll *a* targets for Sweetwater Creek (Table 4-3). Widespread applicability of the 150 mg/m^2 maximum chlorophyll *a* threshold justifies using it as a target. Nordin (1985) uses 50 mg/m2 for smaller streams. A 50 mg/m^2 value will be used as the water quality target for average chlorophyll a conditions because smaller reference streams in the region also indicate a lower average target should be used when compared to the Clark Fork Standards (Table 4-4).

Biological Indicators

The aquatic insect community composition is influenced by algal growth and is used to support the decision process along with nutrient water chemistry and benthic chlorophyll *a* data.

Bioindicators are not used alone to determine impairment, but may provide supporting information in some cases.

Table 4-4. Summary of Nutrient Criteria for Sweetwater Creek.

Targets				Supplemental Indicator
TP (µg/L)	**TN (µg/L)**	**NO_2+NO_3 (µg/L)**	**Benthic Chlor. *a* (mg/m^2)**	**Macroinvertebrate HBI**
20	300	20	Yearly Average 50 Maximum 150	<4

4.3.3 Decision Process for Determining the Linkage Between Nutrients and an Impairment in Ruby TPA

The process for determining if nutrients are affecting an instream beneficial use is outlined in Figure 4-2. Human sources need to be present prior to initiating the process described in this section. An important initial consideration is to determine if human activities are influencing stream channel instability, TSS, or instream flow conditions that reduce instream primary production. In this case a comparison of nutrient water quality conditions to reference condition is used solely to determine if nutrients are likely to affect uses because benthic chlorophyll *a* is not a good indicator of impairment. Nutrients could cause increased benthic algal growth when sediment impacts are corrected. Also, the higher nutrient concentrations could contribute to increased downstream loading. If water quality nutrient conditions are higher than reference or standards, a nutrient TMDL is needed. If they are at or below reference, a TMDL is not needed.

If human influences are not depressing benthic algae growth, chlorophyll *a* should be used as a primary indicator of nutrient impact to beneficial use. Excessive growth of benthic algae is directly linked to nutrient conditions and biological and aesthetic impacts in most mountain and foothill streams. Therefore, if human impacts are not depressing benthic algal growth chlorophyll *a* should be compared to an appropriate reference condition. Nutrient water quality conditions should be examined along with the chlorophyll *a* data in this circumstance as supporting information. Supplemental indicators such as macroinvertebrate community structure are influenced by algal growth and dissolved oxygen concentrations and are used to support the decision process along with nutrient water chemistry and benthic chlorophyll *a* data. Bioindicators are not used alone to determine impairment, but may provide supporting information in some cases.

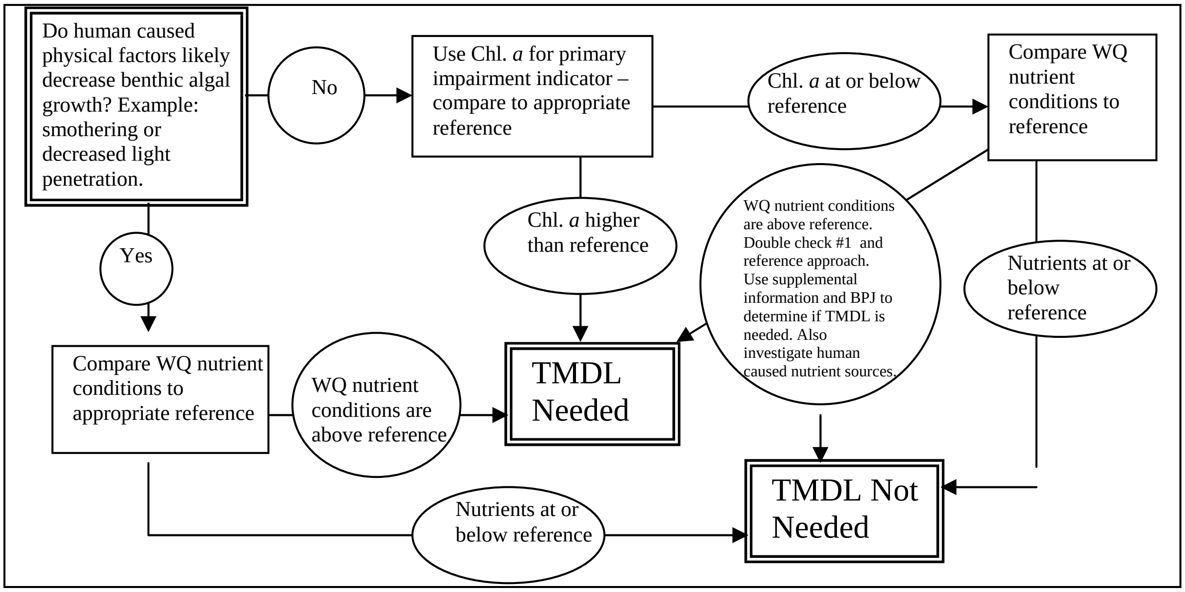

Figure 4-2. Decision Process to Determine if Nutrients are Impacting an Instream Use in the Ruby TPA.

4.4 Sediment

The term sediment is used in this document to refer collectively to several closely-related pollutant categories, including suspended sediment, stream channel geometry that can affect sediment delivery and transport, and sediment deposition on the stream bottom.

4.4.1 Effects of Sediment on Aquatic Life and Coldwater Fisheries

Erosion and sediment transport and deposition are natural functions of stream channels. Sediment deposition is needed to build streambanks and floodplains. Regular flooding allows sediment deposition to build floodplain soils and prevents excess scour of the stream channel. Riparian vegetation and natural instream barriers such as large woody debris, beaver dams, or overhanging vegetation help trap sediment and build channel and floodplain features. When these barriers are absent or excessive erosion is taking place due to altered channel morphology or riparian vegetation, excess sediment is transported through the channel and may be deposited in critical aquatic habitat areas not naturally characterized by high levels of fine sediment.

Excess sediment often has detrimental effects on streams and the aquatic communities living in them. High suspended sediment levels reduce light penetration, which may cause a decline in primary production. As a result, aquatic invertebrate communities may also decline, which may then cause a decline in fish populations. Deposited particles may also obscure sources of food, habitat, hiding places, and nesting sites for invertebrates.

Excess sediment may also impair biological processes of individual aquatic organisms. When present in high levels, sediment may clog the gills of fish and cause other abrasive damage. Abrasion of gill tissues triggers excess mucous secretion, decreased resistance to disease, and a reduction or complete cessation of feeding (Wilber, 1983; McCabe and Sandretto, 1985;

Newcombe and MacDonald, 1991). High levels of benthic fine sediment can also impair reproductive success of fish. Fine sediment deposition reduces availability of suitable spawning habitat for salmonid fishes and can smother eggs or hatchlings. An accumulation of benthic fine sediment reduces the flow of water through gravels harboring salmonid eggs, hindering emergence of newly hatched fish, depleting oxygen supply to embryos, and causing metabolic wastes to accumulate around embryos, resulting in higher mortality rates (Armour et al., 1991).

The sediment criteria presented in Section 4.4.2 are used in a weight of evidence approach. A TMDL will be provided if any of the targets, alone or in combination, indicate that Montana's sediment related water quality standards are exceeded. Just because a target is exceeded does not necessarily mean sediment standards are exceeded. Justification for determining if the State's sediment standards are exceeded for each stream identified as impaired from sediment on the State's 303d list is provided in Section 5.0. Each stream's justification will provide a comparison of existing conditions to the targets, a rationale of how sediment production or transport affects a beneficial use, and a brief discussion of sediment sources. Montana's sediment standards are provided in Section 3.3.

4.4.2 Sediment Targets

Conditions that are considered in determining if Montana's narrative sediment standards are exceeded are: 1) Are the beneficial uses impaired? 2) Have anthropogenic sources increased sediment erosion and/or delivery? 3) Is there a sediment supply problem (i.e., Is there too much or too little sediment in the stream)? 4) Is there an indication of an in-channel sediment transport problem? Each parameter selected for sediment targets relates to one of the questions above and is used in context to answer the questions stated above.

Target values for many of the sediment criteria vary by stream type. Table 4-5 summarizes values for sediment-related criteria. With the exception of entrenchment, targets for channel morphological variables are the 75th percentile of reference reach data for Rosgen stream type, based on the BDNF reference reach dataset. Entrenchment is based on the 25th percentile because higher values for entrenchment ratio are generally more desirable within a given stream type. The limited exception is in severely aggraded systems, where excess sediment may have reduced entrenchment (increased entrenchment ratio). This scenario is only a concern on Ramshorn Creek.

Criteria for channel morphology related parameters are based on the BDNF reference data set instead of on the Rosgen criteria for channel stream types because the BDNF local reference data are more appropriate for the landscape and natural conditions in the Ruby watershed. Targets for other indicators not included in the BDNF surveys are derived from reference sites within the Ruby River watershed. A discussion of the reference site approach is included in Appendix B. The median of reference sites are used instead of the 75th percentile for the indicators with a smaller reference dataset based only on TMDL monitoring, which include percent streambank canopy, percent stable bank, and percent fines in gravels. The median is used because the reference sites were in least impacted areas located on 303(d) listed streams and there were a relatively small number of reference sites that were found. Sediment criteria based on level 2

Rosgen types are compared to existing conditions averaged for reaches of the same stream type because there are usually only one or a few measurements on any 303(d) listed stream.

Ea and Eb stream types have been identified on several tributaries to the Ruby River. These are natural stream types created by a young geology with active uplift. To remain consistent with treatment of these stream types in the BDNF dataset, targets for the Ea types are defined separately from other types, and the Eb types are included in the E stream types.

Table 4-5. Summary of Sediment Criteria.

Sediment Criteria	**Criteria**	**Value or Range**
Entrenchment Ratio **(can vary by +/- 0.2 units)**	**A Channels**	1.2
	B Channels	1.6
	C Channels	3.2
	E Channels	5.0
	Ea Channels	2.5
Surface Fine Sediment (% <6mm)	**A Channels**	24
	B3 Channels	10
	B4 Channels	20
	C3 Channels	14
	C4 Channels	29
	E3 Channels	20
	E4 Channels	38
	Ea Channels	44
Width/Depth Ratio	A Channels	9.2
	B Channels	15.8
	C Channels	25.6
	E Channels	9.1
	Ea Channels	8.3
Bank Erosion Hazard Index (BEHI)	A Channels	24.5
	B Channels	29.8
	C Channels	29.0
	E Channels	23.4
	Ea Channels	23.6
Human Caused Sediment Sources	**No significant sources**	
Supplemental Indicators	**Criteria**	
Percent Streambank Canopy Cover	70% (median for reference reaches)	
Percent Stable Bank	85% (median for reference reaches)	
% Fines in Spawning Gravels (49-pt grid) (<2 mm)	A Channels	Generally not applicable
	B Channels	8 (median B types in good condition)
	C Channels	6 (median C types in good condition)
	E Channels	No information
	Ea Channels	7 (median Ea types in good condition)
Clinger Richness	≥ 14	
Macroinvertebrate MVFP IBI	75% of potential score	

In addition to the sediment criteria listed above, Rosgen channel type departure was determined for all assessed reaches. Departure from natural stream type is used as an additional indicator of impairment. Departure is determined based on morphological variables, such as entrenchment, width/depth ratio, sinuosity, or high enough percent fines to change the stream type. The impairment determination for each stream includes discussion of departure from natural stream type and the variables driving the departure.

4.4.2.1 Sediment Criteria based on Channel Morphology and Stream Bottom Content

Several sediment targets are used to determine impairment due to sediment conditions. Impairment is determined using a "weight of evidence" approach, based on exceedence of target values for sediment criteria. If any of the criteria is exceeded and indicates sediment related water quality standards are exceeded, a TMDL for sediment will be completed. There may be certain situations were one or a couple of criteria are exceeded without clear evidence of standard exceedence. On the other hand, there may be certain situations where one or a couple targets are exceeded and the narrative sediment standards are clearly exceeded. See Section 3.3.2 for a description of the applicable sediment standards.

Entrenchment Ratio

Stream entrenchment ratio is equal to the floodprone width divided by the bankfull width (Rosgen, 1996). It is an indicator of stream incisement, and therefore indicates how easily a stream can access its floodplain. Streams are often incised due to detrimental land management or may be naturally incised due to landscape characteristics. Entrenchment ratio is used to help determine if a stream shows departure from its natural stream type. Usually, when a stream is entrenched, more of the streams energy is concentrated on the streambanks when flooding occurs. Because of the higher energy exerted on the banks, many overly entrenched situations have higher sediment loads derived from eroding banks. If the stream is not actively degrading (downcutting), the sources of human caused entrenchment are historic in nature and may not currently be present, although sediment loading may continue to occur. The entrenchment target based on potential stream type is an indicator of channel adjustment, but is not always practical endpoint for short-term management in many cases. Achieving the potential stream type and entrenchment targets is expected to be a long-term process affected by natural factors as well as management.

Percent Surface Fine Sediment <6 mm

Wolman pebble counts provide an estimate of the distribution of particle sizes in a stream reach. There is considerable variability inherent in the methods used for Wolman pebble counts, but pebble counts are a cost-effective way of determining particle distribution of streams. Pebble count data can be used to compare median particle sizes between streams, evaluate percent fines less than a specific size, and compare particle distributions between streams. However, due to the variability in pebble count data, some uncertainty is assumed in the results.

Surface fine substrate up to 6.35 mm may have detrimental impacts on aquatic habitat. Weaver and Fraley (1991) observed a significant inverse relationship between the percentage of material <6.35 mm and the emergence success of westslope cutthroat trout and bull trout. Further, they demonstrated a linkage between ground disturbing activities and spawning habitat quality.

According to BDNF unpublished data, reference conditions for all stream types indicate that fines <6.25 mm generally should not comprise more than about 25% of the substrate. Target values for percent fine sediment <6 mm are based on values for fines <6.25 mm defined by BDNF. Targets for percent surface fine sediment <6 mm are equal to the 75th percentile of fine sediment values for reference reaches, categorized by Rosgen level 2 stream type (Table 4-6).

Table 4-6. Criteria for Surface Fine Sediment. Values for Fines <6mm are from BDNF Reference Reach Database.

Stream Type	Sample Size	Target % <6 mm (75th Percentile)
A	9	24
B3	26	10
B4	14	20
C3	11	14
C4	19	29
E3	12	20
E4	64	38
Ea	23	44

Width/Depth Ratio

Width/depth ratio is a useful indicator of channel overwidening and aggradation, which are often linked to excess immediate or upstream erosion. Width/depth ratio is derived from channel bankfull width and average depth, and is based on quantified measurements. Width/depth ratio also is a standard measurement for determining stream type, making it a useful variable for comparing conditions on reaches within the same stream type. Targets follow reference values for width/depth ratio for level 1 stream type developed by BDNF from their surveys of reference reaches throughout southwest Montana. Targets for width/depth ratio are equal to the 75th percentile of reference reach data for Rosgen level 1 stream type (Table 4-7).

Table 4-7. Width/Depth Ratio Criteria Based on Rosgen Level 1 Stream Type (BDNF Unpublished Data).

Stream Type	Sample Size	Target W/D ratio (75th percentile)
A	9	9.2
B	43	15.8
C	37	25.6
E	93	9.1
Ea	25	8.3

Significant Human Caused Sediment Sources

Human caused sources need to be present for a TMDL to be written. If the only departure from reference conditions are stream channel conditions that do not affect sediment transport, a habitat restoration plan will be written. TMDLs need to address a reduction of sediment from applying restoration practices to human caused activities. The analysis that supports this parameter is supplied in the Sediment Source Assessment Section (Section 7.0) of this document.

4.4.2.2 Other Sediment Criteria

Additional parameters related to sediment are used with less weight in the impairment decision. These parameters have less weight due to a lack of information about target values, low reproducibility of methods, or the nature of the parameter not being conducive to application in management as a target. These parameters may be used with much more certainty in other areas of the state or in other TMDL projects because regional or TMDL project data were collected differently than in this area. Criteria that carry less weight in the Ruby TMDL process include percent woody vegetation canopy cover on streambanks, percent stable bank, residual pool depth, percent fine sediment (<2 mm) in spawning gravels at pool tail-outs, number of aquatic invertebrate “clinger” taxa and the Montana Valley and Foothill Prairies Ecoregion biotic index for aquatic macroinvertebrate communities (Bollman, 1998). The data used for setting these criteria are provided in the TMDL project data (Appendix D).

Percent Woody Canopy Cover on Streambank

Ocular estimates of streambank canopy cover were conducted as part of stream assessments. Streambank canopy cover was estimated as the percent of streambanks with woody vegetation cover, and was collected as an indirect indicator of streambank stability. This attribute is not meant to indicate the amount of shade to the stream. Use of this parameter is based on the assumption that canopy cover to streams may be naturally low in areas naturally dominated by herbaceous species or low-growing riparian shrubs, or dominated by higher shrubs on larger streams. This parameter should be examined in conjunction with other indicators such as beltwidth, percent stable bank, and width-depth ratio to determine if alterations to riparian area and channel are reducing cover. The guideline value of 70% is based on the median value for best available conditions in the Ruby for all stream types. This attribute was recorded to the nearest 10%. Quality control tests conducted in the field indicate an average margin of error of approximately 10% in estimates of percent cover among different observers. Percent streambank canopy cover is categorized as a less certain sediment criteria because it was collected using a qualitative method, and there are no standard target values for this attribute.

Percent Stable Bank

Ocular estimates of bank stability were conducted as part of stream assessments. Bank stability is estimated using professional judgment, based on bank height and vegetation cover, bank shearing, scouring, and fracturing. This variable is a direct estimate of bank erosion, but is not a direct indication of instream sediment levels. The target value of 85% is based on the median value for best available conditions in the Ruby TPA for all stream types. This attribute was recorded to the nearest 10%. Quality control tests conducted in the field indicate an average margin of error of 10-15% in estimates of percent stable bank among different observers. Percent stable bank is categorized as a less certain sediment criteria because it was collected using a qualitative method, and there are no standard target values for this parameter. However, bank stability is closely tied to presence of sufficient riparian vegetation to stabilize streambanks. Methods using percent of streambank with deep, binding rootmass use 85% as the lower limit indicating full function for that attribute (Thompson et al., 1998).

Bank Erosion Index (BEHI)

The BEHI method developed by Rosgen (1996) is widely used as an indicator of streambank erosion potential or bank stability. BEHI analysis provides a semi-quantitative assessment of streambank stability that can be used to supplement the more quantitative measurements of entrenchment, w/d ratio, and substrate distribution (BDNF, n.d.). Reference values for BEHI are from the Beaverhead-Deerlodge National Forest reference stream dataset, as summarized for stream type (BDNF, n.d.). Some variability is expected in BEHI scoring, due to the low repeatability of scoring methods. To be consistent with BDNF usage of BEHI data, BEHI values are allowed 10% on either side of the target value when comparing existing conditions to reference values. Table 4-8 below lists reference values, targets are based on 75th percentile, and the target value plus or minus 10 percent for BEHI values of major stream types.

Table 4-8. BEHI Targets

Stream Type	Sample Size	Reference Avg BEHI	Target value BEHI (75th percentile)	Target Value Range for Comparison (+/- 10%)
A	7	19.1	24.5	(22.05 – 26.95)
B	38	25.5	29.8	(26.82 – 32.78)
C	34	24.3	29.0	(26.1 – 31.9)
E	80	20.7	23.4	(21.06 – 25.74)
Ea	21	20.7	23.6	(21.24 – 25.96)

Percent Fines in Pool Tail-Out Gravels

A particle size of 2 mm is commonly used to define fine sediment based on the potential of sediment <2 mm to clog spawning redds and smother fish eggs. Studies have shown that increased substrate fine materials less than 2 mm can adversely affect embryo development success by limiting the amount of oxygen needed for development (Meehan, 1991). Percent fines (<2 mm substrate size) in spawning gravels was measured as part of stream assessments using a wire 49-point grid tossed into tailouts of all pools measured over a subreach length equivalent to 20 times the bankfull width. The number of wire cross-sections overlying fine sediment (<2 mm) was documented for each pool, and an average percent fines for the reach was calculated.

The wire grid method is less-commonly used for determining percent fines in surface substrate than the Wolman pebble count, but provides the advantage of focusing on critical habitat, and is therefore more directly related to aquatic habitat support. This method was not feasible where water was too turbid or in steep systems dominated by steep riffle or a series of plunge pools with no spawning habitat. As a result, the dataset for reaches used for reference condition is not robust enough to provide dependable target values. Therefore, the median value of all reaches in “good” condition, as determined from the SRAF score, was used for the target value for B and Ea channels. The median value is used to provide a margin of safety, as reaches in good condition may still exhibit some impairment due to sediment. This parameter is not applied to type 5 substrate streams, such as C5 or E5, because there is not enough data to determine target levels for percent fines in spawning gravels on these naturally fine-sediment-dominated streams.

Clinger Richness

In contrast with water chemistry data, and to some extent physical data, which provide information from a single point in time, examination of the macroinvertebrate community structure and function provides a better understanding of impacts that may have occurred over time. Also, unlike chemical and physical data, examination of the macroinvertebrate community provides a direct measure of the aquatic life beneficial use. The macroinvertebrate target is intended to integrate multiple stressors/pollutants to provide an assessment of the overall aquatic life use condition. Finally, in this case, the macroinvertebrate target provides information regarding impairments specifically associated with sediment.

Individual metrics for aquatic macroinvertebrate are proposed to diagnose potential stressors. Clinger richness can suggest possible sediment impacts. “Clinger” taxa have physical adaptations that allow them to cling to smooth substrates in swiftly flowing water. “Clingers” are sensitive to fine sediments that fill interstices between substrate particles and eliminate habitat complexity (Bollman, 2003). The clinger richness metric was developed by the University of Washington. Bollman has tested the utility of this metric in her own research. Fourteen clinger taxa are expected in mountain streams (Bollman, pers. com). Mountain streams with fewer than 14 clinger taxa are considered influenced by sediment.

The use of macroinvertebrate indices as diagnostic tools to indicate potential causes of impairment is a science that is still under development. The results, therefore, should be viewed with caution. However, given the current state of knowledge, the proposed targets provide the best available direct measure of aquatic life support.

Montana Valley and Foothill Prairies (MVFP) Ecoregion Biotic Index

Macroinvertebrate analysis, as well as periphyton analysis, is used to determine impairment to the beneficial use of aquatic life support. Biological metrics are designed to test for population sensitivity or response to varying degrees of human-induced impacts. Scores are assigned to the individual metrics and the total score allows comparison between sampling sites. The metrics vary depending on the ecoregion in which the sampling is conducted. Historically, the Montana Department of Environmental Quality (MDEQ) has used three ecoregional indices for assessing aquatic life use attainment – 1) Mountain IBI, 2) MountainValley and Foothill Plains (MFVP) IBI, and 3) Plains IBI. The original mountain and plains indices were developed using “Best Professional Judgment” to select metrics viewed as responsive to environmental stressors.

Bollman compared the ability of the MVFP and MDEQ’s Mountain indices to effectively discriminate between minimally and severely impacted sites. The analysis showed better discrimination using the MVFP index and individual metrics (Bollman, 1998). In addition, the dataset used to develop MVFP index was developed using data from approximately seven sites with elevation and topographical characteristic of montane streams. Therefore, the MVFP index (Bollman, 1998) is considered the most appropriate for use in the Ruby Watershed Planning Area.

MDEQ's scoring criteria for 303(d) impairment determinations will be applied to the MVFP IBI. The maximum possible score is 100 percent. Total scores greater than 75 percent are considered within the range of anticipated natural variability and represent full support of their beneficial use (aquatic life). Streams scoring between 25-75 are considered as partially supporting their aquatic life uses and scores lower than 25 percent represent non-support (MDEQ, 2000b). The macroinvertebrate target is intended to integrate multiple stressors/pollutants to provide an assessment of the overall aquatic life use condition.

MDEQ Stream Reach Assessment Form (SRAF) scores may be used to help link sediment and/or habitat conditions to macroinvertebrate community health. The SRAF score is an indicator of stream and riparian area condition, and therefore covers a broader scope of habitat parameters and functions as a supporting index of habitat alteration. SRAF score is not used as a sediment target because it is based on many factors, some of which are not related to sediment, and is therefore limited to an indicator of general stream reach condition. Stream reaches scoring 80 to 100 on the SRAF are considered to be in "good" condition. "Fair" condition correlates to an SRAF score of 60 to 80, while reaches scoring below 60 are considered as "poor" condition. Details of SRAF assessment methods and scoring are included in Appendix E.

The use of macroinvertebrate indices as diagnostic tools to indicate potential causes of impairment is a science that is still under development. The results, therefore, should be viewed with caution. However, given the current state of knowledge, use of narrative from biomonitoring analysis reports and the MVFP index provides the best available measure of aquatic life support. Montana DEQ is currently developing more robust and statistically defensible macroinvertebrate metrics that will likely be used in future assessments. During future TMDL review for the Ruby Watershed, the new macroinvertebrate metrics will likely be used instead of the MVFP metric.

Total Suspended Solids/Turbidity

Suspended solids consist of organic and inorganic materials that are transported to surface waters by overland flow or introduced into a system from streambank erosion. TSS is often used as an indicator of the amount of fine sediment moving through the system. Suspended sediment monitoring provides a direct measure of sediment transport dynamics while turbidity, which is highly correlated with suspended sediment levels, provides an indirect, but more easily conducted measure of sediment. Suspended sediment and turbidity are seasonally variable and strongly correlated to stream discharge. Turbidity and suspended sediment concentrations tend to be hysteretic, with higher values on the rising limb of the hydrograph relative to the falling limb. In supply limited, high-energy stream environments, increased concentrations of suspended sediment during peak flows do not necessarily correspond to impairment of biological function.

The inherent seasonal variability of suspended sediment concentrations, and indirect link to biological impacts makes this a challenging variable to use for siltation impairment targets. Additionally, insufficient data for turbidity and TSS exist to determine natural conditions. Therefore, sediment targets will not be expressed in terms of TSS or turbidity. This approach is taken based on the assumption that addressing other indicators of sediment will reduce TSS inputs to levels expected with reasonable land, water, and soil conservation practices in place.

None of the water bodies in the Ruby River watershed is listed for TSS in 2002/2004, but the west fork Ruby River and the upper and lower Ruby River were listed for TSS in 1996. Sediment TMDLs will address sources of both suspended and bed sediment conditions for these watersheds. Available TSS data for listed water bodies are compared to rough guideline values specified by Newcombe and Jensen (1996) to help determine impairment, but the guidelines are not intended to be used as sediment targets. Newcombe and Jensen (1996) specified TSS levels lethal to fish, summarized below in Table 4-9.

Table 4-9. Lethal Limits of TSS According to Newcombe and Jensen (1996).

Duration	Lethal Limit Concentration
Hourly lethal limit	403 mg/L
Daily lethal concentration	148 mg/L
Weekly lethal concentration	55 mg/L

These values are used for comparison in impairment determination because they provide a framework for relating TSS levels to potential impairment of aquatic life support as a beneficial use. Streams are considered potentially impaired due to high TSS if the measured concentration is equal to or greater than 403 mg/L. In addition, a single sample likely represents the critical exposure timeframe. Samples exceeding daily and weekly lethal concentrations may or may not be representative for the long time periods. TSS sampling sites are mapped in Map 10 of Appendix A. Suspended sediment conditions may exceed this limit naturally and therefore may not necessarily be impaired if exceedences are present unless significant human caused sediment sources are present. Use of the TSS concentration and duration based toxicity literature values should be considered along with biological data because of the uncertainty involved in applying the TSS toxicity criteria.

Trends in TSS are also summarized for the upper Ruby River to address TSS inputs to Ruby Reservoir in the impairment status discussion.

Pool Conditions

Pool conditions are very relevant targets for sediment TMDLs because they relate directly to sediment conditions in the stream, sediment transport, and to the fishery use. MDEQ measured residual pool depths during this project but did not find a sufficient amount of internal reference data to set pool related targets. Also, the Beaverhead-Deerlodge and Greater Yellowstone reference data available for this TMDL project did not have sufficient amount of pool measurements to set pool function targets.

The potential for pool depth and pool frequency fluctuates depending on Rosgen stream type and watershed size. Stream type and size vary greatly in the Ruby Watershed. A pool condition reference data set should consider these two factors because of the variability of streams in the Ruby Watershed. Because of these dependencies, a sufficiently large reference data set was not available to set pool targets at this time. Future Ruby TMDL reviews should consider using residual pool depths and pool frequencies as targets if a sufficient reference data set is available. The Proposed Future Studies and Adaptive Management Strategy section identifies a need for pool reference condition monitoring.

4.4.2.3 Decision Process for Determining the Linkage Between Sediment and Impairments in the Ruby TPA

Targets based on reference conditions have been defined for sediment criteria (percent surface fine substrate, width/depth ratio, streambank stability, canopy cover on streambanks, BEHI). Bioindicators provide additional information about impairment of aquatic life, the beneficial use impaired by sediment for listed water bodies in the Ruby Watershed. These criteria provide a best approximation of natural conditions to be consistent with narrative water quality standards. Variability due to landscape must be considered in impairment determination in some cases.

Numeric standards have not been developed for sediment, therefore impairment must be determined from other indicators related to sediment. There is no perfect metric from biomonitoring, and no perfect indicator of sediment, to determine impairment. Therefore impairment determination follows a weight of evidence approach, in which several indicators are examined to determine impairment. Some general rules are followed in determining impairment, however, determining impairment also requires best professional judgment to take the unique setting for each situation into account when determining if data are indicating impairment of beneficial uses.

Upland, road-related sediment delivery, and streambank sources of sediment have been documented to facilitate allocation for sediment TMDLs (Section 7.0). Data from the sediment source inventories are used as a line of evidence to determine impairment.

Sediment Criteria by Water Body

Alder Creek

Table 4-10. Sediment Criteria for Alder Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
B4	1.6	15.8	20	8	29.8
C4	3.2	25.6	29	6	29
E4	5.0	9.1	38	ND	23.4
E5	5.0	9.1	NA	ND	23.4

NA = Target not applicable to this stream type
ND = No data

Basin Creek

Table 4-11. Sediment Criteria for Basin Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
B4	1.6	15.8	20	8	29.8
E4	5.0	9.1	38	ND	23.4
Ea	2.5	8.3	44	7	23.6

ND = No data

Burnt Creek

Table 4-12. Sediment Criteria for Burnt Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
B4	1.6	15.8	20	8	29.8
Ea	2.5	8.3	44	7	23.6

California Creek

Table 4-13. Sediment Criteria for California Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
B4	1.6	15.8	20	8	29.8
C5	3.2	25.6	NA	NA	29
E4	5.0	9.1	38	ND	23.4

NA = Target not applicable to this stream type
ND = No data

Clear Creek

Table 4-14. Sediment Criteria for Clear Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
E5	5.0	9.1	NA	NA	23.4

NA = Target not applicable to this stream type

Coal Creek

Table 4-15. Sediment Criteria for Coal Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
B4	1.6	15.8	20	8	29.8
C4	3.2	25.6	29	6	29

Cottonwood Creek

Table 4-16. Sediment Criteria for Cottonwood Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
E4	5.0	9.1	38	ND	23.4
Ea	2.5	8.3	44	7	23.6

ND = No data

Currant Creek

Table 4-17. Sediment Criteria for Currant Creek.

	Sediment Criteria				
Potential Stream Type	Entrenchment Ratio	Width / Depth Ratio	Fines <6 mm	Fines 49 pt Grid	BEHI
A4	1.2	9.2	24	ND	24.5
B4	1.6	15.8	20	8	29.8

East Fork Ruby River

Table 4-18. Sediment Criteria for East Fork Ruby River.

	Sediment Criteria				
Potential Stream Type	Entrenchment Ratio	Width / Depth Ratio	Fines <6 mm	Fines 49 pt Grid	BEHI
B4	1.6	15.8	20	8	29.8

Garden Creek

Table 4-19. Sediment Criteria for Garden Creek.

	Sediment Criteria				
Potential Stream Type	Entrenchment Ratio	Width / Depth Ratio	Fines <6 mm	Fines 49 pt Grid	BEHI
A4	1.2	9.2	24	ND	24.5
B4	1.6	15.8	20	8	29.8

ND = No data

Hawkeye Creek

Table 4-20. Sediment Criteria for Hawkeye Creek.

	Sediment Criteria				
Potential Stream Type	Entrenchment Ratio	Width / Depth Ratio	Fines <6 mm	Fines 49 pt Grid	BEHI
E4	5.0	9.1	38	ND	23.4
E4b	5.0	9.1	38	ND	23.4

ND = No data

Indian Creek

Table 4-21. Sediment Criteria for Indian Creek.

	Sediment Criteria				
Potential Stream Type	Entrenchment Ratio	Width / Depth Ratio	Fines <6 mm	Fines 49 pt Grid	BEHI
A3	1.2	9.2	24	NA	24.5
B3	1.6	15.8	10	8	29.8
B4	1.6	15.8	20	8	29.8

NA = Target not applicable to this stream type

Middle Fork Ruby River

Table 4-22. Sediment Criteria for Middle Fork Ruby River.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
E4	5.0	9.1	38	ND	23.4

ND = No data

Mill Creek

Table 4-23. Sediment Criteria for Mill Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
B3	1.6	15.8	10	8	29.8
B4	1.6	15.8	20	8	29.8
E4	5.0	9.1	38	ND	23.4

ND = No data

Mormon Creek

Table 4-24. Sediment Criteria for Mormon Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
B5	1.6	15.8	NA	NA	29.8
E4	5.0	9.1	38	ND	23.4
Ea	2.5	8.3	44	7	23.6

NA = Target not applicable to this stream type
ND = No data

Poison Creek

Table 4-25. Sediment Criteria for Poison Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
B4	1.6	15.8	20	8	29.8
B5	1.6	15.8	NA	NA	29.8

NA = Target not applicable to this stream type

Ramshorn Creek

Table 4-26. Sediment Criteria for Ramshorn Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
A3	1.2	9.2	24	NA	24.5
A4	1.2	9.2	24	ND	24.5
B4	1.6	15.8	20	8	29.8
E4	5.0	9.1	38	ND	23.4
E5	5.0	9.1	NA	ND	23.4
Ea	2.5	8.3	44	7	23.6

NA = Target not applicable to this stream type
ND = No data

Ruby River Below Reservoir

Table 4-27. Sediment Criteria for Lower Ruby River.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
C4	3.2	25.6	29	6	29
E4	5.0	9.1	38	ND	23.4

ND = No data

Ruby River Above Reservoir

Table 4-28. Sediment Criteria for Upper Ruby River.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
E4	5.0	9.1	38	ND	23.4

ND = No data

Shovel Creek

Table 4-29. Sediment Criteria for Shovel Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
E4	5.0	9.1	38	ND	23.4
Ea	2.5	8.3	44	7	23.6

ND = No data

Sweetwater Creek/North Fork Sweetwater Creek
Table 4-30. Sediment Criteria for Sweetwater Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
C4	3.2	25.6	NA	NA	29
E4	5.0	9.1	38	ND	23.4
E5	5.0	9.1	NA	ND	23.4

NA = Target not applicable to this stream type
ND = No data

Warm Springs Creek
Table 4-31. Sediment Criteria for Warm Springs Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
B4	1.6	15.8	20	8	29.8
E4	5.0	9.1	38	ND	23.4
E5	5.0	9.1	NA	ND	23.4

NA = Target not applicable to this stream type
ND = No data

West Fork Ruby River
Table 4-32. Sediment Criteria for West Fork Ruby River.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
E4	5.0	9.1	38	ND	23.4
E4b	5.0	9.1	38	ND	23.4

ND = No data

Wisconsin Creek
Table 4-33. Sediment Criteria for Wisconsin Creek.

	Sediment Criteria				
Potential Stream Type	**Entrenchment Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**
B3	1.6	15.8	10	8	29.8
B4	1.6	15.8	20	8	29.8
Ea	2.5	8.3	44	7	23.6

Uncertainty

The BDNF reference site dataset constitutes the best available data for reference condition channel morphology for southwest Montana. Even so, sample sizes are quite small to derive target values with a high degree of certainty. Because no better reference data are available, the target values derived from the BDNF database are assumed to represent reference conditions for channel morphology and stream bottom content of streams in the Ruby TPA. Sample sizes are also statistically low for reference reaches used to derive target values for other sediment criteria. Sources of uncertainty are mitigated by an adaptive management approach where effectiveness monitoring and further assessment will be used to change the management approach if the current targets do not appear to protect resources, or appear to be too conservative to allow for reasonable use of the resources.

SECTION 5.0
UPDATED DATA AND IMPAIRMENT REVIEW

5.1 Methods for Determining Impairment Status

The Total Maximum Daily Load, Water Quality Restoration Plan Process (TMDL/WQRP) and the Sufficient and Credible Data, Beneficial Use Determination (MDEQ 303(d) impairment reviews) process are two separate procedures that actually complement one another. The MDEQ 303(d) impairment review process, is the process by which the MDEQ utilizes all available chemical, physical and biological information in order to make impairment decisions on the water bodies of Montana. This is the process by which streams are both listed or *de-listed* on the 303(d) list. This is completed annually and reported on biannually in the 303(d)-305(b) Integrated Report. If streams are found as not supporting one or more of their beneficial uses due to one or a combination of pollutants (i.e. sediment, nutrients, temperature) a TMDL is required.

Impairment status was determined using relevant data from U.S. EPA's STORET database, data from MDEQ 303(d) impairment reviews, any relevant data from outside sources, and all new data collected for TMDL purposes. The impairment status review provided in this document is a summary of all the most relevant and recent data that is compared to the targets using decision processes provided in Section 4.0. For pollutants with narrative standards, conditions of 303(d) listed water bodies are compared to reference settings. Numeric standards are used where available. This impairment review is not the formal 303(d) impairment review process, but will be used to update 303(d) impairment reviews in the near future.

Most of the sediment related data presented in this section relies upon data specifically collected for the TMDL process and also on previously-collected USFS and 303(d) assessment related data. The sediment TMDL process used an initial aerial photo analysis that broke stream segments into similar geomorphic reaches. Monitoring site selection within a reach was conducted with the intent of identifying average conditions along each aerial assessed reach. This information could be extrapolated to a reach-scale, and ultimately a listed-segment scale. Using this site selection method represents the average existing conditions for each geomorphic stream type on a given listed segment.

5.2 Impairment Status of Listed Water Bodies

A summary (by water body) of the data that were collected and reviewed through 2004 is presented in this section. Impairment status determinations for this report build upon MDEQ 303(d) impairment reviews for the 2004 303(d) List. Only data pertaining to pollutants for which each water body is listed will be summarized, unless the data indicate a need to review the listing of the water body for other pollutants. Table 5-1 provides a brief summary of the results from this impairment status review. For the sake of brevity, habitat alterations or flow alteration listings are included with the pollutants in the suspected causes of impairment only when no other associated pollutants are listed for a water body. TMDL source assessments for listed pollutants will address physical sources of impairment such as dewatering or habitat alterations as sources.

Table 5-1. Water Quality Summary of Impaired Water Bodies and Proposed Actions for TMDL Development in the Ruby River Watershed.

Water Body Name and Number	Suspected Pollutant or Pollution	Conclusions/ Status	Proposed Action
Alder Creek, MT41C002_040	Sediment	Impacts aquatic life	A sediment TMDL will be written.
	Copper	Error in listing	No TMDL will be written.
	Mercury	Likely impacts aquatic life and potentially human health	A mercury TMDL will be written in the future.
Basin Creek, MT41C003_120	Sediment	Impaired	A TMDL will be written.
Burnt Creek, MT41C003_130	Sediment	Impaired	A TMDL will be written.
California Creek, MT41C002_090	Sediment	Impaired	A TMDL will be written.
Coal Creek, MT41C003_020	Sediment	Impaired	A TMDL will be written.
	Temperature	Unknown	More data is needed to verify impairment. A TMDL may be written in the future.
Cottonwood Creek, MT41C003_030	Sediment	Impaired	A TMDL will be written.
Currant Creek, MT41C002_060	Sediment	Impaired	A TMDL will be written.
	Metals	Not listed but possibly impaired	Further monitoring recommended.
	Nutrients	Not listed but possibly impaired	Further monitoring recommended.
East Fork Ruby River, MT41C003_040	Sediment	Impaired	A TMDL will be written.
Garden Creek, MT41C002_100	Sediment	Impaired	A TMDL will be written.
Harris Creek, MT41C002_120	Sediment	Not impaired	A TMDL will not be written.
Hawkeye Creek, MT41C003_140	Habitat Alterations	Not impaired	A TMDL will not be written.
Indian Creek, MT41C002_030	Flow Modification	Impaired	Flow modification is a source category for the sediment TMDL.
	Habitat Alterations	Impaired	Habitat alterations will be addressed through a sediment TMDL.
	Sediment	Not currently listed but impaired	A TMDL will be written.
Middle Fork Ruby River, MT41C003_090	Sediment	Impaired	A TMDL will be written.
Mill Creek, MT41C002_020	Sediment	Impaired	A TMDL will be written.
	Metals	Not impaired	No TMDL will be written A monitoring plan is provided to track metals conditions.
	Temperature	Impaired	A TMDL will be written.
Mill Gulch, MT41C002_070	Sediment	Not impaired	A TMDL will not be written.
Mormon Creek, MT41C002_110	Sediment	Impaired	A TMDL will be written.
North Fork Greenhorn Creek, MT41C003_070	Habitat Alterations	Not impaired	A TMDL will not be written.

Table 5-1. Water Quality Summary of Impaired Water Bodies and Proposed Actions for TMDL Development in the Ruby River Watershed.

Water Body Name and Number	Suspected Pollutant or Pollution	Conclusions/ Status	Proposed Action
Poison Creek, MT41C003_110	Sediment	Impaired	A TMDL will be written.
	Metals	Not listed; Unknown	Further monitoring recommended.
Ramshorn Creek, MT41C002_050	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for lead.
	Nutrients	Not currently listed but possibly impaired	Further monitoring recommended.
Ruby Reservoir, MT41C004_010	Sediment	Not impaired	A TMDL will not be written.
Ruby River below reservoir, MT41C001_010	Sediment	Impaired	A TMDL will be written.
	Metals	Not impaired	A TMDL will not be written.
	Temperature	Impaired	A TMDL will be written.
Ruby River above reservoir, MT41C001_020	Sediment	Impaired	A TMDL will be written.
	Metals	Not impaired	A TMDL will not be written.
Shovel Creek, MT41C003_150	Sediment	Likely impaired	A TMDL will be written.
Sweetwater Creek, MT41C003_060	Nutrients	Impaired	A TMDL will be written.
	Sediment	Impaired	A TMDL will be written.
Warm Springs Creek, MT41C003_050	Sediment	Impaired	A TMDL will be written.
West Fork Ruby River, MT41C003_080	Sediment	Likely Impaired	A TMDL will be written.
Wisconsin Creek, MT41C002_010	Sediment	Impaired	A TMDL will be written.
	Metals	Potentially Impaired	No TMDL will be written at this time because metal concentrations in water are below standards but sediment metals and biological toxic responses are near thresholds. A monitoring plan is provided.

Several water bodies not currently listed for nutrients show exceedence of target values for nutrients. Other streams in similar settings had nutrient levels below detection, indicating nutrient levels are not uniformly naturally high throughout the watershed. Nutrient water quality data are very limited, consisting of only one or two samples for most water bodies. More monitoring is recommended for all water bodies showing exceedence. Certain water bodies are recommended for more extensive monitoring due to several indications of elevated nutrients, as explained in Section 6.0, Nutrients. Impairment summaries by water body often refer to sampling site names or reach names. Water quality and biomonitoring sample sites and assessment reaches are provided in Map 2 in Appendix A.

5.3 Summary by Water Body

5.3.1 Alder Creek (Alder Gulch)

Alder Creek watershed encompasses the extreme southern portion of the Tobacco Root mountains and the northern portion of the Greenhorn Mountain Range. Alder Creek flows into the Ruby River near the town of Laurin. Headwater areas are forested in the extreme northern and southern portions of the watershed, but most of the area is composed of grass and shrub land. Browns Gulch and Granite Creek are two major tributaries to Alder Creek (Appendix A – Map 1).

Alder Gulch was identified on the 1996 303(d) List for impairment of aquatic life support, coldwater fishery, and threatened for drinking water and primary contact (recreation). Probable causes of impairment listed in 1996 were habitat alterations and siltation. Probable sources were agriculture, channelization, dredge mining, flow regulation/modification, and resource extraction. The 2004 303(d) List indicates that aquatic life, coldwater fishery, and drinking water are not supported, and primary contact (recreation) is partially supported. Potential causes of impairment specified for the 2004 303(d) List are metals, copper, mercury, fish habitat degradation, riparian degradation, siltation, and habitat alteration. The major sources identified during the TMDL source assessment are associated with historic mining, agriculture, transportation and potentially some limited silvicultural activities.

5.3.1.1 Metals

The 2004 303(d) List identifies metals, mercury, and copper as the chemical pollutants likely affecting beneficial uses of Alder Creek. The decision criteria for metals provided in Section 4.0 of this document are used to determine if a specific metal is affecting a designated use. Mercury and lead were the only metals found in the water or sediment at levels that are likely injurious to aquatic life or humans.

The metals data review for Alder Creek includes data for Browns Gulch, a major tributary to Alder Creek that also contains priority abandoned mine sites. Water quality and sediment chemistry information is available from the Montana DEQ Abandoned Mines Reclamation Bureau from near Priority Abandoned Mines. During 1993, data quality objectives were not met on a portion of the water quality samples collected in this watershed. Only samples from this data set that meet data quality objectives are used in the impairment analysis. Water quality, sediment chemistry, and biological data associated with 303(d) listing and TMDL monitoring activities were collected intermittently from 2000-2003 and all meet data quality objectives. Sediment mercury chemistry collected during 2003 is available from Montana DEQ Hardrock Mining Program and meets data quality objectives.

5.3.1.1.1 Copper

The copper listing was found to be in error because it was based on a single water quality aquatic life standard exceedence during 1993 that does not meet laboratory quality assurance requirements. There were no exceedences of copper standards in 23 water chemistry samples that met data quality objectives and were collected during various timeframes and various locations. All sediment metal results indicate that copper is below criteria provided in Table 4-1.

5.3.1.1.2 Mercury

The human health standard for mercury is 0.05 µg/L. The detection limit of labs in Montana is currently above the human health standard of 0.05 µg/L. Thus, unless there is detection of mercury in a sample, the water chemistry analysis cannot determine if mercury levels are above human health standards. Future water chemistry monitoring should use U.S. EPA method 1631 to determine if human health standards are exceeded. U.S. EPA method 1631 provides a detection limit lower than Montana's human health standard. The existing mercury water quality data for Alder Creek cannot determine if human health standards are exceeded. The human health standard was exceeded in Browns Gulch.

The only water quality samples in the watershed with proper data quality requirements from 1993 that detected the presence of mercury are located near the Pacific and Easton mines in Browns Gulch. Mercury was not detected at any of six intermittently spaced sites during August 2000 monitoring. Water quality samples collected at 8 sites targeting priority abandoned mines on Alder Creek and Browns Gulch during both high and low flows in 2003 were all below the mercury detection limit (1 ug/L).

Elemental mercury is very insoluble and descends into sediments because it is heavy. Therefore, mercury is usually found in sediments, but is only present in minute quantities in surface water. Elemental mercury can be transformed via a biological process into methylmercury, which easily enters the food chain. Once mercury enters the food chain, it builds up in animal tissue quite easily. Mercury's bioaccumulation factor is on average 110 times higher than most common heavy metals (Cu, Pb, Cd, Zn). Because of mercury's tendency to bioconcentrate, mercury concentrations in stream sediments were exclusively assessed and compared to criteria to determine if mercury is likely impacting aquatic life use and potentially influencing human health via fish consumption. In specific areas, sediment mercury concentrations were 50-150 times levels that are likely to impact aquatic life use and bioaccumulation. Mercury concentrations found in Alder Creek's sediment are significantly above thresholds that have been shown to affect bioconcentration in edible fish tissue (Maret and Skinner, 2000; MDPHHS, 2003).

Instream sediment metals collected near priority abandoned mines during 1993 in Browns and Alder Gulch show a range in sediment mercury concentrations from <0.05 to 0.481 ppm (Appendix A - Map 11). Sediment sample results ranged from <0.1 to 0.5 ppm at six sites during August 2000 (Table 5-2). Sediment sample results ranged from <0.05 to 23 ppm in Alder Gulch during sampling conducted in 2003 (Appendix A - Map 11). Many of the sediment samples were above the sediment target of 0.2 ppm. Known human influenced sources of mercury in the watershed include aerial deposition and historic gold mining that used mercury amalgamation techniques.

5.3.1.1.3 Lead

One sample collected below the Pacific Mine in Browns Gulch (site BR-2) showed an exceedence of hardness-based chronic water quality standard concentration level for lead, while the sample above the mine was below detection for lead. Sites BR-2 and BR-3, located below the Pacific and Easton mines, are the only monitoring locations showing detectable levels of lead. There were no water quality exceedances of lead standards in Alder Creek.

Instream sediment chemistry data collected in 1993 shows elevated levels of lead below the Kearsage Mine in Mill Gulch, another tributary to Alder Creek. The sediment metal concentrations in Browns Gulch and Mill Gulch are sufficiently high that they pose a risk to the health of aquatic life, according to published guidance values (U.S. EPA, 2001; Maret and Skinner, 2000; Buchman, 1999). Browns Gulch and Mill Gulch are not currently listed for lead. A plan to monitor lead in Browns Gulch and Mill Gulch is provided in Section 11.0. Future 303(d) list review will assess Browns and Mill Gulches. Existing data support that lead is not impacting use in the mainstem of Alder Creek although follow up monitoring will target areas in Alder Creek directly below tributaries that show indications of lead contamination.

Table 5-2. Review of Water Quality Samples that Exceed Standards.

Metal	Date	Flow (cfs)	Hardness (mg/L)	Conc. (µg/L)	Exceedence Summary
Browns Bulch Site 2 (below Pacific mine)					
Lead	2003	0.32	137	14	**Exceeds** hardness based chronic aquatic life criteria (4.7 µg/L)
Browns Gulch above Pacific mine (site 29-118-SW-1)					
Mercury	1993		N/A	20	**Exceeds** human health standards
Browns Gulch above Easton mine (site 29-121-SW-1)					
Mercury	1993		N/A	22	**Exceeds** human health standards
Browns Gulch below Easton mine (site 29-121-SW-2)					
Mercury	1993		N/A	20	**Exceeds** human health standards
Browns Gulch at Easton mine (site 29-121-SW-3)					
Mercury	1993		N/A	27	**Exceeds** human health standards

5.3.1.1.4 Biological Indicators

Macroinvertebrate sample results from all sites on Alder Creek and from BR-2 on Browns Gulch state that impacts from “metals pollution cannot be ruled out,” but direct evidence of toxicity is not evident (Bollman, 2003). Habitat and sediment conditions influenced macroinvertebrate health at many of the sites; impacts because of metals could not easily be separated from other impacts. There is no indication of impairment by metals from the diatom data for Alder Creek. Yet, with mercury contamination, toxicity to aquatic life is usually less severe than bioaccumulation, and ultimately the most sensitive use is related to human health through contaminated fish consumption or drinking water consumption. There are no fish tissue mercury data for Alder Creek although Montana FWP will be collecting these data during the summer of 2005. Levels of mercury in the sediment detected by Montana DEQ have triggered plans for fish tissue monitoring.

Biomonitoring results indicate impairment by metals at a number of sites in Browns Gulch. Diatom results from site BR-1, on Browns Gulch above the Pacific mine, indicate full support of aquatic life use and reflect excellent diatom diversity and species richness for a mountain stream (Bahls, 2003). In contrast, results from sites BR-2 and BR-3, below the Pacific-Easton mine sites, indicate partial support of aquatic life, with metals toxicity as the likely limiting factor (Bahls, 2003).

5.3.1.1.5 Metals Summary

Mercury conditions in the sediments of Alder Creek are exceeding levels shown to impact biological uses and are also likely to impact bioaccumulation of mercury. Sediment mercury levels are above thresholds shown to cause toxic responses to aquatic life in laboratory settings, though it does not appear to be toxic to aquatic life in Alder Creek according to biological measurements used for TMDLs in Montana. A mercury TMDL will be constructed for Alder Creek because mercury can easily bioaccumulate into aquatic life and fish from the sediment and sequentially impact human health through fish consumption.

Water chemistry, sediment chemistry, and biomonitoring data all indicate metals impact uses in Browns Gulch. Brown's Gulch should be considered as a 303(d) list candidate with mercury and lead as causes of impairment. The mercury source assessment for Alder Gulch will address mercury contamination in Browns Gulch. Sediment chemistry is the only indicator of likely impacts in Mill Gulch below Kearsage Mine. Because only sediment lead concentrations were above criteria without other indications of metal toxicity, a follow up monitoring plan is provided for Mill Gulch in Section 11.0.

Currently, mercury water quality data for Alder Creek do not have a low enough detection limit to assess the human health standards adequately. Fish tissue data are also absent. A large component of the mercury TMDL will be an adaptive management approach that identifies further monitoring activities. No other metals were found above water quality standards or sediment metal criteria in Alder Creek.

5.3.1.2 Sediment

5.3.1.2.1 Total Suspended Solids

Only minimal TSS data for Alder Gulch exist. Three samples from 2003 taken at the mouth of Alder Creek range from below detection to 20 mg/L TSS. These limited data are not robust enough to make conclusions about sediment conditions.

5.3.1.2.2 Biology

Biomonitoring data from Browns Gulch and Alder Creek indicate impairment of beneficial uses due to sediment, according to interpretive results from laboratory analysis reports. Macroinvertebrate data from 2003 reflect sedimentation as a limiting factor for aquatic life support at ALD-1, ALD-3, BR-1, BR-2 and BR-4 (Bollman, 2003). The MVFP index score for macroinvertebrate samples on Alder Gulch and Browns Gulch indicates that habitat alteration may be impairing the beneficial use of aquatic life support on part of Alder Creek. Sites ALD-1 and ALD-2, above Virginia City and the confluence of Browns Gulch, show full support of aquatic life according to MVFP index scores (83-89%). However, sites below Browns Gulch confluence and above the confluence of Alder Creek with Ruby River have MVFP scores of 22-33%, much lower than the target of 75% used to indicate full support of aquatic life (Table 5-3). On Browns Gulch the MVFP index score did not meet the target level just below the Pacific mine (72%) or above the confluence with Alder Creek (50%). Clinger richness was also lower than target values in the upper reaches of Browns Gulch and in lower reaches of Alder Creek (Table 5-3).

Table 5-3. Summary of Impairment Based on Macroinvertebrate Metrics for Alder Creek and Browns Gulch (2003 Data).

	Clinger Richness	MVFP Index
Site	**ALD1**	
Target Value	≥14	≥75
Existing Value	13	89
Percent Departure	7%	NE
Site	**ALD2**	
Target Value	≥14	≥75
Existing Value	17	83
Percent Departure	NE	NE
Site	**ALD3**	
Target Value	≥14	≥75
Existing Value	10	22
Percent Departure	28%	71%
Site	**ALD4/A1**	
Target Value	≥14	≥75
Existing Value	12	33
Percent Departure	14%	56%
Site	**Browns 1**	
Target Value	≥14	≥75
Existing Value	5	83
Percent Departure	64%	NE
Site	**Browns 2**	
Target Value	≥14	≥75
Existing Value	7	72
Percent Departure	50%	4%
Site	**Browns 3**	
Target Value	≥14	≥75
Existing Value	19	89
Percent Departure	NE	NE
Site	**Browns 4**	
Target Value	≥14	≥75
Existing Value	9	50
Percent Departure	NE	33%

5.3.1.2.3 Physical Conditions and Sediment Sources

Significant historic and current anthropogenic sources of sediment are present. Extensive streambank erosion occurs in some areas due to current and recent human caused impacts on riparian areas, specifically impacts associated with grazing (see Section 7.0 for more details). Most historic alteration is due to extensive placer mining that has altered channel geometry and destabilized several miles of Alder Gulch. Bank stability was lower than target values for all Rosgen stream types. Percent surface fine substrate based on either Wolman pebble count or 49-point grid also exceeded target levels on all stream channel types. In other areas all small sized sediments were removed via dredge mining that left only large cobbles behind. Historic mining operations also disrupted the continuity of the stream channel and sediment transport. Rosgen stream channel type departure in the placer mined reaches is due to historic mining and current agricultural activities. Lower reaches are slightly entrenched compared to reference conditions.

Sediment deposition and transport are clearly impacted by human causes. Over half the sediment criteria displayed exceedence of target values for most Rosgen stream types present on Alder Creek (Table 5-4).

Table 5-4. Summary of Sediment Impairment Based on Physical Indicators for Alder Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**%Fines <6 mm**	**Fines 49 pt Grid**	**BEHI Bank Erosion Hazard**	**Estimated % Stable Bank**
Target	B4	≥1.6	≤15.8	≤20	≤8	29.8	≥85
Existing	B4	2 S	16 S	21 S	ND	24.9 S	60 S
Percent Departure	No Departure	**NE**	1%	5%	ND	**NE**	29%
Target	C4	≥3.2	≤25.6	≤29	≤6	29	≥85
Existing	C4	4.7 S	18 S	26 S	30 S	14.9 S	80 S
Percent Departure	No Departure	**NE**	**NE**	**NE**	400%	**NE**	6%
Target	E4	≥5	≤9.1	≤38	NA	23.4	≥85
Existing	C4, C5	3	≤23	≤62	24.9	23.7	40 M
Percent Departure	Departure	40%	60%	39%	NA	1%	53%
Target	E5	≥5	≤9.1	NA	NA	23.4	≥85
Existing	C5	2.8 S	10 S	71 S	17 S	20 S	45 S
Percent Departure	Departure	44%	10%	NA	NA	**NE**	47%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No exceedence
S = Single value
M = Two values – maximum given (minimum for % stable bank)

5.3.1.2.4 Summary

The evidence detailed above provides sufficient linkage between sediment and impairment conditions in Alder Creek. Biological uses show impairment, sediment sources are present, and sediment supply and transport are impacted in Alder Creek. Montana's narrative sediment standards are distinctly exceeded in Alder Creek. A sediment TMDL is needed, primarily for the lower reaches of Alder Creek and because of the influence of Browns Gulch. More monitoring is recommended for Brown's Gulch to verify impairment status. Currently, Brown's Gulch is not listed as impaired.

5.3.1.3 Other Considerations

Biomonitoring data from 2003 also indicated thermal modification on Alder Gulch. At Site ALD1, the highest elevation site (Appendix A – Map 2), more tolerant macroinvertebrate taxa indicate warmer, enriched still water environs with finer substrates. At Site ALD3, just below the confluence of Browns Gulch and in an area with active beaver ponds, no cold-stenotherms or sensitive taxa were collected, and 26% of animals taken at the site were distinctly tolerant taxa. Near its confluence with Alder Creek, Brown's Gulch (Site BR-4) supports a tolerant assemblage characteristic of warm water streams. Presence of warmer water taxa in samples collected from ALD3 and BR-4 is probably due in part to beaver complexes; however, channel widening and vegetation removal on Browns Gulch due to mining and grazing activity likely influence water temperature.

Granite Creek, another primary tributary to Alder Creek, should also be further monitored, and considered for 303(d) review after monitoring, due to impacts by past mining and current impacts from grazing, roads, and timber harvest on steep slopes.

5.3.2 Basin Creek

Basin Creek is located in the headwaters area of the Ruby River. The Basin Creek Watershed is entirely managed by the USFS. Many north facing slopes are forested while most of the watershed is grass and shrub land.

Basin Creek is listed for partial support of aquatic life and coldwater fishery in 1996 and in 2004. Probable Causes are habitat alterations and siltation. Agriculture is the only probable source listed in 1996. Causes of impairment specified in 2004 are bank erosion, siltation, riparian degradation, and other habitat alterations. Sources of impairment specified in 2004 are bank modification/destabilization, habitat modification other than hydromodification, highway maintenance and runoff, and unpaved road runoff. The TMDL source assessment identified grazing and natural sources as significant.

5.3.2.1 Sediment

5.3.2.1.1 Total Suspended Solids

TSS concentration found in a sample collected during 2001 was very low (<10 mg/L). Too few TSS data are available for making any conclusions regarding the sediment listing.

5.3.2.1.2 Biology

Borderline impairment to the macroinvertebrate community was found in Basin Creek based on samples collected in 2001 (Table 5-5). MVFP index scores for both sampling sites on Basin Creek (Appendix A – Map 2) are at or just above the target of 75%. Fish spawning is likely impacted in certain areas by the level of fine sediment in the stream. State cutthroat trout survey found 90-99% pure westslope cutthroat trout in Basin Creek (BDNF, 2004).

Table 5-5. Summary of Impairment Based on Macroinvertebrate Metrics for Basin Creek (2001 Data).

	Clinger Richness	MVFP Index
Site	**BAS1**	
Target Value	≥14	≥75
Existing Value	15	78
Percent Departure	NE	NE
Site	**BAS2**	
Target Value	≥14	≥75
Existing Value	18	72
Percent Departure	NE	4%

5.3.2.1.3 Physical Conditions and Sediment Sources

MDEQ 2001 field photos and riparian assessments indicate that riparian habitat impacts due to grazing are the main human cause of sediment. Inventories conducted in 2003 for TMDL source assessment documented natural and human-caused sediment sources along streambanks, and found that sediment sources are largely natural. According to the 2003 sediment source assessment results only 16% of the total sediment load is due to human causes (see Section 7.0). The other 84% of the sediment load was attributed to natural sources, including unstable soils, actively eroding banks and naturally unstable upland slopes. Deposited fine sediment is high in upper reaches of Basin Creek, where current grazing management does not appear to have detrimental effects on the stream (Appendix F – Basin #4). Evidence of past beaver activity was apparent throughout the area surveyed, although some of the features were quite old, indicating higher levels of beaver activity in the past.

The lower reach of Basin Creek has recent beaver activity, which likely has both positive and negative effects on sediment deposition and transport, because dams are currently not maintained. This reach shows signs of improvement in condition such as shrub regeneration most likely due to recent changes in grazing management and due to beaver activity, but grazing still has some influence on near-stream sediment production. Examples of effects still influencing water quality include streambank vegetation removal, floodplain compaction, maintaining dominance of non-native understory species, and bank trampling. These effects are evident primarily along the lower half of the stream. Impacts to riparian habitat were assessed using the MDEQ SRAF stream condition from. SRAF scores range from 92% (Good) at the upstream-most reach to 68% (Fair) at the downstream end of Basin Creek, indicating some impact to riparian condition due to grazing. Restoring riparian vegetation is important for filtering sediment contributed from natural upland sources. Riding is being used to move cattle from riparian areas to allow recovery of streambanks and riparian vegetation, but cattle have been observed returning to the stream within one hour after being moved.

In 2003, results from the Wolman pebble count average 37% surface fine sediment (<6 mm), which exceeds target values for reference B and E stream types from BDNF (n.d.). The average percentage of fines from the 49-point grid technique in spawning areas was 55%, which is relatively high in comparison to other streams in the Ruby drainage and high in comparison to average value for Gravelly landscape. Table 5-6 contains a comparison of existing conditions and sediment-related targets for stream types applicable to Basin Creek. There was no departure from natural stream type for any reaches based on channel morphology, although fine sediment levels were higher than target values.

Table 5-6. Summary of Sediment Impairment Based on Physical Indicators for Basin Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**%Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	B4a	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4a	1.8 S	14 S	24 S	20 S	26.5 S	65 S
Percent Departure	No Departure	**NE**	**NE**	20%	150%	**NE**	24%
Target	E4b	≥5[*]	≤9.1	≤38	ND	≤23.4	≥85
Existing	E4b	7.6 S	6 S	41 S	56 S	16 S	ND
Percent Departure	No Departure	**NE**	**NE**	8%	ND	**NE**	ND
Target	E4a	≥2.5	≤8.3	≤44	≤7	≤23.6	≥85
Existing	E4a	14.5 S	5 S	45 S	88 S	18 S	ND
Percent Departure	No Departure	**NE**	**NE**	2%	1157%	**NE**	ND

[*] E channels are used as targets for Eb stream types (see Section 4.0)
NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

5.3.2.1.4 Summary

Basin Creek appears to be improving due to recent management changes, but exhibits high siltation in its lower reaches. Fine sediment levels are above reference values likely to impact spawning potential for a coldwater fishery. Upland grazing exacerbates natural inputs. Sediment inputs are not likely to be reduced to a large degree by improved grazing management. Instream sediment levels appear to be high in the lower reaches of the stream. The stream is likely still transporting historic sources of human induced sediment. Limited opportunities for better grazing practices are present in the lower elevations of the watershed. A TMDL for sediment will be completed for Basin Creek, but will recommend monitoring the effects of grazing management in riparian areas and uplands and revising the targets and TMDL if needed.

5.3.3 Burnt Creek

Burnt Creek is located near the headwaters area of the Ruby River. The Burnt Creek Watershed is entirely managed by the USFS. The stream flows from the Gravely Mountains and drains a mix of forest, grass and shrub land.

Burnt Creek is listed for partial impairment of aquatic life and coldwater fishery use in 1996 and 2004. Probable causes of impairment for the 1996 list are habitat alterations and siltation. The only probable source listed was agriculture. Siltation, other habitat alterations, and bank erosion are probable causes listed in 2004. Probable sources on the 2004 list are grazing-related sources, agriculture, highway maintenance and runoff, and unpaved runoff. The TMDL source assessment indicates that grazing and natural sources are significant.

5.3.3.1 Sediment

5.3.3.1.1 Total Suspended Solids

TSS concentrations in samples taken in 2001 from Burnt Creek were very low (<10 mg/L) (Appendix A – Map 10). Too few data are available to define annual or seasonal variability in TSS loading for Burnt Creek. No conclusions are made from this data.

5.3.3.1.2 Biology

Results of macroinvertebrate sampling from 2001 indicate slight impairment. MVFP index score for both sites on Burnt Creek were lower than the target value of 75 (Table 5-7). Clinger data meet targets (Table 5-7). Fish recruitment is likely impacted by instream sediment conditions. Abundance of westslope cutthroat trout (potentially hybridized population) was rated at slightly below potential, but the data quality was also rated low (BDNF, n.d.). Fine sediment conditions that affect spawning success are reviewed in the following section.

Table 5-7. Summary of Impairment Based on Macroinvertebrate Metrics for Burnt Creek (2001 Data).

	Clinger Richness	MVFP Index
Site	**BU1**	
Target Value	≥14	≥75
Existing Value	15	61
Percent Departure	NE	19%
Site	**BU2**	
Target Value	≥14	≥75
Existing Value	15	72
Percent Departure	NE	4%

5.3.3.1.3 Physical Conditions and Sediment Sources

MDEQ Stream Reach Assessment data and other riparian assessment data from 2001 (SCD_BUD file) noted some sediment deposition, although siltation and bank erosion were not severe. Observations during MDEQ surveys in 2001 also included streambank erosion on outside bends, channel incisement in some places, and erosion caused by grazing contributing that contribute sediment. The assessment also notes that the source of sediment is partly natural, although human caused sources of habitat degradation (including sediment) are evident. Results of the sediment source assessment (Section 7.0) indicate 65% of sediment production is attributed to grazing-related influences.

A Forest Service stream survey categorizes the reach surveyed as Functioning at Risk, while a reach surveyed by BLM was classified as Non-functioning. Channel Stability ratings from Forest Service surveys of channel morphology (BDNF, n.d.) show Burnt Creek to be in the Fair range where it was assessed. Streambank alteration from livestock was heavy (93%) at the time of the survey in 1995.

Comparison of 2003 assessment data and sediment targets indicates high instream fine sediment levels based on reference conditions. Percent surface fine sediment (<6 mm) from the Wolman pebble count was 37%, which is higher than the target value based on Forest Service reference reaches for any of the applicable stream types (BDNF, n.d.). Percent fines from the 49-point grid averages 40, which is high even for other streams in the Gravelly landscape. Table 5-8 summarizes impairment indicated by sediment targets. No departure from natural stream type was noted based on channel morphology, despite the high fine sediment levels.

Table 5-8. Summary of Sediment Impairment Based on Physical Indicators for Burnt Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**%Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	B4a	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4a	1.8 S	12 S	39 S	65 S	22.8 S	30 S
Percent Departure	No Departure	**NE**	**NE**	95%	713%	**NE**	65%
Target	B4	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4	1.5 S	15 S	29 S	36 S	19.7 S	ND
Percent Departure	No Departure	6%	**NE**	45%	350%	**NE**	ND
Target	Ea	≥2.5	≤8.3	≤44	≤7	≤23.6	≥85
Existing	E4a	5.7 M	11 M	38 M	58 M	19.9 M	25 M
Percent Departure	No Departure	**NE**	25%	**NE**	729%	**NE**	71%

NE = No Exceedence
ND = No data
S = Single value
M = Two values – maximum given (minimum for % stable bank)

Natural sediment inputs from landslides were not documented in the sections of Burnt Creek selected for sediment source inventories, although they do exist on much of the stream (Appendix A – Map 3). To account for natural sources from landslides, calculation of sediment loading from near-stream sediment sources for Burnt Creek included rates derived from areas with similar landslide inputs, based on a GIS layer of landslides digitized from aerial photographs. Landslide inputs derived in this manner were included in natural sources described in Section 7.0 of this document.

Near stream grazing-related sediment sources were high on Burnt Creek. Bank stability was only 27% from the 2003 assessments for Burnt Creek, a result of extensive cattle grazing of the riparian area. Active headcutting is occurring as the channel becomes incised in response to channel disturbance (Appendix F – Burnt #7). Many areas of Burnt Creek are very sensitive to damage from grazing activity because fragile banks composed of fine sediment have built in areas where beaver were previously active but are no longer present (Appendix F – Burnt #5).

5.3.3.1.4 Summary

Biological assessments indicate macroinvertebrate use impairment. Impairment of beneficial uses due to siltation is indicated on Burnt Creek by high instream sediment concentrations that likely impact fish recruitment. Human caused sources comprise at least half the estimated sediment loading. Therefore, a TMDL for sediment will be completed for this water body.

5.3.4 California Creek

California Creek is located in the northeast portion of the Ruby River watershed. The timbered headwaters are in the Tobacco Root Mountains. The mid section is timbered on north facing slopes and shrubs and grasses grow on the south facing slopes. Lower reaches are a mix of grassland and cropland. The upper portion of the watershed consists of National Forest land. Private landowners and the BLM manage the lower portions of the watershed.

California Creek was listed on the 1996 303(d) List for aquatic life support, coldwater fishery, drinking water, and recreation. Probable causes of impairment listed in 1996 are siltation and turbidity. Probable sources of impairment are harvesting, restoration, residue management, road construction, pasture land, and resource extraction. Probable causes of impairment in 2004 include bank erosion, siltation and habitat alterations. Probable sources include dredge mining and erosion from derelict land. Results of the TMDL source assessment indicate that natural sources, grazing, mining and transportation are impacting sediment production.

5.3.4.1 Sediment

5.3.4.1.1 Total Suspended Solids

Two TSS samples were collected during the same day during 2002. TSS was 10.3 mg/L a quarter mile above the USFS boundary, but was 42.7 mg/L at a downstream site 2.1 miles above the highway. Little can be concluded from this data except that TSS concentration increased greatly from upstream to downstream. This very limited TSS data, used along with the TMDL sediment source assessment information indicates that the increases in TSS are influenced both by natural and human influences.

5.3.4.1.2 Biology

MVFP IBI scores from 2002 reflect a trend of reduced habitat integrity from the upstream to downstream end of California Creek, with a score of 100% in the headwaters, 89% just below the confluence of Harris Creek, and only 39% above the mouth (Table 5-9). Clinger richness was lower than the target value at the site furthest downstream, and clinger richness decreases from upstream to downstream in the samples. Instream fine sediment conditions are above reference conditions and are likely to affect fish recruitment.

Table 5-9. Summary of Impairment Based on Macroinvertebrate Metrics for California Creek (2002, 2003 Data).

	Clinger Richness	MVFP Index
Site	**MO4CALC02 (2002)**	
Target Value	≥14	≥75
Existing Value	19	100
Percent Departure	NE	NE
Site	**CAL1 (2003)**	
Target Value	≥14	≥75
Existing Value	17	89
Percent Departure	NE	NE
Site	**MO4CALC01 (2002)**	
Target Value	≥14	≥75
Existing Value	12	39
Percent Departure	14%	48%

California Creek has westslope cutthroat trout that are greater than 99% pure in the headwaters and 90-99% pure in an adjacent area downstream. (BDNF, 2004).

5.3.4.1.3 Physical Condition and Sediment Sources

Physical inventories conducted by MDEQ in 2002 documented a significant source of sediment in the vicinity of old placer tailings and a dumpsite. A headcut and several actively eroding gullies are present at this site. According to the 2002 assessment California Creek is incised downstream of this location, which is 4.8 miles upstream from highway 287 at the town of Laurin. At the location of cross-sections measured in 2003 for the TMDL assessment, the stream was not incised (Table 5-9). Some heavily altered mining areas could be considered incised, but average conditions documented in cross-section surveys are not incised.

Several reaches on California Creek depart from reference channel morphology due to high percent of fines. Percent surface fine sediment <6 mm exceeded target values for B4 and E4 stream types. One reach exhibited departure from its natural stream type due to decreased sinuosity and increased fine sediment (Table 5-10). Entrenchment ratio was slightly lower than target values in C5b reaches, but otherwise did not indicate impairment. Fines in spawning gravels measured by 49-point grid ranged from 0 to 43%, with both highest and lowest values in the alluvial valley area.

Table 5-10. Summary of Sediment Impairment Based on Physical Indicators for California Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**%Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	B4	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4	1.9 M	11 M	48 M	14 M	21 M	70 M
Percent Departure	No Departure	**NE**	**NE**	140%	75%	**NE**	18 %
Target	C5b	≥3.2	≤25.6	NA	≤6	≤29	≥85
Existing	C5b	2.9 S	15 S	67 S	22 S	12 S	90 S
Percent Departure	No Departure	9%	**NE**	NA	260%	**NE**	**NE**
Target	E4	≥5	≤9.1	≤38	NA	≤23.4	≥85
Existing	E5	6.6 S	5 S	64 S	43 S	11 S	80 S
Percent Departure	Departure	**NE**	**NE**	68%	NA	**NE**	6%
Target	A4	≥1.2	≤9.2	≤24	NA	≤24.5	≥85
Existing	A4	1.5 S	9 S	36 S	21 S	32.5 S	40 S
Percent Departure	No Departure	**NE**	**NE**	50%	NA	33%	53%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given (minimum for % stable bank)

Sediment source assessment results indicate a significant (68%) anthropogenic sediment load contribution (Section 7.0). The majority of this human-caused sediment contribution was attributed to channel adjustment from past uses, such as placer mining, overgrazing, and channel manipulation.

5.3.4.1.4 Summary

Conditions on California Creek are quite variable, but biology and fine sediment data in indicate that biology is impacted by sediment. Streambank erosion and benthic fine sediment conditions are above reference conditions and indicate that sediment supply and transport are impacted. Human caused sources are present and contribute a significant amount of sediment. A sediment TMDL will be written. The sediment TMDL will consider sources of deposited fine sediment in the stream channel and turbidity.

5.3.5 Coal Creek

Coal Creek is located in the headwaters area of the Ruby River. The Coal Creek Watershed is entirely managed by the USFS. Many north facing slopes are forested while most of the watershed is grass and shrub land.

Coal Creek was listed in 1996 for aquatic life support and coldwater fishery. The only probable cause listed was habitat alterations, and the probable sources listed were agriculture, rangeland grazing and natural sources. In 2004 probable causes for Coal Creek included riparian degradation, bank erosion, and thermal modification. Probable sources include grazing related sources.

5.3.5.1 Sediment

5.3.5.1.1 Water Quality

Coal Creek was reassessed by MDEQ staff in September of 2002. No TSS values obtained were greater than 10 mg/L. No conclusions can be made from this data.

5.3.5.1.2 Biological Data

According to 2002 macroinvertebrate data on the upper reach of this stream, 27% of the taxa were tolerant to sediment, indicating some impairment due to siltation. Both sites sampled for macroinvertebrates scored lower than 75% for the MVFP index, with the lowest score (39%) at the downstream site (Table 5-11). Clinger richness from both aquatic macroinvertebrate samples on Coal Creek was lower than the target value, indicating possible impairment due to fine sediment.

Table 5-11. Summary of Impairment Based on Macroinvertebrate Metrics for Coal Creek (2002 Data).

	Clinger Richness	**MVFP Index**
Site	**MO4COALC01**	
Target Value	≥14	≥75
Existing Value	12	39
Percent Departure	14%	48%
Site	**MO4COALC02**	
Target Value	≥14	≥75
Existing Value	10	67
Percent Departure	28%	11%

5.3.5.1.3 Physical Condition and Sediment Sources

Many natural sediment sources were noted from the headwaters to the downstream end of Coal Creek. The 2003 stream assessment from the middle reach of Coal Creek documented channel widening due to bank trampling by livestock and vegetation removal. Additionally, signs of past beaver activity were present throughout the length of this stream, but no current activity was noted. Beaver ponds would have moderated sediment delivery from natural sediment sources to lower reaches of the stream and to the Ruby River. Many areas of Coal Creek are very sensitive to damage from grazing activity because fragile banks composed of fine sediment have built in areas where beaver were previously actively trapping sediment through dam building but are no longer present.

The sediment source analysis attributes only 16% of sediment loads to human causes (Section 7.0). Of this portion, 100% was attributed to grazing, although there is the potential for a negligible amount of sediment contribution from one road crossing. Sensitive streambanks have started to recover from past overgrazing, but recovery may not be progressing under current management. Two of the three reaches assessed on Coal Creek received a condition rating of "poor," according to SRAF scores indicating current management is still influencing stream condition.

Table 5-12 summarizes the comparison of sediment criteria and existing conditions for Coal Creek. Together, stream channel geometry, fine sediment deposition and anthropogenic sediment load from eroding banks all indicate that sediment delivery and transport are impacted. One reach exhibited departure from its natural stream type, based primarily on entrenchment and width/depth ratio.

Table 5-12. Summary of Sediment Impairment Based on Physical Indicators for Coal Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**%Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	B4a	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4a	1.4 S	23 S	25 S	ND	20.3 S	40 S
Percent Departure	No Departure	12%	46%	25%	ND	**NE**	53%
Target	C4b	≥3.2	≤25.6	≤29	≤6	≤29	≥85
Existing	C4b	4.2 S	19 S	30 S	3 S	30.1 S	30 S
Percent Departure	No Departure	**NE**	**NE**	3%	**NE**	4%	65%
Target	E4	≥5.0	≤9.1	≤38	NA	≤23.4	≥85
Existing	F4	1.3	23 S	13 S	5 S	30 S	40 S
Percent Departure	Departure	74%	153%	**NE**	NA	28%	53%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

5.3.5.1.4 Summary

Together, stream channel geometry, fine sediment deposition in a specific areas and minor anthropogenic sediment loading from eroding banks all indicate that sediment delivery and transport are impacted. Impairment of Coal Creek due to elevated sediment delivery is likely, but it is important to keep in mind that this is naturally a high-sediment producing watershed. Protecting riparian vegetation and streambanks will allow further channel recovery, maintain filtering buffers below sediment sources, and possibly allow beaver to become re-established to mitigate high scouring flows and trap sediment. The sediment TMDL for Coal Creek will consider mitigating delivery from natural sources of sediment as well as human-caused sources.

5.3.5.2 Thermal modification

MDEQ reassessment temperature data recorded in mid-July from Coal Creek includes two discrete measurements, ranging from 39.2°F to 77.72°F. The maximum temperature was recorded 3.5 miles below the upstream site. The temperature from the lower elevation site falls within the lethal range for most trout species. This maximum value is obviously a red flag value, however further study is needed to substantiate temperature trends on Coal Creek, given the limited data consisting of two discrete temperature recordings.

Biomonitoring sites on Coal Creek had only 0 to 1 cold stenotherm taxon, compared to the guideline value of 4 cold stenotherm taxa indicating support of coldwater biota. It is unknown whether or not this condition is natural. Stagnant pools were frequent at the downstream end of Coal Creek during TMDL monitoring. The recent 6 years of severe drought conditions in the Coal Creek Watershed have produced a naturally intermittent reach. No water from the stream is used for irrigation. Human caused riparian vegetation impacts were documented during the sediment source assessment. Two of the three reaches assessed on Coal Creek were over-widened. These impacts may also affect the amount of shade that blocks solar radiation.

5.3.5.2.1 Summary

The thermal modification listing was completed well after the TMDL project for the Ruby TMDL Planning Area was initiated. Continuous temperature, instream discharge, and effective shade monitoring is needed to determine if beneficial uses are impaired due to human influences. Monitoring and potentially TMDL development in the future will address the thermal modification 303(d) listing for Coal Creek. In the interim period, the same management improvements recommended for a sediment TMDL should positively affect temperature conditions.

5.3.6 Cottonwood Creek

Cottonwood Creek flows from the Ruby Range and is located on the west side of the Ruby River, above Ruby Reservoir. Some north slopes in the headwaters are forested, with the remainder of the watershed composed of grass and shrub lands. Most of the watershed is privately owned except for the BLM managed headwaters.

Cottonwood Creek was listed in 1996 for aquatic life support and coldwater fishery. Probable causes specified were habitat alterations and siltation. Probable sources were agriculture, rangeland grazing, removal of riparian vegetation, and streambank modification and destabilization. Cottonwood Creek is on the 2004 303(d) List for partial support of aquatic life support and coldwater fishery. Causes of impairment listed in 2004 are siltation, dewatering, flow alteration, other habitat alterations, and riparian degradation. Probable sources listed for 2004 are grazing-related sources, crop-related sources, agriculture, unpaved road runoff, and highway maintenance and runoff. The TMDL source assessment indicates that grazing, roads and natural sources of pollutants are significant.

5.3.6.1 Sediment

5.3.6.1.1 Total Suspended Solids

There is not enough data to link impairment of beneficial uses to elevated TSS. Only two samples for TSS have been collected on Cottonwood Creek, both of which are very low (<10 μg/L).

5.3.6.1.2 Biology

Macroinvertebrate data for Cottonwood Creek consists of a single sample that contained very few organisms. It is unclear whether the low abundance of animals in the sample represents polluted or disturbed conditions at the site, or whether it could be attributed to inadequate sampling or natural conditions (Bollman, 2001). The MVFP score for this sample was 50% and clinger richness was only 6, possibly indicating impairment due to sediment (Table 5-13). MFWP Fish population studies show trout populations are suppressed and recruitment of young-of-the-year is stifled by poor reproduction, but impacts are not linked to sources (Oswald, 2000a). Instream sediment levels are elevated above reference conditions and at levels that likely affect fish spawning success (Table 5-14).

Table 5-13. Summary of Impairment Based on Macroinvertebrate Metrics for Cottonwood Creek (2001 Data).

	Clinger Richness	MVFP Index
Site	COT3	
Target Value	≥14	≥75
Existing Value	6	50
Percent Departure	57%	33%

5.3.6.1.3 Physical Conditions and Sediment Sources

MDEQ field notes and photos from 2001 indicate that dewatering, fine sediments and diminished the riparian vegetation likely impact aquatic life and coldwater fishery. Forest Service and BLM stream assessments classify Cottonwood Creek as Functioning at Risk. Stream assessments conducted in 2003 documented generally fair conditions on Cottonwood Creek, with smaller areas in poor condition. The areas in poor condition are incised, with most riparian vegetation removed, poor bank stability, and raw trampled banks that provide immediate sources of sediment. Channel surveys were not conducted in these areas, therefore morphological data do not reflect the incised condition of these downcut areas (Table 5-14, Appendix F – Cot #8).

Several areas with severe riparian vegetation removal and downcut channels have signs of past beaver activity. Areas with current beaver activity on Cottonwood Creek and neighboring streams generally are less incised, have more riparian shrubs, and more mesic vegetation overall, but are silting in quickly and are very prone to erosion (Appendix F – Cot #4).

The sediment source analysis attributes 40% of sediment loads to human causes (Section 7.0). The majority of anthropogenic sediment loading is attributed to grazing (68%), with roads and channel manipulation also contributing (28% and 3%, respectively). There is an irrigation diversion on Cottonwood Creek near the mouth, but most of the stream is not affected by dewatering (Appendix A – Map 12).

Wolman fine sediment (<6 mm) ranged from 43 to 58% in 2003 data, which is higher than BDNF reference values for E and Ea type streams (Table 5-14). All reaches had 49-point grid values of over 40 percent fines in spawning gravels, which is high compared to reference reaches. Deposited fine sediment was high enough in one reach to cause departure from its natural stream type. Large portions of certain monitoring reaches have unstable streambanks when compared to reference conditions. The combination of these factors indicates that sediment delivery and transport are impacted. Table 5-14 summarizes sediment criteria and existing conditions for Cottonwood Creek for other parameters.

Table 5-14. Summary of Sediment Impairment Based on Physical Indicators for Cottonwood Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**% Fines < 6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	E4b	≥5[*]	≤9.1	≤38	NA	≤23.4	≥85
Existing	E4b	2.8 S	3 S	54 S	46 S	ND	40 S
Percent Departure	No Departure	44%	**NE**	42%	NA	ND	53%
Target	E4a	≥2.5	≤8.3	≤44	≤7	≤23.6	≥85
Existing	E4a	3.5 S	6 S	43 S	44 S	15.3 S	60 S
Percent Departure	No Departure	**NE**	**NE**	**NE**	529%	**NE**	29%
Target	E4a	≥2.5	≤8.3	≤44	≤7	≤23.6	≥85
Existing	E5a	3.5 S	8 S	58 S	41 S	19.2 S	40 S
Percent Departure	Departure	**NE**	**NE**	32%	486%	**NE**	53%

[*] E channels are targets for Eb types (see Section 4.0)
NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

5.3.6.1.4 Summary

Stream channel geometry and fine sediment conditions depart from reference conditions and indicate that sediment supply and transport are impacted. Human caused sources are present and contribute a significant amount of sediment. A sediment TMDL will be written for Cottonwood Creek.

5.3.7 Currant Creek

Currant Creek is a tributary to Ramshorn Creek. Currant Creek is located in the northeast portion of the Ruby River watershed. The timbered headwaters are in the Tobacco Root Mountains. Uplands in the lower portion of the watershed are mostly grassland. The National Forest Service manages almost the entire watershed except for mining withholdings along the stream corridor and approximately one section of BLM managed land.

Currant Creek was listed in 1996 for aquatic life support and coldwater fishery. The only probable cause listed is siltation, and the only source listed is silviculture. The 2004 303(d) List considered this stream fully supporting all beneficial uses based on data from a lower reach of the stream.

5.3.7.1 Sediment

5.3.7.1.1 Total Suspended Solids

A water quality sample taken in 2002 revealed relatively high levels of TSS. Concentration of TSS was 142 mg/L, a concentration that may adversely affect certain life cycles of salmonids (Newcombe and Jensen, 1996). Impairment condition cannot be based exclusively on this one sample result, although it may indicate that sources of sediment are present in the watershed.

5.3.7.1.2 Biology

Biological samples were collected on Currant Creek in 2002 as part of the 303(d) reassessment and during 2003 and 2004 for TMDL assessment monitoring. The samples collected in 2002 and 2003 are from below the priority abandoned mine site on Currant Creek. Sample CURA1 from 2004 is above the mine site, while CUR2 is below the mine site. Results of biomonitoring are listed in Table 5-15.

Macroinvertebrate data from 2002-2004 indicated cold, clean water characterizes the site below the mine. MVFP scores from 2002 to 2004 ranged from 94-100%, indicating full support of aquatic life (Bollman, 2002, 2003, 2004). Samples from below the mine site contained 14-16 “clinger” taxa, suggesting clean substrates unpolluted by fine sediment deposition. Presence of several caddisfly taxa also indicate clean substrates. Results from sample CUR1A, taken above the mine site in 2004, also indicated the sample was collected from an area with cold, clean water (Bollman, 2004). The MFVP score of 89 indicates full support of aquatic insects. Only 10 “clinger” taxa were found in this sample, indicating possible fine sediment deposition, but the presence of a specimen in the genus *Paraperla* indicated unsilted hyporheic habitats was available. Although one sample in the headwaters had fewer clinger species than the criteria, overall, the aquatic insect community indicates a healthy coldwater stream setting.

Fine sediment deposition is higher than in comparable reference streams and may be impacting fish spawning. Fish data from 1991 confirms the presence of a brook trout population (BDNF, n.d.). The fishery survey was conducted near the forest boundary and found six brook trout in 500 feet. Comments on the fishery survey report note, “Many of the small pools and backwater areas are filled with fine sediment. This is limiting to fish." Fine sediment conditions are described in the next section of this document.

Table 5-15. Summary of Impairment Based on Macroinvertebrate Metrics for Currant Creek (2002-2004 Data).

	Clinger Richness	MVFP Index
Site	**CUR1A upstream (2004)**	
Target Value	≥14	≥75
Existing Value	10	89
Percent Departure	28%	NE
Site	**CUR2 downstream (2004)**	
Target Value	≥14	≥75
Existing Value	14	100
Percent Departure	NE	NE
Site	**CUR-1 (2003)**	
Target Value	≥14	≥75
Existing Value	16	100
Percent Departure	NE	NE
Site	**MO4CURR01 (2002)**	
Target Value	≥14	≥75
Existing Value	15	94
Percent Departure	NE	NE

5.3.7.1.3 Physical Condition and Source Assessment

According to BDNF data collected in 1991, the "existing condition" of the channel at the site was a Rosgen A4/A5 stream type. A4/A5 stream types are inherently unstable, with steep banks that contribute large quantities of sediment. The stream type at this location appears to be caused partially by natural conditions but could be influenced by placer mining in the area. Numerous erosional processes are at work, including bank collapse, dry ravel, freeze/thaw and lateral scour caused by debris flows. BDNF rated the site as non-functioning and the trend was "static."

Grazing has had an influence on the condition of Currant Creek. The rancher with the grazing lease reported that some improvements were attained since the BDNF assessment in 1991. This was accomplished by fencing some areas to exclude cattle from the riparian area and stream channel. Grazing impacts and possibly minor road impacts were the only anthropogenic stressors observed in the 2002 MDEQ assessment, although silviculture was indicated as the probable source of impairment for the 1996 listing. Areas of past harvest were not observed or evaluated as a source of sediment during the reassessment process. In the lower gradient sections, it is possible that some fraction of the stream substrate's composition of fine particles is due to historic logging. However, the channel is capable of transporting sediment and considerable flood plain area is available for energy dispersal.

MDEQ stream assessments from 2002 concluded Currant Creek is in sustainable condition. The Stream Reach Assessment score is 91%, indicating non-impairment and full-support. The Riparian Assessment score is 94%, indicating a "Sustainable" condition. Some hoof shear and pugging on banks was noted and localized cattle access points were present, resulting in a few over-widened areas. Old placer tailings are evident. Some are near the channel but most of them are vegetated and sufficient access to the floodplain is usually available. This assessment was completed in the lower portion of the watershed.

More detailed stream assessments conducted in 2003 indicated some impacts to riparian vegetation and channel condition. According to assessments conducted in 2003, average bank stability was 63%, with a maximum value of 75% (Table 5-16). Stream condition was rated poor according to SRAF scores on the upstream reach, largely due to streambank and floodplain trampling and a shift in riparian vegetation communities resulting from overgrazing by livestock. For example, desirable riparian shrubs on the upper reach are decadent and are being replaced by shrubs more resistant to grazing, such as prickly currant and rose. In addition, riparian understory species have been replaced to a large extent by pasture species such as Kentucky bluegrass (*Poa pratensis*) and other shallow-rooted grasses, further contributing to bank instability.

Grazing influences on the vegetation are reflected in the sediment source characterization. The sediment source characterization analysis estimated 58% of the sediment load is due to human causes (Section 7.0). Of the anthropogenic sediment load, 66% was attributed to grazing-related sources and 34% was attributed to roads. Currant Creek runs through easily eroded soils; therefore, natural erosion is easily exacerbated by these human influences.

Channel morphology measurements in 2004 also indicate habitat impairment, with values for deposited fine sediment, width/depth ratio, and bank stability that exceed the sediment criteria (Table 5-16).

Table 5-16. Summary of Sediment Impairment Based on Physical Indicators for Currant Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**% Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	A4	≥1.2	≤9.2	≤24	NA	≤24.5	≥85
Existing	A4	1.5 M	11 M	34 M	79 M	21.9 M	50 M
Percent Departure	No Departure	**NE**	19%	42%	NA	**NE**	41%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given (minimum for % stable bank)

5.3.7.1.4 Summary

Aquatic insect and periphyton samples indicate sediment is likely not impairing aquatic life use; however, notes from a fish survey did note likely impacts to fish habitat from fine sediment. Stream geometry, instream sediment and bank erosion appear to be higher than reference conditions. Human caused sediment sources are present and contribute significantly to the natural load. Because of the presence of human caused sediment sources, a high amount of sediment within the stream, and fishery reports that indicate sediment conditions are impacting the fishery, a sediment TMDL will be written. The 2004 303(d) listing was based on a smaller amount of information than this assessment. This analysis will be incorporated into future 303(d) listing assessment.

5.3.7.2 Metals

Metals have not been listed as a cause of impairment for Currant Creek. However, a water quality sample collected in 2002 by MDEQ yielded lead and copper levels that exceeded hardness-based chronic standards for aquatic life. Further monitoring was conducted to determine impairment of beneficial uses due to metals. Results of all sampling are outlined below.

5.3.7.2.1 Water Chemistry

The Goldschmidt-Steiner priority abandoned mine site on Currant Creek may be a source of heavy metals to Currant Creek and Ramshorn Creek below the confluence of Currant Creek. Mine Waste Cleanup Bureau (MWCB) data from 1993 was not used for this analysis due to data quality concerns but it showed exceedence of state standards. One site was sampled by MDEQ in 2002 for water column metals. Lead and copper exceeded chronic aquatic life standards in the 2002 water quality sample (Table 5-17). These are relatively low concentrations and are well below the acute aquatic life standards. Sampling was conducted following a storm, which may have resulted in the slightly elevated metals values, however there are sources of metals in the drainage. Samples collected during June of 2004 showed an exceedence of chronic lead standard, and copper was the same concentration as the hardness-based chronic aquatic life standard. Most samples for lead collected during 2004 were below detection. At least one abandoned mine is present upstream of the sampling site and tailings are present near the stream channel (MDEQ, 2004 unpublished data).

Table 5-17. Summary of Heavy Metals Water Quality Exceedences for Currant Creek.

Metal	Date	Flow (cfs)	Hardness (mg/L)	Conc. (µg/L)	Exceedence Summary
Currant Creek Site M04CURRC01					
Lead	9/17/2002	2	74	7	**Exceeds** hardness based chronic aquatic life criteria (2.2 µg/L)
Copper	9/17/2002	2	74	10	**Exceeds** hardness based chronic aquatic life criteria (7.2 µg/L)
Currant Creek Site M04CURRC02					
Lead	6/3/2004	1.4	37	6	**Exceeds** hardness based chronic aquatic life criteria (0.9 µg/L)

5.3.7.2.2 Instream Sediment Samples

Instream sediment samples collected by MWCB in 1993 indicate lead and zinc values exceeding guideline sediment metals concentrations provided in Section 4.0 of this document by 33% and 38% respectively.

5.3.7.2.3 Biology

Periphyton samples taken in 2002 and 2003 from below the mine site contained 0.0% abnormal cells. Periphyton data from 2004 samples indicated the site above the mine had a higher percentage of abnormal cells than the site below the mine. Neither sample exhibited levels of abnormal cells indicating toxic conditions.

5.3.7.2.4 Summary

Because of the presence of mining sources, water chemistry samples slightly above chronic aquatic life standards and metals concentrations found in stream sediments, a monitoring plan is provided to observe future metal and toxicity trends in this watershed. Both high flow sampling and sediment metal sampling will be identified in the monitoring plan. Future 303(d) reviews should use data provided in this document and any subsequently collected data based on the monitoring plan provided in Section 11.0. No metals TMDL will be written at this time.

5.3.7.3 Other Indications of Impairment

Water quality sampling in 2002 revealed high total phosphorus and very high TKN levels. Total nitrate plus nitrite concentration of the 2002 Currant Creek sample is 8 to 10 times higher than levels found in regional reference conditions, but was collected during a storm event (Table 4-3). No excessive algae growth was observed by MDEQ at the sample site. Further monitoring for nutrients is recommended. Human caused sources are likely associated with grazing and road impacts.

5.3.8 East Fork Ruby River

East Fork Ruby River is located in the headwaters area of the Ruby River. The watershed is entirely managed by the USFS. The headwaters of this tributary are forested and flow from the Gravely Mountains. In mid and lower elevations many north-facing slopes are forested while the rest of the area is composed of grass and shrub land.

East Fork of the Ruby River is listed on the 1996 303(d) List for non-support of aquatic life and coldwater fisheries. Flow alteration and habitat alterations are indicated as the probable causes. Agriculture, natural sources, rangeland grazing, and streambank modification are probable sources. Impairments for East Fork Ruby River on the 2004 list are partial support of aquatic life and coldwater fisheries. Probable causes are bank erosion, fish habitat degradation, other habitat alterations, and riparian degradation. Probable sources are identified as grazing-related. The TMDL source assessment found natural and grazing sources.

5.3.8.1 Sediment

5.3.8.1.1 Total Suspended Solids

The limited TSS data for East Fork Ruby River TSS concentration found in limited sampling were very low. Too few TSS data are available for making any judgments.

5.3.8.1.2 Biology

A survey for westslope cutthroat trout conducted in 2002-2004 estimated the abundance of the hybridized cutthroat trout was slightly below potential (BDNF, 2004). Review of earlier USFS and MFWP assessments conducted on the East Fork linked poor habitat and physical conditions to severely depressed trout populations. The MVFP macroinvertebrate metric score for both sites samples was slightly less than 75% (72 and 67%). Clinger richness was 16 at site EF1 and 13 at site EF2 (Table 5-18).

Table 5-18. Summary of Impairment Based on Macroinvertebrate Metrics for East Fork Ruby River (2001 Data).

	Clinger Richness	MVFP Index
Site	**EF1**	
Target Value	≥14	≥75
Existing Value	16	72
Percent Departure	NE	4%
Site	**EF2**	
Target Value	≥14	≥75
Existing Value	13	67
Percent Departure	7%	11%

5.3.8.1.3 Physical Conditions and Sediment Sources

Stream assessments by USFS, MFWP, and MDEQ indicated streambank alteration and vegetation removal by cattle, bank and channel instability, and otherwise poor habitat conditions (MDEQ, 2003 - SCD_BUD file). Inventories specify sediment-related causes of impairment including siltation, channel widening, streambank alteration, and high suspended sediment yield. According to Page (1978), East Fork Ruby River had the third-highest sediment yield of the water bodies assessed in the upper Ruby basin. MDEQ stream reach assessments from 2001 specify that grazing impacts likely increase erosion and sedimentation above naturally high levels, and that habitat alteration due to grazing is evident. Reaches on the East Fork Ruby were ranked as "fair" condition, with the exception of one in "poor" condition according to SRAF assessments. Vegetation-related variables in the SRAF assessment were rated below 60% of the potential score for all reaches, indicating disturbance to riparian areas due to grazing.

Assessments from 2003 indicate grazing impacts on the downstream end of the East Fork Ruby River and on one of the most upstream reaches (EFR4A). The TMDL sediment source characterization identifies human caused sediment loading contributes 21% of the overall load, all of which was attributed to grazing.

Width/depth ratio exceeded targets for most reaches. All sediment indicators except BEHI from data collected in 2003 exceeded sediment criteria for some stream types (Table 5-19). Percent fines (<6 mm) from the Wolman pebble counts were higher than the criteria based on USFS reference B stream types, but not high relative to other reaches within the Gravelly landscape. The average results of 49-point grid assessments indicated 20% fines in gravels, but the average percent fine sediment is high primarily because of one reach, EFR4A, which had an average of 41% fines. This reach is near the upstream end of the East Fork in an area with abundant sign of past beaver activity. The channel is widened and is cutting down through older beaver pond sediments. Several other reaches exhibit channel widening, as is discussed below. Pictures of this reach also reveal some bank trampling and alteration of riparian communities due to recent grazing (Appendix F – EFR #5). Entrenchment was low for B4 reaches. Table 5-19 summarizes sediment targets and existing conditions for East Fork Ruby River.

Table 5-19. Summary of Sediment Impairment Based on Physical Indicators for East Fork Ruby River.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**%Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	B4	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4	1.4 S	33 S	29 S	8 S	14.9 S	55 S
Percent Departure	No Departure	12%	109%	45%	**NE**	**NE**	41%
Target	B4a	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4a	1.7 M	21 M	46 M	41 M	26.7 M	40 S
Percent Departure	No Departure	**NE**	33%	130%	413%	**NE**	53%
Target	E4a	≥2.9	≤8.3	≤44	≤7	≤23.6	≥85
Existing	E4a	3.8 S	11 S	21 S	ND	17.8 S	55 S
Percent Departure	No Departure	**NE**	33%	**NE**	ND	**NE**	35%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

5.3.8.1.4 Summary

Biological and physical data indicate slight to moderate impairment of instream beneficial uses in specific areas of East Fork Ruby River. Slight to moderate human caused sediment sources are present. Stream channel geometry, areas of bank erosion, and fine sediment conditions depart from reference conditions indicating that sediment supply and transport are impacted. Implementation of restoration practices will likely achieve sediment criteria and support instream uses that are currently impacted by grazing. A TMDL is needed to address sediment sources that are impacting uses.

5.3.9 Garden Creek

Garden Creek flows from the Ruby Mountains and flows into the west side of Ruby Reservoir. Most north slopes are forested, with the remainder of the watershed composed of grass and shrub lands. Most of the watershed is privately owned except for BLM managed headwaters.

Garden Creek was listed on the 1996 303(d) List for partial support of aquatic life and coldwater fisheries. Flow alteration, habitat alterations and siltation are indicated as the probable causes. Agriculture, rangeland and silviculture are listed as the probable sources. Garden Creek is listed again as partial support of aquatic life and coldwater fisheries on the 2004 list. Riparian degradation, bank erosion and habitat alterations are listed as probable causes. Grazing-related sources are listed as probable sources. The TMDL source assessment identified natural, grazing and road related sources.

5.3.9.1 Sediment

5.3.9.1.1 Total Suspended Solids

TSS samples from 2002 yielded a value of 4.8 mg/L at the upstream site and 12.7 mg/L at a site 4.4 miles farther downstream. Little can be concluded from the two TSS samples.

5.3.9.1.2 Biology

Macroinvertebrate data from the 2002 MDEQ reassessment indicate impairment. The lower site on Garden Creek had an MVFP index score of 44% and had fewer clinger taxa than criteria (Table 5-20).

Table 5-20. Summary of Impairment Based on Macroinvertebrate Metrics for Garden Creek (2002 Data).

	Clinger Richness	**MVFP Index**
Site	**MO4GARDC01**	
Target Value	≥14	≥75
Existing Value	15	94
Percent Departure	NE	NE
Site	**MO4GARDC02**	
Target Value	≥14	≥75
Existing Value	11	44
Percent Departure	21%	41%

5.3.9.1.3 Physical Conditions and Sediment Sources

Several physical parameters indicate impairment due to sediment. In 2003, the Wolman surface fine sediment (<6 mm) averaged 45%, 2 to 3 times the average values for reference A and B stream type reaches (Table 5-21). The 49-point grid fine sediment averaged 42%, which is several times higher than levels found on reference reaches, and indicates that deposited sediment is reducing available spawning habitat. Width/depth ratio is higher than the reference value for the B4 stream type areas of Garden Creek, which also has low streambank cover and low stable bank. Bank stability averaged 51% for all Garden Creek reaches, which is lower than that on most reference reaches. No departure from natural stream type was determined for any reaches of Garden Creek, despite high fine sediment deposition. The Table 5-21 provides a comparison of sediment criteria and existing conditions on Garden Creek.

Table 5-21. Summary of Sediment Impairment Based on Physical Indicators for Garden Creek.

	Sediment Criteria						
	Potential Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**%Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	A4	≥1.2	≤9.2	≤24	NA	≤24.5	≥85
Existing	A4	1.7 S	5 S	34 S	ND	21.8 S	50 S
Percent Departure	No Departure	**NE**	**NE**	42%	ND	**NE**	41%
Target	B4	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4	1.7 S	25 S	54 S	54 S	24.8 S	30 S
Percent Departure	No Departure	**NE**	58%	170%	575%	**NE**	65%
Target	E4a	≥2.5	≤8.3	≤44	≤7	≤23.6	≥85
Existing	E4a	16.2 M	10 M	52 M	31 S	18.7 M	45 M
Percent Departure	No Departure	**NE**	21%	18%	343%	**NE**	47%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given (minimum for % stable bank)

Prior surveys conducted by BLM and USFS rated the assessed reaches on Garden Creek as non-functioning. The location of these reaches is mapped in Map 2 of Appendix A. The TMDL sediment source characterization (Section 7.0) estimated 40% of the total sediment loading is due to human causes, 73% of which was attributed to grazing, and 23% of which was attributed to road-related sources. The presence of human caused sediment sources, along with stream channel geometry and fine sediment departure from reference conditions, indicate that sediment supply and transport are likely impacted by human activities that can be addressed by conservation practices (Appendix F – Garden #7).

5.3.9.1.4 Summary

Impairment is indicated by biological data for the lower, B-type reaches. Physical variables for sediment indicate impairment in all reaches of Garden Creek. Also, human caused sources of sediment are significant; therefore a sediment TMDL will be completed. A sediment TMDL for Garden Creek will consider road and grazing influences.

5.3.10 Harris Creek

Harris Creek is a small tributary to California Creek. The timbered headwaters are in the Tobacco Root Mountains. The mid section is timbered on north facing slopes and shrubs and grasses grow on the south facing slopes. Lower reaches are mostly grassland with limited cropland. The upper portion of Harris Creek's watershed consists of National Forest land. Private landowners and the BLM manage the lower portions of the watershed. Harris Creek was identified in 1996 303(d) List for impairment of aquatic life support and coldwater fishery. The only probable cause provided was siltation, and the only probable source identified was agriculture. In 2004, a new 303(d) review based upon more data determined that this stream was fully supporting all beneficial uses.

5.3.10.1 Sediment

5.3.10.1.1 Total Suspended Solids

TSS was 7.8 mg/L after heavy rainfall during one sampling event in 2002. Harris Creek was visually clear at the time of sampling in spite of heavy rains in the prior 24 hours. This information will be used along with other indicators sediment conditions within the watershed.

5.3.10.1.2 Physical Conditions and Sediment Sources

A geomorphic stream assessment conducted by the forest service on the upper portion of this segment in 1991 (BDFN, n.d.) indicates stream channel instability. The US Forest Service has subsequently created a new grazing allotment management plan for this area and is using riparian vegetation indicators to determine when livestock should be moved from allotments. A number of riparian areas were assessed with PFC methods in 1992 and were considered non-functioning or functioning-at-risk. More recent data is described in subsequent paragraphs that identify better conditions due to changes in grazing.

MDEQ assessment data from 2002 included a stream reach assessment score of 90.8% and a riparian assessment (like PFC) score of 93%, both indicating sustainable riparian conditions. Only minor influences from cattle grazing were evident. According to the 2002 assessment, streambank stability was 80%. Qualitative information provided by the 2002 assessment indicates that spawning gravel and pool habitat appear abundant. While minor impacts from historic mining and grazing are present, current land use does not appear to present physical and habitat conditions that are likely to affect beneficial uses.

Historic placer mining has affected middle and lower sections of the stream by lowering the level of the valley bottom up to 30 feet in some areas. A new, stable stream channel and riparian zone has developed in the placer valley. The placer mining created a sufficiently wide valley bottom to allow for flood prone areas that dissipate stream energy during storm events. Additionally, it appears that the most sensitive instream uses that can be influenced by sediment and habitat conditions are currently supported.

5.3.10.1.3 Biology

An aquatic macroinvertebrate sample from 2002 yielded very few sediment-tolerant taxa. Seventeen clinger taxa were found in the sample suggesting that siltation is not impacting aquatic insect habitat (Table 5-22). In addition, the MVFP index score for Harris Creek was 94%, indicating full support of aquatic insect use. Periphyton monitoring (Bahls, 2003) results indicate a siltation index of 23, which indicates full support of this use. All aquatic insect and periphyton metrics indicate full support of aquatic life uses.

Table 5-22. Summary of Impairment Based on Macroinvertebrate Metrics for Harris Creek (2002 Data).

	Clinger Richness	MVFP Index
Site	MO4HARRC01	
Target Value	≥14	≥75
Existing Value	17	94
Percent Departure	NE	NE

5.3.10.1.4 Summary

Although Harris Creek was listed on the 1996 303(d) List, more recent chemical, biological, riparian, and limited physical data do not indicate impairment of beneficial uses. Data that supported the 1996 listing were collected in 1991 and 1992 on public lands. Since that time land management has improved and more recent data indicate the stream is not impaired. A sediment TMDL is not needed for Harris Creek.

5.3.11 Hawkeye Creek

Hawkeye Creek is located in the headwaters area of the Ruby River. The watershed is entirely managed by the USFS. The headwaters of this tributary are forested and flow from the Snowcrest Mountains. In mid and lower elevations many north-facing slopes are forested while the rest of the area is composed of grass and shrub land.

Hawkeye Creek was listed on the 1996 303(d) List for partial support of aquatic life and coldwater fisheries. Habitat alteration was indicated as the probable cause. Agriculture was listed as the probable source. This stream is considered fully supporting all beneficial uses on the 2004 303(d) List.

5.3.11.1 Water Chemistry

No exceedences of Montana’s primary numeric water quality standards were found. Iron exceeded the secondary drinking water standard (0.52 mg/L). The total nitrogen value (0.300 mg/L) was near the Upper Clark Fork River nutrient standard and total phosphorus (0.059 mg/L) exceeded the UCFR standard of 0.020 mg/L. Natural sources of these constituents may be a consideration, due to the erodible soils and geology of the upper Ruby River watershed and the fact that this sample was collected during a storm event. Nearby unvegetated hillslopes contribute to the sediment supply thereby elevating phosphorus loads in response to this natural condition. Furthermore, the nutrient criteria and targets presented in Section 4.0 of this document do not apply as well to runoff events such as this sample.

TSS was 25.7 mg/L during the 2002 sampling event. The water quality monitoring took place following heavy rains during the previous 24 hours. This is a moderately high value, but below the guideline value of 55 mg/L for chronic TSS concentration that would affect salmonids (Newcombe and Jensen, 1996). The TSS datum does not provide a solid basis for making conclusions about impairment due to sediment conditions. This limited information will be used along with other sediment criteria to determine impairment.

5.3.11.2 Biology

The 2002 reassessment macroinvertebrate data indicated a low percentage of sediment tolerant taxa. However, the MVFP index score was only 44%, indicating moderate impairment and partial-support of aquatic life uses (Table 5-23). Thirteen clinger taxa were present but only four caddisfly taxa were represented. Nevertheless, it appears that according to the overall taxa found in the sample, clean, hard substrates, unimpaired by fine sediment deposition, were available for colonization (Bollman, 2002).

Table 5-23. Summary of Impairment Based on Macroinvertebrate Metrics for Hawkeye Creek (2002 Data).

	Clinger Richness	MVFP Index
Site	**MO4HKWEC01**	
Target Value	≥14	≥75
Existing Value	13	44
Percent Departure	**7%**	**41%**

MDEQ considers the biological results to be equivocal, mostly due to the naturally high sediment supply in the drainage, resulting from the erosive soils and active geology of the upper Ruby River watershed. Although there are no diversions of flow, there is fairly strong evidence in the macroinvertebrate data that the stream naturally goes dry, or nearly dry, and is re-colonized most easily and quickly by tolerant taxa. The biological results indicate the true condition of the stream but they do not reveal the natural verses anthropogenic sources of the stressors pertaining to flow and sediment. The drainage was grazed in the past and may be lightly grazed currently, but grazing impacts are minor. The watershed is not roaded and little in the way of recreation or other land use occurs. The sources of sediment are nearly all natural and the low seasonal flow conditions are totally natural.

5.3.11.3 Physical Conditions and Sediment Sources

According to MDEQ assessment notes, flow conditions were good at the time of the assessment but the macroinvertebrate sampling suggests that the channel has gone dry periodically and re-colonization occurs. This hypothesis based on aquatic insect sampling was not verified by field investigations.

Risk of excess erosion and sedimentation is indicated by low streambank stability, as well as excess fine sediment deposition in one reach (Table 5-24). According to stream assessments conducted in 2003, bank stability averaged 48%. Stream bank erosion is discontinuous and occurs on outside channel bends. The stream is naturally prone to erosion and sedimentation. High silty banks and natural sediment sources were noted in field observations. Low entrenchment ratio at E4 reaches indicates slight incisement. This appears to be due to landform and adjustment from past beaver activity, and is considered primarily natural. This is also the case for the E4b reach. The MDEQ Stream Reach Assessment score from 2002 was 79%, which indicates a relatively stable stream channel. The Riparian Assessment score was 92%, rated “sustainable.” Field photos show raw, eroding hillsides away from the channel. Willows were common but not continuous.

Table 5-24. Summary of Sediment Impairment Based on Physical Indicators for Hawkeye Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**% Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	E4	≥5	≤9.1	≤38	NA	≤23.4	≥85
Existing	E4	2.5 S	3 S	37 S	33 S	26.5 S	45 S
Percent Departure	No Departure	50%	**NE**	**NE**	NA	13%	47%
Target	E4b	≥5*	≤9.1	≤38	NA	≤23.4	≥85
Existing	E4b	2.9 S	5 S	45 S	65 S	17.5 S	50 S
Percent Departure	No Departure	42%	**NE**	18%	NA	**NE**	41%

* Entrenchment targets for Eb channels are based on E channels (see Section 4.0)
NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

Less than 1% of the total sediment load for Hawkeye Creek was attributed to human causes, all of which was attributed to grazing. Sediment sources on Hawkeye Creek are predominantly natural. Woody riparian species (mainly willow) do not appear to be browsed at all. There was minor, infrequent evidence of past livestock trampling of soils and streambanks. Nearby bare soils on the upland slopes are testament to the fragile geology and the inability of these soils to stabilize with vegetation. The stream intercepts eroding hillsides upstream of the assessment site. Old vegetated landslides are common in the upper Ruby and small landslide prone areas may be present in the Hawkeye drainage. A near-continual supply of fine sediment settles in pools and embeds gravels in riffle and runs. A sediment plume off the mouth of Hawkeye Creek in September indicates that the sediment supply is virtually continuous, rather than associated with runoff and storm events. High flow in the Ruby River during spring runoff probably flushes most of the plume downstream each year.

5.3.11.4 Summary

Sediment and flow-related perturbances are mostly natural. The Forest Service modified the grazing management regimen several years ago and little if any grazing impacts are noticeable. Additionally, cattle are now trucked rather than trailed to and from the upper Ruby grazing allotments, so impacts from trailed cattle on the lower reaches of these tributaries are avoided. The naturally erosive geology is predominantly responsible for the sediment supply and stream channel erosion. From an instream habitat standpoint, Hawkeye Creek does not typify a pristine mountain or foothill stream. Nor do the biological and habitat data suggest that aquatic life is fully supported. However, since the condition is overwhelmingly a result of the natural conditions of the watershed, MDEQ has judged all beneficial uses fully-supported. Few to no reasonable conservation practices can be further implemented in this watershed. Indicators of natural erosion and conflicting biological data related to siltation recommend further study on this stream as a potential reference in highly erodible, steep gradient, landscape. All of this information considered together indicates there is no need for a TMDL.

5.3.12 Indian Creek

Indian Creek is located in the northeast portion of the Ruby River watershed. The timbered headwaters are in the Tobacco Root Mountains. Lower areas of the watershed are a mix of grassland and cropland. The upper portion of the watershed consists of National Forest land. The BLM and private landowners respectively own the middle and lower portions of the watershed. Historically Indian Creek was a tributary to Mill Creek. Now Indian Creek flows into Leonard Slough.

Indian Creek was listed in 1996 for partial impairment of aquatic life support and coldwater fishery and threatened drinking water and primary contact recreation. The only probable cause listed is flow alteration and the only probable source is agriculture. Indian Creek is a municipal watershed for the town of Sheridan. Sheridan obtains drinking water from wells in the alluvial aquifer. On the 2004 303(d) List, Indian Creek probable causes of impairment are dewatering, riparian degradation, and fish habitat degradation.

5.3.12.1 Sediment

Indian Creek is not currently listed for any pollutants for which a TMDL management plan can be written. The TMDL and watershed restoration planning assessments for the Ruby Watershed considered streams with riparian habitat pollution listings and sediment related pollutant listings with the same methods. This sediment section addresses the riparian habitat pollution listings for Indian Creek as well as providing information for determining if the stream is impaired due to sediment conditions.

5.3.12.1.1 Biology

The MVFP macroinvertebrate index (Bollman, 2001) indicates impairment at lower sites on Indian Creek. The MVFP score from 2002 sampling at the upper biomonitoring site was 89%, but at the lower site in the Alluvial Valley the score is only 50%, compared with the target value of 75%. Clinger richness was low for the lower reach as well, indicating possible impairment due to fine sediment (Table 5-25).

Table 5-25. Summary of Impairment Based on Macroinvertebrate Metrics for Indian Creek (2002, 2003 Data).

	Clinger Richness	MVFP Index
Site	**MO4INDC01**	
Target Value	≥14	≥75
Existing Value	18	89
Percent Departure	NE	NE
Site	**MO4INDC02**	
Target Value	≥14	≥75
Existing Value	10	50
Percent Departure	29%	33%
Site	**IND-1**	
Target Value	≥14	≥75
Existing Value	20	100
Percent Departure	NE	NE

5.3.12.1.2 Physical Conditions and Sediment Sources

According to SRAF assessments there is a general trend on Indian Creek from good instream condition in the Tobacco Root area on upstream reaches to poor condition on downstream reaches within the alluvial valley (Appendix F – Indian #6). The TMDL sediment source characterization estimated 88% of the sediment load to be human-caused; 55% was attributed to grazing, as well as 20% to past impacts, 20% to more recent channel manipulation, and 5% to road-related sources (Section 7.0). The downstream end of Indian Creek has been drastically altered in the past due to channel manipulation, which consisted of straightening and diverting much of the lower end of the stream. Bank stability in this area is approximately 50%. Streambank sediment sources due to current and past management activities are minor in the headwaters, but increase by two orders of magnitude from the upstream to downstream reaches, showing a moderately high impact due to agricultural-related sources in many reaches the alluvial valley (downstream). Road-related sediment inputs are high in some areas, primarily in the Tobacco Root landscape, but contribute a low proportion of the total sediment load. One reach, IND4E, is in notably lower condition than other reaches, due to dewatering, bank trampling, and removal of riparian vegetation. This reach also exhibits the highest percent of fines in spawning areas when compared to other reaches in the same landscape.

Comparison of existing conditions to target values indicates impairment due to sediment in some reaches of Indian Creek (Table 5-26). Most reaches of Indian Creek exhibit departure from a natural stream type. The reach showing no departure has a high width/depth ratio for an A3, but width/depth ratio is variable due to landform and all the other characteristics match an A type. High fine sediment was also noted, especially on reaches with low percent stable bank (Table 5-26). The presence of human caused sediment sources along with stream channel geometry and fine sediment departure from reference conditions indicate that sediment supply and transport are likely impacted by human activities that can be addressed by conservation practices.

Table 5-26. Summary of Sediment Impairment Based on Physical Indicators for Indian Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**% Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	A3	≥1.2	≤9.2	≤24	NA	≤24.5	≥85
Existing	A3	1.3 S	26 S	13 S	7 S	15 S	90 S
Percent Exceedence	No Departure	**NE**	183%	**NE**	NA	**NE**	**NE**
Target	B4	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4, C4a, F4b	1.6	21.5	31.8	21	22.9	72
Percent Departure	Departure	**NE**	36%	59%	163%	**NE**	15%
Target	B3	≥1.6	≤15.8	≤10	≤8	≤29.8	≥85
Existing	C3a	3.2 S	18 S	26 S	1 S	32.5 S	20 S
Percent Exceedence	Departure	**NE**	14%	160%	**NE**	9%	76%
Target	B3a	≥1.6	≤15.8	≤10	≤8	≤29.8	≥85
Existing	B3a, C3a	2.8 M	26 M	15 M	6 M	11 M	85 M
Percent Exceedence	Departure	**NE**	65%	50%	**NE**	**NE**	**NE**

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given (minimum for % stable bank)

5.3.12.1.3 Summary

Indian Creek is not currently listed for any pollutants that can be addressed through the TMDL system; however, a TMDL for sediment will be written to address sediment sources because newly collected information links sediment production with sediment conditions that cause impairment of instream uses. Future 303(d) lists will consider the more recently collected sediment and source assessment data.

5.3.12.2 Other Considerations

The wastewater treatment facility below Sheridan is permitted for discharge of wastewater into a tributary to Indian Creek. There are no indications of elevated nutrients or temperature in Indian Creek from existing data; however, little sampling for these parameters has been conducted in Indian Creek below the WWTP. The tributary to Indian Creek into which the effluent flows is noticeably affected. The City of Sheridan is working with Montana DEQ to reduce BOD concentration in the effluent, which currently exceeds permit limits. Currently there are no nutrient listings in the Ruby watershed downstream of the effluent.

De-watering issues should be investigated further on this stream for their effect on stream temperature, as well as nutrient concentrations and sediment deposition. Indian Creek is on the

MFWP Chronically Dewatered Streams list. Local sources have indicated water is diverted year-round from Indian Creek. The location of irrigation diversions on Indian Creek is illustrated on Map 12 of Appendix A. Indian Creek supports a pure westslope cutthroat trout population. Apparently, sections of Indian Creek are dewatered more severely now than prior to the last decade, and have caused fish kills and reduction in fish populations in some segments of the stream. Maintaining adequate instream flow for aquatic habitat requirements is likely one of the most limiting factors in sections of Indian Creek and should be a management priority. Stream flow impacts to sediment transport will be addressed in the source assessment portion of the Indian Creek sediment TMDL.

5.3.13 Middle Fork Ruby River

Middle Fork Ruby River is located in the headwaters area of the Ruby River. The mainstem lies in shrub and grassland dominated foothill landscape. Major tributaries to the Middle Fork Ruby River are Hawkeye, Basin, Shovel, Swamp, Divide, Poison, and Coal creeks. The watershed is entirely managed by the USFS. This area is the location of an Arctic grayling reintroduction program, and is therefore a priority for maintaining high-quality habitat.

Middle Fork Ruby River was listed in 1996 for non-support of aquatic life and coldwater fisheries. Probable causes were habitat alterations and siltation. Probable sources were agriculture, natural sources, rangeland grazing, and streambank modification/destabilization. This water body was reassessed and identified on the 2004 303(d) List for partial support of aquatic life and coldwater fisheries. Probable causes are bank erosion, fish habitat degradation, siltation, other habitat alterations, and riparian degradation. Probable sources are agriculture, grazing-related sources, highway maintenance and runoff, and unpaved road runoff. The TMDL source assessment found natural, grazing and road related sources.

5.3.13.1 Sediment

5.3.13.1.1 Total Suspended Solids

The two samples for suspended solids near the confluence at three forks indicate TSS levels above 55 mg/L, which can cause moderate habitat degradation for juvenile salmonids if that level of TSS is present for a week (Newcombe and Jensen, 1996). These samples were collected by MDEQ in June of 2001. There are not enough data to determine if persistently high TSS levels are present or the source of this sediment at the moment it was collected. This information will be used with other indicators of sediment production within the watershed.

5.3.13.1.2 Biology

Macroinvertebrate samples from 2001 at sites near the confluence with the East and West Forks suggest minimal fine sediment deposition. Clinger richness was at or above the target value, but MVFP scores for the sites on the Middle Fork were 72% and 67%, both slightly lower than the target of 75%. Macroinvertebrate community indicates a slightly impaired situation (Table 5-27).

Table 5-27. Summary of Impairment Based on Macroinvertebrate Metrics for Middle Fork Ruby River (2001 Data).

	Clinger Richness	MVFP Index
Site	**MF3**	
Target Value	≥14	≥75
Existing Value	14	72
Percent Departure	NE	4%
Site	**MF5**	
Target Value	≥14	≥75
Existing Value	15	67
Percent Departure	NE	11%

5.3.13.1.3 Physical Conditions and Sediment Sources

Notes from MDEQ assessments indicate that high sediment in this reach is due to bank erosion and contributions from the tributaries. Stream assessments from 2003 also document high sediment contribution from tributaries. Enlargement of point bars, filling of pools, and overwidening due to lateral erosion are sediment-related sources of impairment identified by MDEQ in field notes. Field photos taken by MDEQ document severe bank erosion, especially in downstream reaches, and indicate a lack of riparian shrubs to stabilize banks. Assessments conducted in 2003 also document eroding banks on the Middle Fork Ruby River, although overall bank stability rated high. Natural high eroding banks are present, originating from stream meanders cutting into toe slopes (Appendix F – MFR #6). Average bank stability was 77% and the average BEHI value was 16.7. Neither of these values indicates bank stability as a problem.

None of the sediment target or supplemental indicator parameters exceeded target levels by greater than 11% (Table 5-28). Width/depth ratios and percent deposited fine sediment were generally higher than target values for an E4 stream type, but none was high enough to result in departure from the E4 type. The middle reach assessed on the Middle Fork Ruby River (MFR2B) has active and recent beaver damming, and is in adjustment, with high exposed banks and new bars formed from trapped sediment. Fines measured by 49-point grid were highest in this reach, with 63%, which is high compared to reference reaches, and is high among all reaches. In contrast, fines measured by 49-point grid were only 4% in the reach downstream of the beaver complex. Two reaches exceed targets for entrenchment, giving a low overall entrenchment for the stream type (Table 5-28). Streams above and below beaver complexes are entrenched where the stream has adjusted from historic beaver influence and under more recent influences of grazing on sensitive pond sediments. Many areas of Middle Fork Ruby are still well-connected to the floodplain and are generally in good condition. The upper reaches of the Middle Fork Ruby River provide varied aquatic and riparian habitat due to ponding from current beaver activity, despite high sediment levels in ponded areas that are trapping sediment (Appendix F – MFR #2).

Table 5-28. Summary of Sediment Impairment Based on Physical Indicators for Middle Fork Ruby River.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**% Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	E4	≥5	≤9.1	≤38	NA	≤23.4	≥85
Existing	E4	2.8	10	42	68 M	20.4	80
Percent Departure	No Departure	44%	10%	11%	NA	**NE**	6%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

The sediment source characterization for the mainstem of the Middle Fork Ruby River estimated only 11% of the sediment load to be human-caused; of this, 97% was attributed to grazing and 3% to roads. Field assessments from 2003 document grazing impacts to streambanks and riparian vegetation on the upstream reach, but overall, riparian shrub cover and bank stability are good. Sediment source assessments were conducted on Hawkeye, Basin, Shovel, Poison, and Coal creeks. These tributaries to the Middle Fork Ruby all have a high sediment contribution from natural sources and most remaining loading from grazing-related sources. Natural loading is high enough on Coal and Hawkeye Creeks to contribute a significant amount of sediment to the Middle Fork Ruby River. The sediment source characterization (Section 7.0) summarizes sediment sources from Middle Fork and its tributaries.

5.3.13.1.4 Summary

Physical and biological indicators provide evidence of minor impairment of beneficial uses due to sediment. Most sediment indicators are very close to criteria. Human caused sediment sources are also present and appear to be a small but significant contributor to instream sediment conditions. Impacts from land use are not problematic over the entire water body, therefore restoration efforts should be focused on reaches showing impairment and also tributaries that generate human caused sediment loads. Slight to moderate human caused sediment sources coincide with slight impairments in this stream reach. It is likely that implementation of reasonable conservation practices will result in uses being attained. A sediment TMDL will be completed for the Middle Fork Ruby River, but will consider natural influences and will follow an adaptive management approach that includes recommendations for future monitoring to determine the streams potential with reasonable conservation practices in place. The Middle Fork Ruby River will be addressed via both a TMDL for the mainstem Middle Fork Ruby River and for required sediment TMDLs in 303(d) sediment listed tributaries.

5.3.14 Mill Creek

Mill Creek is located in the northeast portion of the Ruby River watershed. The timbered headwaters are in the Tobacco Root Mountains. Lower areas of the watershed are a mix of grassland and cropland. The upper portion of the watershed consists of National Forest land. Private landowners own most of the middle and lower portions of the watershed except for small areas of State and BLM land. Land use in the Mill Creek watershed includes urban, crop production, grazing, recreation and forestry related human influences.

Mill Creek was listed in 1996 for partial impairment of aquatic life support and coldwater fishery and threatened drinking water and primary contact recreation. Probable causes listed were flow alteration, siltation, and thermal modifications. Probable sources were agriculture, channelization, flow regulation/modification, highway maintenance and runoff, and resource extraction. Mill Creek is on the 2004 303(d) List for partial impairment of aquatic life support, coldwater fishery, and primary contact (recreation). Probable causes of impairment are dewatering, lead, zinc, metals, flow alteration, other habitat alterations, and riparian degradation. Probable sources are crop-related sources, acid mine drainage, abandoned mining, agriculture, resource extraction, habitat modification other than hydromodification, and removal of riparian vegetation.

5.3.14.1 Metals (Lead and Zinc)

5.3.14.1.1 Water Chemistry

There are several priority abandoned mine sites on Mill Creek (Appendix A – Map 7). Data collected by the MDEQ Abandoned Mines Bureau in June 1993 indicated exceedances for mercury, lead and zinc in samples from the Smuggler and Uncle Sam mines, but all of these samples were collected from small tributaries or adits (Table 5-29). MDEQ staff conducted reassessments including water chemistry at nine sites along Mill Creek in 2000. Water quality was also sampled during high flow conditions on the falling limb of the hydrograph for the 2003 TMDL assessment at a site on Mill Creek below Smuggler mine and in the adit of Smuggler mine. Summer low flow sampling for the 2003 TMDL assessment included a site at Middle Road along with the Smuggler Mine sampling. No exceedences of human health or aquatic life standards were found during 2000 or 2003 in Mill Creek. Table 5-29 summarizes metals samples exceeding water quality standards for Mill Creek. The prior 303(d) metals listings were based in error on water quality data collected from a mine adit that flows into Middle Fork Mill Creek, not on actual instream data from Mill Creek.

Table 5-29. Water Quality Samples Showing Elevated Metals, from MWCB 1993 Data.

Mine Name	Location	Sample ID	Hg (µg/L)	Zn (µg/L)
Smuggler	Adit	29-010-SW-1	0.2600	NE
Uncle Sam	Middle Fork Mill	29-383-SW-1	0.1900	NE
Uncle Sam	Middle Fork Mill	29-383-SW-2	0.2000	NE
Uncle Sam	Adit	29-383-SW-3	0.1800	1240.00
Uncle Sam	Adit	29-383-SW-5	0.2600	2090.00

NE = No exceedance.

5.3.14.1.2 Biology

The percentage of abnormal diatoms fell well below metals criteria that indicate toxic influence in all samples collected in Mill Creek (Bahls, 2003).

5.3.14.1.3 Sediment Metals

Some mine tailings from the Buckeye Mine near Brandon (also called the Brandon Mine) have washed into Mill Creek in the past and are currently deposited on the floodplain. Sampling was being conducted in 2004 as part of a restoration project for that tailings site and but are not included in this data review. In Mill Creek at the Buckeye mine site, lead concentration in channel sediment samples during 1993 were elevated more than 800%, copper was elevated more than 300%, and zinc was elevated more than 500%. None of the individual sediment metal concentrations below Buckeye mine are above sediment metal criteria described in Section 4.0, although, a few measurements fall just below the criteria and may act in combination to cause toxicity although there is no biological data collected from this area (Table 5-30).

According to benthic sediment samples collected in 1993 by the Abandoned Mine Bureau, copper concentrations were elevated 200% and lead and zinc concentrations were elevated more than 300% from upstream to downstream in Middle Fork Mill Creek at the Uncle Sam site. Lead, copper and zinc sediment concentrations were all found at high levels down grade of the upper Uncle Sam adit.

Table 5-30. Sediment Metals Data Exceeding Guideline Values at Uncle Sam Mine on Middle Fork of Mill Creek (MWCB 1993 Data).

Metal	Date	Site	Conc. (mg/kg)	Exceedence summary
Lead	6/16/1993	SE2	68	Exceeds sediment criteria; considered moderate exceedence
Copper	6/16/1993	SE2	86.9	Exceeds sediment criteria; considered moderate exceedence
Zinc	6/16/1993	SE2	216	Exceeds sediment criteria; considered moderate exceedence

5.3.14.1.4 Summary

Due to the presence of metal sources and some borderline sediment metals concentrations found below Buckeye mine and the potential impairment of a tributary, the Middle Fork of Mill Creek, further monitoring for metals is recommended in this watershed. No metals TMDL for Mill Creek is needed at this point because there were no exceedences of water quality standards, no toxic responses found in the sampled biological communities, and no exceedences of sediment metal criteria in Mill Creek. The initial metals listings for zinc and lead were made in error because data from adits were thought to have been sampled from Mill Creek. A follow-up monitoring plan will address the effects of the Buckeye mine site remediation and will provide further source assessment and impairment determination monitoring strategy to use near Uncle Sam Mine adits in the Middle Fork of Mill Creek.

5.3.14.2 Temperature

5.3.14.2.1 Temperature, Shade and Discharge Data

Data collected in 2002 and 2003 from continuous temperature loggers indicate a large increase in temperature from the upstream to downstream sites (Table 5-31). The highest seasonal 7-day average of the maximum daily temperature at Middle Road (the downstream site) for both years exceeded 74°F, which approaches lethal temperatures for Rainbow trout and brown trout, and surpasses lethal temperatures for westslope cutthroat trout. The instantaneous maximum temperature at this site was 79.6°F, which is higher than the lethal temperature for all trout species in the Ruby watershed. Mill Creek is classified as able to support a coldwater fishery which includes trout, but temperatures are at levels that affect the fishery. Fishery information from Montana FWP indicates a depressed population of brook trout in the lower reaches of Mill Creek.

Mill Creek is identified on Montana FWPs list of chronically dewatered streams. Flow monitoring on Mill Creek indicates a drastic decline instream flow from above Brandon down to below Sheridan, then an increase in flow just downstream of Sheridan to the confluence with the Ruby River. Most of the water returning to the channel is taken out again above the confluence for part of the year (Payne, 2004). Trends in temperature and flow are discussed further in Section 6.0 as part of the thermal source assessment. The reduction in flow on Mill Creek is apparently due both to natural subsidence into the alluvial fan as well as dewatering for irrigation of fields (Payne, 2004).

SNTEMP modeling and associated temperature, riparian canopy and flow monitoring were conducted for Mill Creek during 2004-2005 to determine if stream temperature would fluctuate in response to shading, width to depth ratios, and increases in instream flow due to improved irrigation efficiency. The modeling simulated the hottest days of summer therefore the standards applicable to this timeframe for Mill Creek are a one half degree Fahrenheit increase over the State's definition of natural conditions. Natural conditions relate to the application of all reasonable land soil and water conservation practices applied in the watershed, which will protect the beneficial use (cold-water fisheries in this case). See Appendix C for a detailed description of the SNTEMP modeling effort.

Increasing canopy cover to reference conditions alone, without increases in flow, predicted a temperature reduction of 0.42ºF in reach M8, the most downstream reach. This modeling result indicates that temperature in this segment is influenced by decreased shading. In all other reaches the temperature is likely not influenced a great deal by human caused stream canopy alterations according to the modeling results.

Montana water quality law states that water rights can not be affected by the water quality related codes and rules, including TMDLs, and therefore the modeling scenarios were set to only account for increase in flow that can be realized from reasonable irrigation system water savings and leasing those savings to instream use without decreasing the amount of irrigated land in the watershed. The modeling results indicate that applying irrigation water savings to instream flows would likely not reduce water temperatures in lower Mill Creek. Applying both a reference shade and irrigation water savings to instream flows in combination also would not reduce water temperatures in lower Mill Creek. The results of modeling reflect that high temperatures due to severe dewatering cannot be overcome only from irrigation efficiency BMPs and leasing savings to instream use.

Two irrigation ditch return water influences in the lower sections of Mill Creek were not assessed by the SNTEMP monitoring. These influences were found below the most sensitive flow locations during the modeling calibration. The model would not calibrate without large warm water influences. Further investigation indicated that two ditches empty into Mill Creek in the areas that the model indicated. With very low instream flows, even small irrigation return flows are likely to influence instream water temperatures. Budget and time constraints precluded monitoring in these ditches during the heat of the summer the following year. The model indicates that these irrigation diversions are warm water influences, but they also re-water the stream with water originating mostly from the Ruby River, creating a more hospitable environment for fish than a dewatered streambed. It is very likely that these warm water influences along with slightly reduced shading along the stream corridor produce conditions that exceed state standards, although the modeling could not fully verify this is the case without data collected from the ditches.

**Table 5-31. Summary of Temperature Data From Continuous Recorders Placed in Mill Creek.
Sites Are Listed From Upstream to Downstream.**

Site Name	Start Date	Stop Date	Highest 7 Day Seasonal Avg. Max (°F)	Seasonal Max (°F)
2002 Data				
MILL CR ABOVE USFS BOUNDARY 2002	07/12/02	10/16/02	59.3	61.1
MILL CR IN SHERIDAN-2002	07/12/02	10/17/02	68.0	71.9
MILL CR BELOW MIDDLE RD.-2002	07/13/02	10/20/02	75.6	80.0
2003 Data				
Mill CR ABOVE USFS BOUNDARY-2003	06/11/03	09/30/03	59.5	59.7
Mill CR. BELOW MIDDLE RD.-2003	06/11/03	09/30/03	77.7	79.3
2004 Data				
Mill CK HEADWATERS	07/21/04	08/09/04	58.8	60.2
Mill CK (RM 15.5)	07/21/04	08/09/04	55.2	56.3
Mill CK ABOVE DIVERSION (RM12.8)	07/22/04	08/09/04	59.3	60.0
Mill CREEK BELOW BRANDEN	07/22/04	08/09/04	61.0	62.0
Mill CREEK ABOVE SHERIDAN	07/22/04	08/10/04	65.6	62.0
Mill CREEK IN VALLEY (RM 6.5)	07/22/04	08/09/04	67.3	68.5
Mill CK 100 FT ABOVE MIDDLE RD	07/22/04	08/09/04	71.1	72.2
Mill CK AT SPRINGS	07/23/04	08/11/04	66.2	67.8
Mill CK ABOVE RUBY (RM 0.21)	07/23/04	08/11/04	67.9	68.8

Table 5-32. Summary of Impairment Based on Temperature Targets for Mill Creek.

Target	Proposed Criterion	Reach or Site	Exceedence Summary
Adherence to state standard	For waters classified as A-1 or B-1, a 1ºF maximum increase above naturally occurring water temperature is allowed within the range of 32ºF to 66ºF; within the naturally occurring range of 66ºF to 66.5ºF, no discharge is allowed which will cause the water temperature to exceed 67ºF; **and where the naturally occurring water temperature is 66.5ºF or greater, the maximum allowable increase in water temperature is 0.5ºF.**	All reaches	Increases in temperature due to reduced riparian shade conditions along with warm ditch return water entering the stream likely increase water temperatures more than 0.5ºF when water is warmer than 66.5ºF.
Meet the Target Above or Flow and Shade Surrogate Targets Identified Below			
Instream flow	All irrigation return flows can not increase stream temperature more than 0.25 ºF cumulatively.	Pertinent to pediment and alluvial valley landscapes	Modeling indicated warm water surface irrigation water is likely entering lower Mill Creek.
Percent Canopy Cover	Comparable with reference sites (55% for headwaters; 71% for pediment; 35% for alluvial valley).	Headwaters – Forested (M1-M3)	On average the reaches achieved the canopy cover target. One reach had naturally lower shading potential than the target.
		Pediment/glacial outwash fan – Cottonwood and Willow mix (M4-M6)	Reach M4 and M6 are below target canopy cover partly due to human influenced riparian clearing.
		Alluvial Valley – Mostly Willows (M7-M9)	Reaches M8 and M9 are considered below potential due partly to human causes.

5.3.14.2.3 Summary

Water temperature in the middle and lower reaches of Mill Creek are above lethal limits for some species of trout and would negatively impact all trout species. A TMDL will be written because modeling indicates warm water surface return flow and shading are likely impacting temperatures in Mill Creek to an extent that state water quality standards are exceeded. Because of uncertainties involved with the source assessment, the TMDL will depend upon adaptive management and follow-up monitoring.

5.3.14.3 Sediment

5.3.14.3.1 Total Suspended Solids

There are no TSS data from Mill Creek. Other information is based on field observations. Water flowing into Mill Creek from irrigation ditches is noticeably more turbid than the creek water. Additionally, Ruby River water is diverted into Mill Creek in the alluvial valley area known as Mill Slough and removed again from Mill Creek in a diversion just above the confluence of Mill Creek with the Ruby River. Ruby River water is often noticeably more turbid than Mill Creek water. Pictures of runoff from the town of Sheridan show a marked increase in turbidity (Appendix F – Mill #17).

5.3.14.3.2 Biology

Macroinvertebrate assemblages from 2000 and 2003 on the upper reaches of Mill Creek indicated excellent water substrates free of fine sediment deposition and full support of aquatic life. Macroinvertebrate data from the Middle Road site lower on Mill Creek suggest that fine sediment deposition could be smothering aquatic insect habitat, and reflects partial impairment of aquatic life use for both years. MVFP scores also reflect a downward trend in condition from upstream to downstream. MVFP scores for samples collected in upstream reaches in the Tobacco Root landscape ranged from 78 to 100%. The MVFP score for a sample collected in Sheridan was 50%, and below Sheridan at Middle Road the score dropped to 44%. Clinger richness at this lower site was also lower than the target value (Table 5-33).

Table 5-33. Summary of Impairment Based on Macroinvertebrate Metrics for Mill Creek (2000, 2003 Data).

	Clinger Richness	MVFP Index
Site	**M6 (2000)**	
Target Value	≥14	≥75
Existing Value	27	78
Percent Departure	NE	NE
Site	**M13 (2000)**	
Target Value	≥14	≥75
Existing Value	ND	50
Percent Departure	NA	33%
Site	**MIL-1 (2003)**	
Target Value	≥14	≥75
Existing Value	17	100
Percent Departure	NE	NE
Site	**MIL-2 (2003)**	
Target Value	≥14	≥75
Existing Value	9	44
Percent Departure	36%	41%

5.3.14.3.3 Physical Conditions and Sediment Sources

Few reaches exhibit departure from natural Rosgen stream type. High fines were noted but did not result in departure from natural Rosgen level II stream type. In Mill Creek, fine sediment in the Pediment and Tobacco Root landscapes is low on average (4-21% surface fines <6 mm and 5-7% fines from the 49-point grid), with relatively low bank erosion potential scores (BEHI 14.3-14.5) and 72-90% bank stability. In contrast, the Alluvial Valley management area (E4 type) reflects impairment based on several indicators. Fines <6 mm averaged exceeded the target values in all stream types. Entrenchment ratio exceeded target values in B3 and E4 reaches, but did not indicate departure from potential stream type on B3 reaches. Table 5-34 provides a summary of targets and existing conditions for reaches on Mill Creek by potential stream type.

The TMDL source assessment estimates that about half of the sediment load entering Mill Creek is derived from human caused sources including roads, grazing, urban and mining activities. Roads and mining are the predominant sediment sources in the mountains. Grazing and urban influences are the predominant sediment sources in the Ruby Valley.

Table 5-34. Summary of Sediment Impairment Based on Physical Indicators for Mill Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**%Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	B3	≥1.6	≤15.8	≤10	≤8	≤29.8	≥85
Existing	B3	1.4	16	12	8.5	15	95
Percent Departure	No Departure	12%	1%	20%	6%	**NE**	**NE**
Target	B4	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4, C4b	9.4 M	16 M	21 M	5 M	19 M	25 M
Percent Departure	Departure	**NE**	1%	5%	**NE**	**NE**	71%
Target	E4	≥5	≤9.1	≤38	NA	≤23.4	≥85
Existing	E4, B4c	3.6 M	17	53 M	28 S	22.5 M	57 M
Percent Departure	Departure	28%	87%	39%	NA	**NE**	33%
Target	B3a	≥1.6	≤15.8	≤10	≤8	≤29.8	≥85
Existing	B3a	1.6 S	13 S	13 S	3 S	15 S	95 S
Percent Departure	No Departure	**NE**	**NE**	30%	**NE**	**NE**	**NE**

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given (minimum for % stable bank)

5.3.14.3.4 Summary

A sediment TMDL is recommended for Mill Creek because of high fine instream sediments in the pediment area. Stream channel characteristics such as W/D ratio and entrenchment ratios also suggest sediment delivery and transport problems. Biological measurements indicate sediment impacts aquatic life. The presence of significant human caused sources also indicates that restoration practices could be implemented to address sediment loading.

5.3.14.4 Other Considerations

Macroinvertebrate data from 2003 indicate that nutrient enrichment cannot be ruled out as one challenge to biotic integrity at MIL-2 (Bollman, 2003). Some nutrient fractions measured in water quality samples taken from Mill Creek indicate nutrient enrichment. Total Kjeldahl nitrogen as N was 700 µg/L in a 2003 sample, which is over 2 times the average U.S. EPA regional reference value of 307 µg/L (U.S. EPA, 2000a, 2001). Soluble reactive phosphorus (SRP) in a 2003 sample was 400 µg/L, which is orders of magnitude greater than other samples collected in the Ruby watershed in 2003, as well as the target value recommended for the CFR (6-8 µg/L). Sheridan's WWTP lagoons are located near Mill Creek and may contribute nutrients via ground water.

Mill Creek is not listed for nutrients, but further monitoring for nutrients and further investigation of potential inputs, including concentrated livestock operations and wastewater treatment, is recommended.

5.3.15 Mill Gulch

Mill Gulch is a small tributary to Granite Creek, which is one of the major tributaries to Alder Creek. The headwaters of Mill Gulch are mostly forested, with some open south-facing slopes and several areas of timber harvest. The middle and lower sections of Mill Gulch are also forested, with a forest road occasionally paralleling the stream in more confined canyon areas. The headwaters of Mill Gulch were listed on the 1996 303(d) List for partial support of aquatic life and coldwater fisheries. Siltation was indicated as the probable cause. Silviculture was listed as the probable source. In 2002, a new 303(d) review based upon more recent data determined that this stream was fully supporting all beneficial uses. This watershed appears to have recovered from past timber harvest-related sediment supply problems. The clearcuts are now reestablished with young trees and grasses. Mill Gulch Creek transports moderately high amounts of sediment but is not considered impaired because biological uses appear to be supported. Some localized grazing-related sources appear to influence sediment supply near the confluence of Mill Gulch with Granite Creek, but these are not of significant size to impair beneficial uses.

5.3.15.1 Sediment

5.3.15.1.1 Total Suspended Solids

Water chemistry samples were colleted by MDEQ in 2002 at one site above the USFS boundary. Too few samples are available to determine impairment based on TSS.

5.3.15.1.2 Biology

Biological samples were collected by MDEQ from Mill Gulch in 2002. Analysis of periphyton data collected in 2002 indicated that Mill Gulch had excellent biological integrity for a mountain stream and diatom species richness was exceptional (Bahls, 2003). All periphyton metrics indicated full support. The MVFP macroinvertebrate index score was 100% for Mill Gulch, indicating full support of aquatic life use (Table 5-35). Clinger richness from the 2002 macroinvertebrate sample reflected a slight exceedence of the target value, indicating possible impairment due to sedimentation (Table 5-35), but other indices do not indicate impairment. This sample was collected in the headwaters of Mill Gulch (Appendix A – Map 2). A cursory assessment conducted in 2003 on the lower reaches of this stream indicated that impacts on beneficial uses due to land use were more likely in this area but no biological data were collected at the downstream end of Mill Gulch. Only the stream segment above the Forest Service boundary is included on the 1996 303(d) List.

Table 5-35. Summary of Impairment Based on Macroinvertebrate Metrics for Mill Gulch (2002 Data).

	Clinger Richness	MVFP Index
Site	MILL01	
Target Value	≥14	≥75
Existing Value	13	100
Percent Departure	7%	NE

5.3.15.1.3 Physical Conditions and Sediment Sources

A cursory stream assessment conducted in 2003 documented minor areas of streambank erosion and reduced riparian condition due to livestock grazing in limited areas, but generally good conditions. Past mining and road-building influence the channel dynamics of Mill Gulch although not enough to affect biological uses. A corral just above the road crossing on Mill Gulch is a small source of sediment. The corral affects only a short distance of the stream that is well below the segment listed as impaired.

According to a MDEQ data collected for 303(d) assessment, the Stream Reach Assessment score on the listed segment was 95%, indicating full-support, and non-impairment. The Riparian Assessment score was 94%, rating "Sustainable.” The location is in a fairly steep drainage dominated by a mature spruce canopy. Second growth timber in old clearcuts is well-established, probably at least 12 years old. There is one Forest Service road and only one road crossing was observed, located upstream of the sampling site. The road surface was in exceptionally stable condition and the culvert was of adequate size and it was correctly installed. The 2003 TMDL road sediment source inventory did not include this site.

5.3.15.1.4 Summary

Only the segment above the Forest Service boundary was listed as impaired for sedimentation on the 1996 303(d) List. The 1996 listing was based on data collected in 1973 and from a mine site.

Subsequent data and observations indicate full-support of all beneficial uses in Mill Gulch above the Forest Service boundary. A sediment TMDL is not needed for Mill Gulch. Further monitoring may be warranted on lower reaches of Mill Gulch as well as on Granite Creek, the stream into which Mill Gulch flows.

5.3.16 Mormon Creek

Mormon Creek flows from the Ruby Range and is located on the west side of the Ruby River, above Ruby Reservoir. Some north slopes in the headwaters are forested, with the remainder of the watershed composed of grass and shrub lands. Most of the watershed is privately owned except for the BLM managed headwaters.

Mormon Creek was listed on the 1996 303(d) List for partial support of aquatic life. Flow alteration, habitat alterations and siltation were indicated as the probable causes. Agriculture and rangeland were listed as the probable sources. In 2004, habitat alterations and siltation were indicated as the probable causes. Range grazing was indicated as the probable cause. The TMDL source assessment identified natural and grazing related sources.

5.3.16.1 Sediment

5.3.16.1.1 Total Suspended Solids

TSS from one sample collected in September of 2002 was 15.9 mg/L. Flow and runoff conditions during this sampling event are poorly understood, therefore little can be concluded from this data.

5.3.16.1.2 Biology

Biological data are from monitoring conducted by MDEQ in 2002. Slight impairment was indicated by macroinvertebrate data from 2002 (Bollman, 2002). The MVFP score was 61%. Clinger richness was also lower than the target value, indicating possible impairment due to sediment (Table 5-36).

Table 5-36. Summary of Impairment Based on Macroinvertebrate Metrics for Mormon Creek (2002 Data).

	Clinger Richness	MVFP Index
Site	**MO4MORMC01**	
Target Value	≥14	≥75
Existing Value	12	61
Percent Departure	14%	19%

5.3.16.1.3 Physical Condition and Sediment Sources

Stream assessments were conducted on four reaches on Mormon Creek, all of which were rated Fair according to SRAF methods (average score of 74%). Two assessment reaches, MOR2C and

MOR4A, exhibited a departure from reference condition due to a high proportion of fine sediment (<6 mm). Percent stable bank indicated impairment in all stream types (Table 5-37). According to the 2003 stream assessments bank stability ranged from 35% to 55%. In addition, pasture grass, which adds very little to streambank stability, dominates the understory in most reaches, and one reach (MOR1D) had less than 10% streambank shrub canopy cover (Appendix F– Mor #7). Existing conditions on Mormon Creek are compared to sediment criteria in Table 5-37. None of the assessment reaches exhibited departure from its natural Rosgen stream type. The Eb reaches have a B type stream slope and sinuosity character but an E type of cross section character and are not as entrenched as a B channel. This is due to active uplifting and geologic adjustment common in the Ruby valley and is not considered a departure. The E5b reach is more entrenched than an E but this does not necessarily indicate entrenchment due to human influences.

Table 5-37. Summary of Sediment Impairment Based on Physical Indicators for Mormon Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**% Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	E5b	≥5*	≤9.1	NA	NA	≤23.4	≥85
Existing	E5b	3.3 S	12 S	84 S	ND	15.5 S	40 S
Percent Departure	No Departure	34%	**NE**	NA	ND	**NE**	53%
Target	E4b	≥5*	≤9.1	≤38	NA	≤23.4	≥85
Existing	E4b	9.4 S	2 S	49 S	ND	26.6 S	35 S
Percent Departure	No Departure	**NE**	**NE**	29%	ND	14%	59%
Target	E4a	≥2.5	≤8.3	≤44	≤7	≤23.6	≥85
Existing	E4a	12.9 S	6 S	52 S	59 S	15.7 S	55 S
Percent Departure	No Departure	**NE**	**NE**	18%	743%	**NE**	35%

* E channels are targets for Eb types (see Section 4.0)
NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

The sediment source characterization (Section 7.0) estimated 32% of the total sediment load is due to human causes. Of this, all was attributed to grazing. This indicates that grazing management changes could be implemented to reduce the sediment load to Mormon Creek.

5.3.16.1.4 Summary

A sediment TMDL is will be completed for Mormon Creek because indications of biological impairment, excessive fine sediment deposition, and significant human caused sediment sources indicate that sediment delivery and transport are impacting beneficial use.

5.3.17 North Fork Greenhorn Creek

North Fork of Greenhorn Creek flows southwest out of the Greenhorn Mountains. The watershed is mostly timbered with large meadow areas on south facing slopes. The lowest portion of the watershed is composed of foothill grasslands. Almost the entire watershed is managed by USFS and BLM. The North Fork of Greenhorn Creek was identified on the 1996 303(d) List for a threatened coldwater fisheries use. Habitat alterations were indicated as the probable cause. Agriculture, placer mining, resource extraction, and rangeland were listed as the probable source. In 2004, a new 303(d) review by MDEQ determined that this stream was fully supporting all beneficial uses.

5.3.17.1 Water Chemistry

The limited water quality data on North Fork Greenhorn Creek from 2002 and 2003 show no impairment of water quality due to water chemistry. The amount of toxic metals found in stream sediment is near background level.

5.3.17.2 Physical Conditions

MDEQ assessment data from 2002 included a stream reach assessment score of 98% and a riparian assessment (much like PFC) score of 100%, both indicating sustainable riparian conditions. Assessment notes documented clean substrate and a channel well-shaded by a diverse riparian canopy of spruce, alder, willow, aspen, and birch. Woody debris and aquatic habitat were abundant.

The USFS lands have not been grazed since 1996. During 2002, the USFS removed a grazing allotment in this area. There was no sign of grazing in the drainage during the reassessment monitoring. An old jeep trail is present, but is now only used as a hiking and pack trail. A few, small mining prospects are located in tributaries north of the North Fork of Greenhorn Creek. A small area on a tributary has been placer mined. The mining impacts only a small area of a small tributary and does not appear to impact uses.

Another stream assessment conducted in 2003 rated the assessed reach of North Fork Greenhorn Creek as good condition, with a score of 89%. Bank stability was also good at 80%.

5.3.17.3 Biology

Results of aquatic insect and periphyton sampling over 2002 and 2003 indicate full support of aquatic life uses. Biological samples were collected from North Fork Greenhorn Creek in 2002 by MDEQ for 303(d) reassessment and in 2003 for TMDL assessment. Aquatic macroinvertebrate samples from 2002 and 2003 both yielded MVFP index scores of 100%, indicating full support of aquatic insect use. Habitat alteration can also be indicated by excess sediment. Samples from North Fork Greenhorn Creek in 2002 and 2003 both reflected a very low percentage of sediment-tolerant taxa. In both samples the number of clinger taxa suggests that siltation is not impacting aquatic insect habitat (Table 5-38).

Table 5-38. Summary of Sediment Impairment Based on Macroinvertebrate Metrics for North Fork Greenhorn Creek (2002, 2003 Data).

	Clinger Richness	MVFP Index
Site	**MO4GHCNF01**	
Target Value	≥14	≥75
Existing Value	22	100
Percent Departure	NE	NE
Site	**NFG-1**	
Target Value	≥14	≥75
Existing Value	17	100
Percent Departure	NE	NE

5.3.17.4 Summary

Although North Fork Greenhorn Creek was listed on the 1996 303(d) List, more recent chemical, biological, riparian, and limited physical data do not indicate impairment of beneficial uses. The 1996 listing is based on data collected by MFWP. The basis for the 1996 listing as threatened for sediment was the presence of potential sediment sources and the presence of potentially genetically pure westslope cutthroat trout. Since that time the habitat condition appears to have recovered and more recent data indicates the stream is not impaired according to updated methodologies for 303(d) listing.

5.3.18 Poison Creek

Poison Creek is located in the headwaters area of the Ruby River. The watershed is entirely managed by the USFS. The headwaters of this tributary are forested and flow from the Gravely Mountains. In mid and lower elevations many north-facing slopes are forested while the rest of the area is composed of grass and shrub land.

Poison Creek was listed on both the 1996 and the 2004 303(d) List for partial support of aquatic life and coldwater fisheries beneficial uses. Probable causes of impairment specified on the 1996 list were habitat alterations and siltation. The only probable source listed in 1996 was agriculture. Probable causes specified on the 2004 list were bank erosion, other habitat alterations, riparian degradation, and siltation. Probable sources listed were agriculture and grazing-related sources.

5.3.18.1 Sediment

5.3.18.1.1 Total Suspended Solids

TSS levels from 2001 MDEQ samples on Poison Creek were not high enough to indicate impairment of beneficial use based on Newcombe and Jensen (1996), but one sample does not provide enough information to determine impairment.

5.3.18.1.2 Biology

Macroinvertebrate samples from 2001 and 2004 comprise the available information for Poison Creek. Few organisms were collected in the 2001 sample, limiting interpretation. The MVFP score for this sample was 78%, slightly higher than the target value of 75% (Table 5-39). Both samples from 2004 scored lower than 75% for the MVFP index, indicating slight impairment. Clinger richness was also below target levels, possibly indicating some minor to moderate influence of sediment (Table 5-39). Overall, it appears aquatic insects are, to some extent, affected by sediment conditions.

Table 5-39. Summary of Impairment Based on Macroinvertebrate Metrics for Poison Creek (2001 and 2004 Data).

	Clinger Richness	MVFP Index
Site	**POI2 (2001)**	
Target Value	≥14	≥75
Existing Value	12	78
Percent Departure	14%	NE
Site	**POI1 UP (2004)**	
Target Value	≥14	≥75
Existing Value	13	61
Percent Departure	7%	19%
Site	**POI1 DN (2004)**	
Target Value	≥14	≥75
Existing Value	12	61
Percent Departure	14%	19%

5.3.18.1.3 Physical Conditions and Sediment Sources

Forest Service channel surveys from 1995 (BDNF, unpublished data) on two reaches on Poison Creek were compared to reference reaches. These surveys revealed several potential sources of sediment. The upper reach of Poison Creek is rated having poor channel stability compared to good stability of a reference reach. The lower reach of Poison Creek was rated fair for channel stability. Field notes from the assessment indicate that riparian vegetation is lacking and in poor condition.

Additional monitoring was conducted in 2003 for the TMDL assessment. SRAF Stream assessments conducted on Poison Creek in 2003 rated reaches from Poor to Fair condition. Two of the three reaches showed departure from reference condition due to excess fine sediment. Two reaches are more highly entrenched than reference conditions. Two reaches also exceeded target values for width/depth ratio due to channel widening, contributing to departure from natural stream type in one reach (Table 5-40). However, much of Poison Creek appears to be recovering from past overgrazing. According to stream assessment data collected in 2003, Wolman <6 mm surface fines exceeded the target level for B4 stream reaches. In general, surface fine sediment in Poison Creek was high compared to other reaches in the Gravelly landscape used for “reference” condition. Table 5-40 summarizes targets and existing conditions for assessed reaches on Poison Creek.

Table 5-40. Summary of Sediment Impairment Based on Physical Indicators for Poison Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**% Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	B4	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4	1.4 S	19 S	33 S	21 S	23 S	45 S
Percent Departure	No Departure	12%	20%	65%	163%	**NE**	47%
Target	B4a	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4a	1.4 S	13 S	39 S	ND	18.9 S	60 S
Percent Departure	No Departure	12%	**NE**	95%	ND	**NE**	29%
Target	B5	≥1.6	≤15.8	NA	NA	≤29.8	≥85
Existing	C5b	2.6 S	21 S	41 S	ND	20.9 S	50 S
Percent Departure	Departure	**NE**	33%	NA	ND	**NE**	41%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

Stream assessment narrative data from the 303(d) impairment and data tracking files for this water body describe sources of sediment and siltation. According to these surveys, lateral cutting of raw, wasting banks on outside meanders produces large amounts of sediment. The narrative also mentions a moderate amount of downcutting, as evidenced by abandoned channels adjacent to the active stream channel at a higher elevation. The stream appears to be recovering somewhat from past grazing impacts, but current impacts are still affecting the condition of the stream. The sediment source characterization (Section 7.0) estimated 44% of the total sediment load is due to human causes. Of the human caused sources, all was attributed to grazing. Poison Creek, like other streams in the Gravelly landscape, has high sediment inputs from natural sources. Portions of Poison Creek were placer-mined in the past but this past placer mining activity was not a source of sediment to Poison Creek.

5.3.18.1.4 Summary

A sediment TMDL will be completed for Poison Creek because impaired biology, the presence of significant human caused sources, high fine sediments and stream channel characteristics all point to sediment delivery and transport problems that impact a beneficial use. Improvements due to recent management changes will be considered in development of the TMDL.

5.3.18.2 Metals (Cadmium)

5.3.18.2.1 Data Review

Water quality samples collected from two sites one the same day in June of 2001 showed an exceedence of chronic aquatic life standards for total recoverable cadmium on Poison Creek (Table 5-41). Poison Creek was sampled again in June and August of 2004. One sample from June 2004 showed a cadmium level equal to the hardness-based chronic aquatic life standard for total recoverable cadmium, but this value was at the lower detection limit (0.0001 mg/L). The other 3 samples all had cadmium levels below detection. All of the samples that exceed chronic cadmium standards occur during higher flows and spring runoff conditions. There are no current or known past mining activity that are likely to affect cadmium concentrations on Poison Creek except for a small area of placer mining. Placer mining could potentially be a source of cadmium but this type of mining usually doesn't produce long-term water quality metal problems other than potential mercury contamination from mercury amalgamation used in sluice boxes.

Table 5-41. Exceedence Summary for Metals in Poison Creek Samples.

Metal	Date	Flow (cfs)	Hardness (mg/L)	Conc. (µg/L)	Exceedence Summary
Poison Creek Site M04POISC01					
Cadmium	6/18/2001	ND	62	0.2	**Equal to** hardness based chronic aquatic life criteria (0.2 µg/L)
Poison Creek Site M04POISC02					
Cadmium	6/18/2001	ND	64	0.4	**Exceeds** hardness based chronic aquatic life criteria (0.2 µg/L)
Poison Creek Site M04POISC01					
Cadmium	6/03/2004	15.2	42	0.1	**Equal to** hardness based chronic aquatic life criteria (0.1 µg/L)

ND = No data

The number of abnormal diatoms is below toxicity criteria. No sediment metal samples have been collected.

5.3.18.2.2 Summary

A TMDL must be completed for streams exceeding metals water quality standards if human caused sources are causing the statewide standards to be exceeded. However, there is currently not enough information to determine sources of cadmium in Poison Creek. It is possible that placer mining could affect cadmium concentrations in Poison Creek. It is also possible that the cadmium levels are natural. Poison Creek was not listed for metals or cadmium on any of Montana's 303(d) lists. Metals monitoring should be completed to help develop existing condition synopsis and to help identify sources. Monitoring should include water sampling at high and low flows, sediment metals monitoring and biomonitoring above and below known mine locations. Future 303(d) listing review for Poison Creek should consider newly collected data. The State of Montana will list cadmium as a cause of impairment in Poison Creek if human caused sources are identified. A TMDL would follow if a listing occurs.

5.3.19 Ramshorn Creek

Ramshorn Creek is located in the northeast portion of the Ruby River watershed. The timbered headwaters are in the Tobacco Root Mountains. The mid section is timbered on north facing slopes and shrubs and grasses grow on the south facing slopes. Lower reaches are a mix of grassland and cropland. The upper portion of the watershed consists of US Forest Service land. Private landowners and the BLM manage the lower portions of the watershed.

Ramshorn Creek was listed on the 1996 303(d) List for partial support of aquatic life and coldwater fisheries beneficial uses and threatened support of drinking water. The only probable cause of impairment specified on the 1996 list was metals, and the only probable source was resource extraction. MDEQ staff reassessed Ramshorn Creek during September 2002. This water body is listed for partial support of coldwater fisheries and aquatic life support on the 2004 303(d) List. Probable Causes listed are dewatering, siltation, and lead. Probable sources include unpaved road runoff, irrigated crop production, and mine tailings.

5.3.19.1 Metals (Lead)

5.3.19.1.1 Data Review

MDEQ sampled heavy metals on Ramshorn Creek in 2002 after a storm event. A sample collected above the confluence of Currant Creek had a concentration of 3 µg/L, which exceeds hardness-based chronic water quality standards by 230% (Table 5-42). The other 2002 sample was collected near the highway 287 crossing and had a concentration of 2 µg/L, which is below the hardness based standard. These same sites were re-sampled in June and August of 2004. The lead concentration in the spring runoff samples on Ramshorn Creek exceeded chronic water quality standards for aquatic life (Table 5-42).

Table 5-42. Metals Exceedence Summary for Ramshorn Creek.

Metal	Date	Flow (cfs)	Hardness (mg/L)	Conc. (µg/L)	Exceedence Summary
Ramshorn Creek Site M04RAMHC01					
Lead	9/17/2002	4	48.7	3	**Equal to** hardness based chronic aquatic life criteria (1.3 µg/L)
Lead	6/03/2004	23	31	3	**Exceeds** hardness based chronic aquatic life criteria (0.7 µg/L)
Ramshorn Creek Site M04RAMHC02					
Lead	6/03/2004	2.85	71	4	**Exceeds** hardness based chronic aquatic life criteria (2.1 µg/L)

Lead concentrations were found at levels above sediment criteria (in Section 4.0) down stream of the Goldshmidt/Steiner mine in Currant Creek. Currant Creek is a major tributary to Ramshorn Creek.

No abnormal cells were observed in 2003 periphyton samples. Periphyton samples from the same sites in 2004 contained 24% metals tolerant diatoms at the lower site but a low proportion of abnormal cells, and a healthy assemblage at the upper site. The abnormal number of periphyton cells found in all the samples were below criteria provided in Section 4.0 of this document but there are higher numbers of metal tolerant taxa present at the lower site.

5.3.19.1.2 Summary

At higher flows, during runoff events, lead concentrations were found to exceed chronic aquatic life standards. Slight indication of a community toxic response in diatom communities may also support the need for a TMDL. A TMDL will be written for lead found in Ramshorn Creek. Because of limited data, the TMDL provided in this document will depend heavily on adaptive management and future monitoring.

5.3.19.2 Sediment

5.3.19.2.1 Total Suspended Solids

There is only one recent TSS sample from Ramshorn Creek, taken in 2002, which showed a TSS concentration of 11.4 mg/L. No conclusions can be made from this single observation.

5.3.19.2.2 Biology

Aquatic insect samples were collected from Ramshorn Creek in 2002 by MDEQ for 303(d) reassessment. Aquatic insect samples were also collected in 2003 and 2004 for the TMDL assessment. Table 5-43 summarizes sample locations for the different sampling years. The sites at the Forest Service boundary and above the Currant Creek confluence are close to one another and should reflect the same environmental conditions.

Table 5-43. Locations of Samples for Ramshorn Creek from 2002-2004.

Site Description	Years Sampled	Sample IDs	Notes
Forest Service Boundary	2004	MO4RAMHC01,	Close to MDEQ Site above Currant Creek
Above Currant Creek Confluence	2002-2003	RAM-1, RAM1_8702	Near Forest Service boundary
Between FS boundary and Hwy	2003	RAM-2	Transition area between forested and cropped land
Above highway	2002-2004	MO4RAMHC02, RAM-3, RAM2_8701	Site closest to mouth

In general, macroinvertebrate data from 2002 through 2004 reflect a trend toward increased fine sediment from the upstream to downstream end of Ramshorn Creek. Macroinvertebrate samples from upstream reaches scored 100% for the MVFP index in the 2003 and 2003 data and 94 in the 2004 data (Table 5-44), indicating full support of aquatic life (Bollman, 2004). Samples from the lower site at the highway scored 44-61%, indicating impairment of aquatic life. Clinger richness, which may be a more direct indicator of sediment deposition, was well below target values at the lower sample site, possibly indicating excessive fine sediment at that site (Table 5-44). The low diversity of taxa in this sample made interpretation difficult, and did not point specifically to fine sediment deposition (Bollman, 2004). However, field observations note a lack of substrate for sampling due to excessive fine sediment.

Table 5-44. Summary of Impairment Based on Macroinvertebrate Metrics for Ramshorn Creek (2002, 2003, 2004 Data).

	Clinger Richness	MVFP Index
2002 Data		
Site	**MO4RAMHC01**	
Target Value	>14	>75
Existing Value	18	100
Percent Departure	NE	NE
Site	**MO4RAMHC02**	
Target Value	>14	>75
Existing Value	5	44
Percent Departure	64%	43%
2003 Data		
Site	**RAM-1**	
Target Value	>14	>75
Existing Value	20	100
Percent Departure	NE	NE
Site	**RAM-2**	
Target Value	>14	>75
Existing Value	26	100
Percent Departure	NE	NE
Site	**RAM-3**	
Target Value	>14	>75
Existing Value	9	44
Percent Departure	36%	43%
2004 Data		
Site	**RAM1_8702**	
Target Value	>14	>75
Existing Value	19	94
Percent Departure	NE	NE
Site	**RAM2_8701**	
Target Value	>14	>75
Existing Value	4	61
Percent Departure	71%	19%

An almost pure westslope cutthroat trout population exists in the headwaters of Ramshorn Creek. No fishery information could be found for lower reaches.

5.3.19.2.3 Physical Conditions and Sediment Sources

In channel assessments conducted by the Forest Service during 1998 indicate that stream channel cross section geometry is comparable to a reference reach, although the substrate showed higher fine sediment and channel stability was lower than the reference reach. The 2003 stream channel cross section profile data reflected excellent channel condition in the Tobacco Root Management area (Ea stream types) but poor values in the Alluvial and Pediment Management Areas (B4, E5 types) (Table 5-45). Some assessed reaches show excessive fine sediment deposition. Bank stability is low in most reaches (Table 5-45).

Table 5-45. Summary of Sediment Impairment Based on Physical Indicators for Ramshorn Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**%Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	Ea	≥2.5	≤8.3	≤44	NA	≤23.6	≥85
Existing	E3a	2.7 S	12 S	19 S	12 S	15 S	70 S
Percent Departure	No Departure	**NE**	44%	**NE**	NA	**NE**	18%
Target	Ea	≥2.5	≤8.3	≤44	NA	≤23.6	≥85
Existing	E4a	2.9	8	30	26 M	13	80
Percent Departure	No Departure	**NE**	4%	**NE**	NA	**NE**	6%
Target	B4	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4	1.5 S	17 S	45 S	ND	43 S	30 S
Percent Departure	No Departure	6%	8%	125%	ND	44%	65%
Target	E5	≥5.0	≤9.1	NA	NA	≤23.4	≥85
Existing	A5e	1 S	5 S	95 S	ND	36 S	35 S
Percent Departure	Departure (ditch)	80%	**NE**	NA	NA	54%	59%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

Much of Ramshorn Creek was placer-mined in the past, which has contributed greatly to channel incisement and bank instability in some areas. The downstream end of Ramshorn Creek at the A5e reach has been straightened and ditched. After meeting a large ditch Ramshorn Creek is primarily straight and incised, and has a muddy channel bed (silt-clay). The turbid ditch return water empties into the lower Ruby River via this straightened channel. This straightened section, which would normally be an E5 type, exhibits departure from natural stream type due to severely lowered sinuosity and increased entrenchment (Appendix F – Ram #12). The channel has incised several feet and is unstable, except in some areas where beaver activity is keeping water levels higher.

No other reaches exhibited departure from natural stream type, although high fines were noted for all lower gradient reaches. A road parallels Ramshorn Creek its entire length and has many areas where sediment enters the stream directly from the road (Appendix G – Ram# 10). There is not enough sediment to cause a shift in channel morphology for whole reaches, but deposition throughout the stream bottom is high in many places and alters channel width/depth ratio (Appendix F – Ram# 8).

The sediment source assessment estimated 90% of sediment loading is from human-caused sediment inputs (see Section 7.0). Of this, most of the sediment loading was attributed to grazing, roads, and past uses such as placer mining and channel straightening (47%, 24%, and 23%, respectively), with the remaining load attributed to more recent channel manipulation (2%)

and other human causes (4%), which may include more recent mining activity and other agricultural influences. Significant human caused sediment sources, high instream fines, local shifts in stream channel geometry and high turbidity identified in irrigation return water all indicate that sediment production, deposition and transport are significantly altered in Ramshorn Creek.

5.3.19.2.4 Summary

Biological indicators show likely impairment due to siltation. Human caused sediment sources, high instream fines and stream channel geometry and high turbidity identified in irrigation return water all indicate that sediment production, deposition and transport are influencing uses in Ramshorn Creek. There is ample evidence of impairment due to excess fine sediment delivery and deposition in Ramshorn Creek, therefore a sediment TMDL is needed.

5.3.19.3 Other Indications of Impairment

Based on 2003 and 2004 periphyton data, Ramshorn Creek in the Alluvial Valley management area should be evaluated more closely for nutrient loading as a cause of impairment to beneficial uses.

5.3.20 Ruby River MT41C001_010 (Ruby River Below Reservoir)

Lower Ruby River was listed on the State's 1996 and 2004 303(d) Lists for partial support of aquatic life, coldwater fisheries, and swimmable waters (recreation) beneficial uses. The segment was listed as threatened for support of drinking water on the 1996 List. Probable causes of impairment listed in 1996 include flow alteration, metals, siltation and suspended solids. Probable sources of impairment include agriculture, flow modification, highway maintenance and runoff, pasture land, resource extraction, and streambank modification and destabilization. In 2004 the probable causes listed are dewatering, fish habitat degradation, flow alteration, other habitat alterations, riparian degradation, siltation, channel incisement, and thermal modifications. Probable sources include agriculture, crop-related sources, grazing-related sources, hydromodification, flow regulation/modification, habitat modification-other than hydromodification, removal of riparian vegetation, and bank modification/destabilization. The lower Ruby River is considered a MFWP Chronically Dewatered Stream. This review of the lower Ruby River assesses data for Ruby River below the Ruby Dam and for Clear Creek, a secondary channel of the lower Ruby River. Clear Creek is not included on the 303(d) list of impaired waters as a water body distinct from the lower Ruby. Clear Creek will be addressed with the lower Ruby River in the remainder of this document.

5.3.20.1 Sediment

5.3.20.1.1 Total Suspended Solids

Most of the available TSS data for the lower Ruby River are from samples collected from 1994 to 2003 (Appendix A – Map 10). TSS levels in 32% of the samples exceed 148 mg/L, which may cause sublethal effects on eggs and larvae of coldwater fish at exposures of one day or more

(Newcombe and Jensen, 1996). Most of the samples with TSS concentrations higher than 148 were collected during spring runoff of 1997 and 1998, but three samples from low flow periods also exceed 148 mg/L. TSS sample locations are mapped in Map 10 of Appendix A. Samples taken further downstream showed lower TSS levels. Samples collected above Ruby Reservoir showed higher TSS concentrations than below the reservoir. These data indicate that during some timeframes suspended sediment conditions in the lower Ruby River likely affect instream biological uses. The sediment source assessment will play a pivotal role in determining if human sources are likely impacting instream sediment conditions. The source assessment is reviewed briefly in Section 5.3.20.1.3.

5.3.20.1.2 Biology

MVFP scores from samples collected in 2000 and 2003 on the lower Ruby River ranged from 28 to 56%, all indicating impairment of aquatic life use support. Clinger richness was also lower than target values for all but 3 sites (Table 5-27). The aquatic insect community shows a general degradation in community structure in a downstream direction. This is likely partially caused by the presence of Ruby Dam removing sediment and starving the stream of sediment in the reaches below the dam. This situation creates larger substrate sizes in the upstream reaches of this segment. The water picks up and redeposits sediment from both natural and human caused sources as it flows downstream.

Table 5-46. Summary of Impairment Based on Macroinvertebrate Metrics for Ruby River Below Reservoir (2000, 2003 Data).

	Clinger Richness	MVFP Index
Site	**R1**	
Target Value	≥14	≥75
Existing Value	16	61
Percent Departure	NE	19%
Site	**R30**	
Target Value	≥14	≥75
Existing Value	4	33
Percent Departure	71%	56%
Site	**R3**	
Target Value	≥14	≥75
Existing Value	15	50
Percent Departure	NE	33%
Site	**R5**	
Target Value	≥14	≥75
Existing Value	13	78
Percent Departure	7%	NE
Site	**R11**	
Target Value	≥14	≥75
Existing Value	14	44
Percent Departure	NE	41%
Site	**R13**	
Target Value	≥14	≥75
Existing Value	8	56
Percent Departure	43%	25%
Site	**R20**	

Table 5-46. Summary of Impairment Based on Macroinvertebrate Metrics for Ruby River Below Reservoir (2000, 2003 Data).

	Clinger Richness	MVFP Index
Target Value	≥14	≥75
Existing Value	11	44
Percent Departure	21%	41%
Site	**R-1**	
Target Value	≥14	≥75
Existing Value	13	44
Percent Departure	7%	43%
Site	**R-2**	
Target Value	≥14	≥75
Existing Value	10	28
Percent Departure	28%	63%
Site	**R-3**	
Target Value	≥14	≥75
Existing Value	10	39
Percent Departure	28%	48%

Periphyton sample analysis (Bahls, 2001) also indicates that sediment impacts become more pronounced in a downstream direction.

The sport fishery of the lower Ruby River is predominantly composed of brown trout although rainbow trout are present in certain areas with greater ground water influence. Brown trout that inhabit the Jefferson River use portions of the lower Ruby River and selected tributaries for spawning. Fish surveys indicate that populations fluctuate greatly, and are influenced by many factors that include stream channel conditions, water temperature, fishing pressure and annual instream flow conditions.

5.3.20.1.3 Physical Conditions and Sediment Sources

For both Ruby River and Clear Creek, departures from the potential Rosgen type and reference conditions were primarily driven by width/depth ratio and entrenchment, which may produce instream conditions that cause excessive sediment deposition or excessive bank alteration from channel adjustment. The departure for width/depth ratio assumes the potential of the lower Ruby to be an E type channel. The altered conditions in the lower Ruby River are partially due to the Ruby Dam cutting off upstream sediment sources. The stream channel flows through deep soil structures that can influence channel condition. The presence of the dam may not fully allow the channel to reach a stable stream form in many places, although improvements in channel condition and bank erosion can be realized through BMPs (Appendix F – LRR #1). Percent fines and bank erosion also exceed criteria in many reaches. Comparisons of targets to physical data collected in 2003 for these water bodies are summarized in Tables 5-47 and 5-48.

Table 5-47. Summary of Sediment Impairment Based on Physical Indicators for Ruby River Below Reservoir.

	Sediment Criteria						
	Potential Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**%Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	C4	≥3.2	≤25.6	≤29	≤6	≤29	≥85
Existing	C4	4.3 S	30 S	17 S	ND	27.7 S	65 S
Percent Departure	No Departure	**NE**	17%	**NE**	ND	**NE**	24%
Target	E4	≥5	≤9.1	≤38	NA	≤23.4	≥85
Existing	C4 (n = 7)	3.5	30	29	19	22.9	65
Percent Departure	Departure	30%	230%	**NE**	NA	**NE**	24%
Target	E4	≥5	≤9.1	≤38	NA	≤23.4	≥85
Existing	E4, F4, F4b, B (all n = 1)	1.7	26.5	34	17	23.6	71
Percent Departure	Departure in most reaches	66%	191%	**NE**	NA	0.8% (**NE**)	16%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

Table 5-48. Summary of Sediment Impairment Based on Physical Indicators for Clear Creek.

	Sediment Criteria						
	Potential Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	E4	≥5	≤9.1	≤38	NA	≤23.4	≥85
Existing	F, F4	1.4 M	27 M	71 S	24 S	28.2 S	60 S
Percent Departure	Departure	72%	197%	87%	NA	20%	29%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

The sediment source assessment estimated 74% of sediment loading is from human-caused sediment inputs (see Section 7.0). Of this, most of the sediment loading was attributed to grazing, roads, and past uses such as historic channel straightening and vegetation removal (45%, 16%, and 27%, respectively), with the remaining load attributed to more recent channel manipulation (4%) and other human causes (9%), such as cultivation and recreation (Appendix F – LRR #13 and #20). Human causes contribute a significant sediment load to the Ruby River, indicating management changes can reduce sediment loading within the context of this flowregulated system. Tributaries also are source of sediment loading. Ramshorn Creek and Alder Creek provide the largest sediment inputs among the listed tributaries to the lower Ruby River. Loads attributed to human causes on tributaries are summarized under the sediment impairment discussions for those water bodies. Loads from the upper Ruby River are greatly reduced by the Ruby River Reservoir, as is explained in the discussion for that water body.

5.3.20.1.4 Summary

Much of the Ruby River appears to be adjusting to impacts from the past and appears to be improving in condition. However, sediment production is currently excessive. The presence of human caused sediment sources along with shifts in stream channel geometry, and the presence of benthic fine sediments indicate that sediment delivery, transport and deposition are impacting uses. A sediment TMDL will be written to identify sources of sediment and will estimate how much restoration practices are likely to reduce sediment production.

5.3.20.2 Temperature

The lower Ruby River is identified on the 2002 303(d) List as potentially impaired by thermal modification. Flow regulation, irrigation, and removal of riparian vegetation are the sources most likely to affect temperature. The Ruby Reservoir is located directly upstream of this segment of the Ruby River and is likely a mitigating factor for temperature, given the higher temperatures documented for the upper Ruby. Outflow from the Ruby Reservoir is bottom-drawn, and therefore is contributing relatively cold water to the river downstream of the dam if a minimum pool is kept in the reservoir.

MDEQ initiated continuous temperature monitoring in 2002 that included installation of fourteen temperature loggers on the mainstem of the Ruby River above and below the reservoir to characterize the thermal regime of the Ruby River. Nine loggers recorded data for the lower Ruby River from July to October in 2002. Because several loggers were lost, temperature data were collected by only 5 loggers from June to September in 2003. In 2004 temperature loggers were placed at 15 sites for the hottest 2-week period of the year, from late July to early August. Logger sites in 2004 were placed specifically to calibrate and ground-truth temperature modeling, and are not all at the same sites as in previous years. Logger sites in all three years were distributed throughout the lower Ruby River.

Logger data reveal water temperatures were the highest in 2003. Temperatures measured in 2004 were generally lower than those from 2002-2003. In all years there is a warming trend from the top site just below the reservoir to the sites just upstream of Alder. Near the town of Alder the temperatures drop again, then start general warming trend from the area near Silver Springs and the Ramshorn Creek confluence down to the mouth. Forward-looking infrared (FLIR) imagery collected in 2003 verifies this trend. Comparison of FLIR imagery with landscape features in GIS reveals that the cooling trend above Alder is due to the ground water inputs from the historic channel of Alder Gulch. Alder Creek also contributes cold water further downstream at its new channel, which has been diverted to the north because of extensive historic placer mining. The FLIR monitoring report with complete methods and results is provided in Appendix G. Payne (2004) also discusses temperature trends in relation Alder Creek inputs and stream flow in the lower Ruby. Further discussion of temperature trends in relation to flow is included in the temperature source characterization, Section 6.0.

Table 5-49. Summary of Temperature Data from Continuous Recorders Placed in the Lower Ruby River.
Sites Are Listed From Upstream to Downstream for each year. Several Thermisters were Lost Due to Scour in Flood Flows or Vandalism from 2002 to 2003.

Site Name	Start Date	Stop Date	Highest 7 Day Seasonal Avg. Max (°F)	Seasonal Max (°F)
2002 Data				
RUBY RIVER AT RUBY R DAM FAS-2002	07/11/02	09/25/02	66.8	67.2
RUBY R AT VIGILANTE FAS-2002	07/11/02	09/25/02	68.8	69.5
RUBY R AT COY BROWN FAS-2002	07/11/02	09/25/02	68.4	70.3
RUBY R AT ALDER-2002	07/11/02	09/25/02	66.1	69.2
RUBY RIVER NEAR LAUREN-2002	07/11/02	09/25/02	67.2	70.0
RUBY R NEAR SILVER SPRINGS-2002	07/10/02	10/26/02	69.1	71.8
RUBY R SW OF SHERIDAN-2002	07/10/02	10/23/02	71.8	74.6
RUBY R, 2 MI UPSTREAM OF TWIN BRIDGES-2002	07/10/02	10/25/02	73.8	76.5
RUBY R NEAR TWIN BRIDGES-2002	07/10/02	10/16/02	75.1	77.7
2003 Data				
RUBY R AT COY BROWN FAS-2003	06/11/03	09/30/03	72.7	74.0
RUBY R AT ALDER 2003	06/11/03	09/30/03	68.3	69.2
RUBY R AT LAURIN-2003	06/11/03	09/30/03	68.6	68.9
RUBY R NR SILVER SPRINGS-2003	06/11/03	09/30/03	70.6	71.5
RUBY R, 2 MI UPSTREAM OF TWIN BRIDGES-2003	06/11/03	09/30/03	75.3	76.4
2004 Data				
RUBY R. AT USGS GAGE BELOW DAM	07/21/04	08/09/04	65.7	66.5
RUBY R. BELOW MAJOR DIVERSIONS	07/21/04	08/09/04	69.4	70.3
RUBY R. ABOVE CLEAR CK. BRANCH	07/21/04	08/09/04	69.3	70.7
RUBY R. AT RUBY SPRINGS LODGE	07/21/04	08/10/04	66.9	68.0
RUBY R. ABOVE ALDER CK	07/22/04	08/10/04	66.4	67.4
RUBY BELOW BIVENS CK	07/22/04	08/10/04	67.9	68.6
RUBY R ABOVE SILVER SPRINGS	07/22/04	08/10/04	67.9	68.6
RUBY R. DOWNSTREAM OF SILVER SPRINGS	07/22/04	08/10/04	67.2	68.1
RUBY R. DOWNSTREAM OF RAMSHORN CK	07/22/04	08/10/04	68.9	69.4
RUBY R AT FAY RANCHES	07/21/04	08/10/04	69.0	69.8
RUBY R. ABOVE W. BENCH DITCH	07/21/04	08/10/04	70.4	71.3
RUBY R. AT MORSE LAND	07/22/04	08/10/04	64.3	65.1
RUBY R. ABOVE MILL CK	07/23/04	08/11/04	71.1	72.0
RUBY R BELLOW MILL CK	07/23/04	08/11/04	71.3	72.0
RUBY R. 2 MI UPSTREAM OF TWIN BRIDGES-2004	07/21/04	08/11/04	72.1	73.1

To build upon the more qualitative studies of temperature, SNTEMP modeling was conducted for Ruby River below Ruby Reservoir to assess how stream temperature would fluctuate in response to increased stream shading and increases in instream flow due to improved irrigation efficiency. Modeling an increase in stream shading to reference levels resulted in a simulated average decrease in stream temperature of 1.5ºF along the whole listed segment, with a maximum decrease of 2.1ºF occurring at the end of Reach LR14 and a minimum decrease of 0.7ºF at end of Reach LR03 (Appendix C). An increase in stream shading could be achieved through reasonable management changes designed to increase riparian vegetation.

The effects of irrigation are dependent on a complex interaction of surface water and ground water. A modeling scenario that reduced irrigation withdrawals and a resulting increase in instream flow produced unexpected results due to the ground water-surface water interactions. This scenario also reduced the ground water influence on the lower Ruby River because of the increased irrigation efficiency. Temperature in this flow scenario is warmer compared with the baseline at the upper reaches of the Ruby River (LR02 to LR11) because of the increased inflow of surface water and decreased inflow of ground water. However, larger volumes of surface flows modeled in the increased instream flow scenario are not warmed up by solar radiation as rapidly compared to flows under the baseline conditions. Consequently this scenario predicted water temperatures in the lower part of the river (reaches KM 31.8 to LR16) would be lower than baseline temperatures by 0.4 to 1.5ºF. The greatest resulting temperature difference is at the site nearest the mouth of the Ruby River (LR016).

A modeling scenario increased shading and instream flow together, and resulted in an average simulated stream temperature decrease of 1.2ºF. Reaches LR02-LR04, located between the large irrigation diversions at the upstream end of the lower Ruby River and Alder Gulch, showed warming of 0.04 to 1 ºF under this scenario. Lower reaches, KM31.8 to LR016, showed the greatest decrease in stream temperature, ranging from 1.9 to 3.2ºF. The maximum estimated cooling in this scenario occurred in the reach just above the Ruby River mouth (LR016). Details of methods used for modeling and model results are included in Appendix C.

Comparison of existing width/depth ratio is summarized by stream type in the discussion of sediment impairment status, above. Many areas of the lower Ruby River are over widened but a sensitivity analysis of the temperature model indicated that stream width did not significantly affect water temperatures.

Forward-looking infrared (FLIR) analysis conducted in 2003 indicated most tributary and irrigation return water is cooler than the water in the lower Ruby River. Notable exceptions are Ramshorn Creek, which is 5.2°F warmer than the lower Ruby River and is primarily ditch water at its confluence, and warmer irrigation returns at river miles 3.6 and 18.1. Details of FLIR assessment methods and results are provided in Appendix G.

Results of the analyses described above were used to determine temperature impairment for the lower Ruby River, summarized below in Table 5-50.

Table 5-50. Summary of Impairment Based on Temperature Targets for Lower Ruby River.

Target	Proposed Criterion	Current Status
Maximum allowable increase over naturally occurring temperature	For waters classified as A-1 or B-1, a 1ºF maximum increase above naturally occurring water temperature is allowed within the range of 32ºF to 66ºF; within the naturally occurring range of 66ºF to 66.5ºF, no discharge is allowed which will cause the water temperature to exceed 67ºF; and where the naturally occurring water temperature is 66.5ºF or greater, the maximum allowable increase in water temperature is 0.5ºF.	Modeling indicates that water temperature is increased by more than 0.5ºF when water temperatures are above 66.5ºF by irrigation inefficiency and riparian vegetation impacts that result in lower shade. In some sections the model predicted that these factors increase temperatures by 3.2ºF.
Meet the Temperature Target Above or Meet All of the Surrogate Targets Below.		
Instream flow	Apply irrigation water savings from irrigation efficiency projects to instream use during warmest months (Apr.-Oct). Estimated water savings by reach are provided in Appendix C.	Modeling IWM efficiency savings applied to instream use indicates that the middle portion of this segment will likely be slightly warmed during hot weather but will cool the lower reaches of the Ruby River by an estimated 0.4 to 1.5ºF and provide cooler water to the Jefferson River, another thermally listed river segment.
Irrigation Return Flows	No irrigation return flow that is warmer than stream water.	None were found by the forward looking infrared data on the Ruby River, but warm irrigation water returns likely occur in Mill Creek and Ramshorn Creek. The irrigation influences on tributaries may warm the lower Ruby River.
Effective Shade	Comparable with reference sites (33%). Target justification and details are provided in Section 4.0.	Most reaches below target value (12% average canopy cover/ range of 2 – 33%).

5.3.20.2.1 Biology

Macroinvertebrate sampling in 2000 from just below the Coy Brown Bridge indicated that the assemblage of macroinvertebrates showed some impairment based on indicators related to elevated temperatures and/or nutrient enrichment. Minor impairment due to elevated temperature and/or nutrient enrichment was also indicated at the sampling site below the Mill Creek confluence. Near its confluence with the Beaverhead River, the Ruby River supports an extremely tolerant assemblage of macroinvertebrates, indicating warm water temperatures and/or nutrient enrichment. Cold stenotherms were absent from most samples taken from the lower Ruby River in 2000 and 2003. Nutrients and temperature can cause similar shifts in aquatic insect community structure; therefore the number of cold stenotherm taxa is used as an indicator only.

5.3.20.2.2 Summary

Modeling indicates that temperature standards are exceeded. Although the coldwater fishery in the lower Ruby River provides blue ribbon fishing opportunities, the fishery is composed mostly of brown trout that have higher temperature tolerance than other trout species. Aquatic insects appear to be impacted by either temperature or nutrient conditions. A temperature TMDL for the lower Ruby River is needed.

5.3.20.3 Metals

5.3.20.3.1 Data Review

Metals was listed as a cause of impairment of beneficial uses in 1996 and drinking water was indicated as threatened. The lower Ruby is considered fully supporting drinking water on the 2004 303(d) List. Metals concentrations during the 1970s for the lower Ruby were monitored at the gauge stations below the reservoir and near the mouth of the Ruby. The 1996 listing for metals was based on the 1970's water chemistry data. Analysis of the 1970s data indicates that it does not meet data quality objectives for this TMDL project and actual data used for the 1996 303(d) listing is not reliable. Additional metals water quality data for this water body included five samples collected by MDEQ in 2000. No exceedences of aquatic life standards or human health standards were found for toxic trace metals at the sites sampled. No elevated levels of toxic trace metals were found in the sediment samples from four samples collected during the summer of 2000. Samples from below the reservoir and at Seyler lane above the mouth of the Ruby were collected three times during 2003. Metals were below detection for all samples.

Three periphyton samples had 0% abnormal cells, also indicating no impairment due to metals.

5.3.20.3.2 Summary

There is no indication of impairment by metals for the lower Ruby River based on recent biological and water chemistry data and the 1996 303(d) listing for metals appears to be in error because it was based on data that does not meet current data quality objectives, therefore a TMDL for metals will not be completed.

5.3.21 Ruby River MT41C001_020 (Ruby River Above Reservoir)

The upper Ruby River was listed in 1996 for non-support of aquatic life and coldwater fisheries and threatened support of drinking water. Probable causes of impairment listed were flow alteration, metals, habitat alterations, siltation, and suspended solids. Probable sources listed were agriculture, channelization, flow regulation/modification, rangeland, removal of riparian vegetation, and streambank modification and destabilization and natural sources. On the 2004 list the upper Ruby is fully supporting drinking water supply, and is listed for partial impairment of aquatic life and coldwater fisheries. Probable causes are bank erosion, channel incisement, fish habitat degradation, other habitat alterations, riparian degradation, and siltation. Probable sources are agriculture, grazing-related sources, habitat modification other than hydromodification, removal of riparian vegetation, bank modification/destabilization, and highway maintenance and runoff.

5.3.21.1 Sediment

5.3.21.1.1 Total Suspended Solids

The upper Ruby flows through highly erodible Tertiary sediments (Appendix A – Maps 4). The upper Ruby often flows turbid after a storm, with turbidity lasting for days, due to the high clay content of surrounding soils (Appendix F – URR#6 and #25). Available data from NRCS for TSS indicates that suspended sediment levels get high enough on the upper Ruby to impair coldwater fisheries and aquatic life according to guidelines provided by Newcombe and Jensen (1996). NRCS collected samples for total suspended solids (TSS) approximately monthly from April-November in 1987 and April-October in 1998. Of the 26 samples collected on the upper Ruby River at Cottonwood Bridge, 50% exceeded 148 mg/L, while 27% exceeded 403 mg/L, at which level adult salmonids may experience mild physiological stress after just one hour (Newcombe and Jensen, 1996). On the Ruby River reach directly above the reservoir, 40% of the TSS samples collected exceeded 148 mg/L, while 18% exceeded 403 mg/L, indicating concentrations do reach levels potentially detrimental to salmonids. Based on NRCS data collected in 1997-1998, the estimated average annual suspended sediment yield at the lowest site (USGS gage site) on the upper Ruby in 1997 and 1998 were 74,800 and 67,060 tons, respectively (Van Mullem, 2000). An annual average sediment yield for 1938-1997 was estimated at 32,560 tons/yr.

In a separate study Dalby and others (1999) monitored suspended sediment above, below, and 3.5 miles downstream of Ruby Reservoir. Intensive sampling was conducted during an initial test flush from the reservoir, then synoptically after the initial period, using a sampling frequency that varied from twice daily to weekly. TSS concentrations at the station just above the reservoir frequently exceeded 500 mg/L. This information alone indicates that instream suspended sediment concentrations reach levels that likely cause stress to the fish and aquatic life. Source assessment information will be used to determine the extent of natural and human caused influences to the suspended sediment yields.

5.3.21.1.2 Biology

Macroinvertebrates were sampled at four sites on the upper Ruby in 2000 by MDEQ. Macroinvertebrates were also sampled in 1999 and 2000 on the Snowcrest Ranch by the University of Montana. All samples were collected using a traveling kick-net method.

The MVFP index score for 2000 samples ranged from 44 to 78. All samples except the site below the confluence of Cottonwood Creek were below the target value of 75, indicating impairment. Macroinvertebrates were also sampled at the USGS gauge station above Ruby Reservoir in 2003. The MVFP score for that site was 44, well below the target value (Table 5-51). Clinger richness was low at this site in 2003, but was close to the target value.

Table 5-51. Summary of Impairment Based on Macroinvertebrate Metrics for Ruby River Above Reservoir (2000 and 2003 Data).

	Clinger Richness	MVFP Index
Site	**R-1 (2000)**	
Target Value	≥14	75
Existing Value	ND	61
Percent Departure		19%
Site	**R-3 (2000)**	
Target Value	≥14	≥75
Existing Value	ND	50
Percent Departure		33%
Site	**R-5 (2000)**	
Target Value	≥14	≥75
Existing Value	ND	78
Percent Departure		**NE**
Site	**R-11 (2000)**	
Target Value	≥14	≥75
Existing Value	ND	44
Percent Departure		41%
Site	**R-1 (2003)**	
Target Value	≥14	≥75
Existing Value	13	44
Percent Departure	7%	43%

ND = No data
NE = No Exceedence

Samples collected in 1999 and 2000 indicated the site just downstream of the confluence of the East and West Forks the Ruby River supported a benthic assemblage that suggests mildly elevated water temperature, but no effects of fine sediment deposition. However, fine sediment deposition appears to have impaired benthic assemblages at all sampled sites from the Forest Service boundary to the most downstream site sampled on the Snowcrest Ranch. The site below Cottonwood Creek was characterized by clean substrates, free of fine sediment deposition, as indicated by the composition of the assemblage collected at that site. Macroinvertebrate data indicate that fine sediment may have compromised habitats in areas of slow moving current, but a diversity of habitats was available.

The most complete set of monitoring sites from the Snowcrest Ranch occurred during 2000. The 2000 data are summarized below in Table 5-52. Clinger richness was low for most sites, and averaged below the target value of 14, indicating possible impairment due to sediment.

Table 5-52. Summary of Impairment Based on Macroinvertebrate Metrics for Ruby River at Snowcrest Ranch (2000 Data).

	Clinger Richness	MVFP Index
Sites	**RU-A – RU-H**	
Target Value	≥14	≥75
Values Range	8 - 14	22 - 39
Avg. Existing Value	10.5	43
Percent Departure based on average	25%	43%
Sites	**RU2000-01 – RU2000-06**	
Target Value	≥14	≥75
Values Range	9 - 14	22 - 44
Avg. Existing Value	11.8	38
Percent Departure based on average	16%	49%

Trout populations have been depressed in certain areas of the upper Ruby River. The cause of low fish abundance may be due to naturally high sediment supply and temperature conditions and partly due to land use management practices and unpaved roads. The sediment source assessment will be pivotal in determining if the fishery potential is being impacted by human caused sediment sources.

5.3.21.1.3 Physical Condition and Sediment Sources

The upper Ruby River is adjusting to the geological influences on channel downcutting and to recent flooding, as well as past and current land management influences. This area is clearly in transition due to both natural and management-related influences. Above Greenhorn canyon, the river is following the slope of a syncline that produces downward cutting down and deflection into the left bank, causing high eroding toe slopes in many places. The upper Ruby River is probably also in adjustment from past beaver activity. Current beaver activity still has a large influence on many areas of the upper Ruby River, but the channel is downcutting partly due to reduced beaver activity in many areas. A geological uplift in the upper Ruby watershed also contributes to a stream system in adjustment over large timeframes. Areas below the canyon also have deep soil structure that influence channel condition. Other influences such and historic and recent widespread grazing also influence channel morphology. Stream types often change among E, C, and F types due partly to these influences.

Six of the nine upper Ruby River assessment reaches with morphological data have a sinuosity of greater than 1.5, as derived from GIS using a stream layer constructed from aerial photos at approximately a 1:7000 scale. This high sinuosity indicates an E potential channel type. Reaches with a sinuosity between 1.2 and 1.5 are considered a potential C type because there is not sign of activities causing reduced sinuosity over large reaches.

Width/depth ratio in the assessed reaches showed the greatest exceedence of target levels for E4 potential stream types. Bank erosion and deposition of fine to gravel-sized substrate keep the width/depth ratios higher than the E4 potential stream type. Entrenchment ratio and percent stable bank also exceeded target values (Table 5-53). Values for surface fine sediment ranged from 17- 44% and exceeded the target value in many reaches. Data from the 49-point grid also indicate high surface fines.

Bank stability was lower than target values in E4 reaches and in one C4 reach. Using regional bank stability as a target may not be fully appropriate for this stream segment because of the geologic conditions described in the paragraph above. However, wildlife and cattle grazing use on the floodplain have both influenced woody shrub cover available to strengthen streambanks. Another factor that affects streambank stability in this segment is beaver activity. Streambanks are generally stable in areas now colonized by beaver, but sediment deposition and scouring is quite variable in these areas and dependent on pool and dam placement.

Table 5-53. Summary of Sediment Impairment Based on Physical Indicators for Ruby River Above Reservoir.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**%Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	E4	≥5	≤9.1	≤38	NA	≤23.4	≥85
Existing	F4, C4	2.3	29.5	30	26.1	22.8	46
Percent Departure	Departure	50%	224%	**NE**	NA	**NE**	46%
Target	C4	≥3.2	≤25.6	≤29	≤6	≤29	≥85
Existing	F4, C4	1.4	28	34	39.8 M	13.6	45 M
Percent Departure	Departure in most reaches	56%	9%	17%	563%	**NE**	47%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given (minimum for % stable bank)

Sediment source characterization results (see Section 7.0) estimate that 28% of the total sediment load along the mainstem from the three forks area to the Ruby Reservoir is from human causes. Of the anthropogenic load, 90% is attributed to grazing, while 9% is attributed to roads. Approximately 1% is attributed to “other human causes” including channel armoring and less than 1% is attributed to channel manipulation. Tributaries also contribute sediment inputs to the upper Ruby River. Of the listed tributaries, Sweetwater Creek contributes the highest sediment load to the upper Ruby. Sediment sources to tributaries are summarized in the sediment impairment discussion for those water bodies. Improvements in grazing management on the mainstem and tributaries are likely to significantly lower sediment loading to the upper Ruby River.

5.3.21.1.4 Summary

The presence of considerable human caused sediment yields on both the main stem Ruby and on tributaries, borderline fine sediment data, entrenched stream channel conditions, high suspended sediment concentrations, a high amount of bank erosion, and indications of biological impairment all considered together indicate that sediment production, delivery, and transport likely have some affect on beneficial uses within the stream. Natural sediment conditions will be considered in the TMDL and restoration plan. A Sediment TMDL will address sources of both suspended and deposited sediment.

5.3.21.2 Metals

The upper Ruby River was listed for metals on Montana's 1996 303(d) List, but not on the 2004 303(d) List.

Data collected during 1979 showed chronic aquatic life standard exceedences for copper and lead. Analysis of the 1970s data indicates that it is not reliable and does not meet data quality objectives for this TMDL project. Additional metals water quality data for this water body included five samples collected by MDEQ in 2000. MDEQ data from 2000 show no exceedences of human health standards or aquatic life standards for toxic trace metals occurred in the water column at the 4 sites sampled (SCD_BUD file). Sediment samples at 4 sites yielded no elevated levels of toxic metals that would affect aquatic life. No abnormal diatoms were found in 2000 and 2003 periphyton sampling results, indicating no toxicity. It appears that the 1996 metals listing for this segment was made in error by using poor quality data. More reliable water chemistry, sediment chemistry and biological data do not support listing of the upper Ruby River for metals; therefore no TMDL for metals is necessary.

5.3.22 Ruby River Reservoir

Ruby Reservoir was included on the 1996 303(d) List for threatened support of aquatic life and coldwater fisheries. The probable cause was siltation, and probable sources listed were agriculture, domestic wastewater lagoon, and rangeland. This water body was deemed to fully support all uses during 2005 after reassessment.

One of the main reasons the Ruby River Reservoir original listing occurred was because it drained completely on September 1, 1994. As a result, a channel was cut into the sediments at the upstream end of the reservoir, sending a large sediment pulse downstream and causing a large fish kill below the reservoir. A MFWP fish mortality count conducted the next day revealed 2,562 dead trout. The majority of the sediment laden water was diverted into the West Bench and Vigilante canals, and most of the sediment deposit was contained within the first 3 miles below the reservoir (Montana DNRC, 2004). The sediment deposit was estimated at approximately 3000 cubic yards. A reservoir management plan is now in place to manage water supply and maintain a minimum pool in the reservoir to prevent further erosion and deposition due to drawdown.

5.3.22.1 Physical Condition and Sediment Sources

Some minor bank erosion occurs because of water level fluctuation. The erosion is within reason for a reservoir that was originally constructed for irrigation purposes and is expected to have water level fluctuation. During the last decade of reasonable dam operation, TSS levels in the outlet are lower than water inflowing from the upper Ruby River. This indicates that wave action is not causing significant suspended sediment problems.

Most of the water and sediment entering the Ruby Reservoir comes from the upper Ruby River. Most of the sediment load in the upper Ruby River is contributed by tributaries. A study in 1978 concluded the sediment yield from the upper Ruby River basin averaged 165 tons/mi^2, one-fourth of which originated from channel erosion on the Ruby River mainstem (Page, 1978). Based on NRCS data collected in 1997-1998 and flow records from the USGS gage site, the estimated average annual suspended sediment yield at the gage station above Ruby Reservoir was 32,560 tons (Van Mullem, 2000).

The reservoir is a sediment sink, and as a result is filling in over time. Only an estimated 5% of the sediment entering the reservoir from the upper Ruby watershed flows through the reservoir and into the lower Ruby River (Van Mullem, 2000). Dalby and others (1999) found that dam outflows typically had suspended solids concentrations of 10 to 50 mg/L. In contrast, sediment concentrations at a station above the reservoir frequently exceeded 500 mg/L during one week in early June. The fact that the reservoir is silting in is not in question. According to the source assessment for the upper Ruby River TMDL, approximately 1/4 to 1/3 of the sediment produced in the upper Ruby watershed could be caused by human influence. These sources are identified and addressed in TMDLs for the upper Ruby River Watershed. The reservoir is likely filling more quickly than it would with improved grazing practices in portions of the watershed.

The next step in determining if the Ruby Reservoir is in compliance with Montana's sediment standards is linking increased sediment deposition to negative effects on the designated uses. Sediment deposition within the reservoir does not appear to affect fisheries or aquatic life use within the reservoir. Fish species depend upon the Ruby River and tributaries for spawning areas. Most areas of the valley that was inundated contained rather fine soils to begin with so macroinvertebrate habitat is likely not affected.

Sediment deposition affects storage capacity and retention time, which can have an effect on other physical or chemical conditions within the reservoir. At this point in time it does not appear that temperature, nutrient or metals conditions are affected by sediment deposition. Current reservoir capacity and maintenance of a minimum pool based on a management plan developed in 1995 have provided sufficient habitat for a viable trout fishery (Figure 5-1). Indirect evidence supports that aesthetics are not impacted; there are no reports of the use being obstructed.

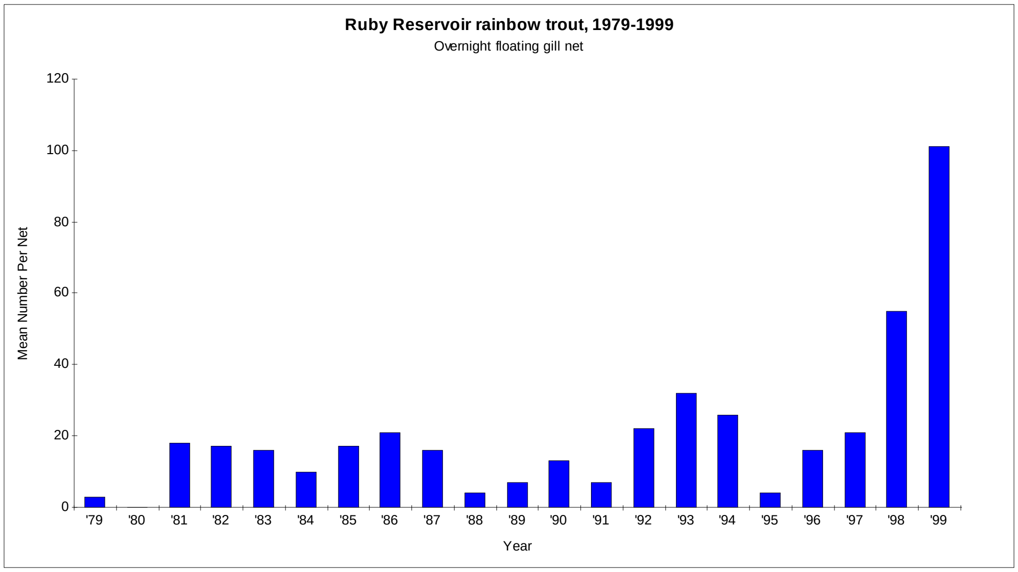

Figure 5-1. Caption should change to: Trend in Rainbow Trout Counts from the Ruby Reservoir, 1979-1999. Chart Re-created from Oswald (2000b). Numbers Best Approximated to Show Trends. Mean Length from 1990 to 1999 was Between 10 and 15 Inches.

5.3.22.2 Summary

Although there is increased erosion within the watershed, the increased sediment deposition does not currently affect any beneficial uses within the Ruby Reservoir. Because it appears that fish and aquatic life are impacted from sediment conditions in the upper Ruby River and specific tributaries, TMDLs will be written for many of the rivers and streams that are sources of sediment to the Ruby Reservoir. Following management plans provided in TMDLs for tributaries of the Ruby Reservoir will reduce the rate of sediment deposition within the reservoir.

5.3.23 Shovel Creek

Shovel Creek is located in the headwaters area of the Ruby River. The watershed is entirely managed by the USFS. The headwaters of this tributary are forested and flow from the Snowcrest Mountains. In mid and lower elevations many north-facing slopes are forested while the rest of the area is composed of grass and shrub land.

Shovel Creek was listed on the 1996 303(d) List for impairment of aquatic life and coldwater fisheries. Habitat alterations and siltation were indicated as the probable cause. Agriculture was listed as the probable source. The 2004 303(d) List MDEQ determined that this stream was fully supporting all beneficial uses.

After further monitoring during the TMDL process, the Shovel Creek was closely scrutinized for good cause delisting but didn't meet criteria based on the newly collected data. There is low certainty about the impairment condition of the Shovel because a compilation of biological, physical and source assessment data for sediment impairment indicates no clear indication of fully supporting uses nor a clear indication that uses are impaired by sediment. There are controllable sediment sources in the watershed. To be conservative, a TMDL will be written because of the uncertainties about impairment status.

5.3.23.1 Sediment

5.3.23.1.1 Water Chemistry

The one sample for TSS was taken in 2002 and had a concentration of 3.1 mg/L. This TSS datum provides little basis to base judgment about suspended sediment conditions.

5.3.23.1.2 Biology

The MVFP metric score for a macroinvertebrate sample was 61, which is slightly below criteria (Table 5-54). Montana’s new (draft) macroinvertebrate metrics were looked at in this case because of the borderline MVFP metric scores. The newer metric analysis indicates that macroinvertebrates are being supported but are only slightly above criteria. Clinger richness is high, indicating sediment free substrates are present. The presence of 4 stonefly taxa also indicated that large-scale aquatic habitat features were intact (Bollman, 2002). A periphyton data statistical assessment indicates a high probability that sediment is not impacting diatoms that grow on the substrate. Biological assessments support varying conclusions about sediment impacts to aquatic life.

Table 5-54. Summary of Impairment Based on Macroinvertebrate Metrics for Shovel Creek (2002 Data).

	Clinger Richness	MVFP Index
Site	MO4SHOVC01	
Target Value	≥14	≥75
Existing Value	16	61*
Percent Departure	NE	19%

* New macroinvertebrate metrics are above criteria

5.3.23.1.3 Physical Conditions and Sediment Sources

According to MDEQ reassessment monitoring in 2002, the Stream Reach Assessment score was in the lower range of Full-Support (80.8%), and the riparian assessment score was 89%, indicating “sustainable” condition. The 2002 condition assessment was completed on the downstream end of Shovel Creek.

Pictures of Shovel Creek from MDEQ reassessment field work document some habitat alteration and high natural erosion. This stream transports large amounts of fine sediment; substrate is often embedded with fines, but there is clean hard substrate available for colonization by macroinvertebrates. Assessment notes also documented slumped vegetated banks located on outside meander bends caused by undercutting during runoff. Willows are not continuous, as is typical of the upper Ruby streams, and banks are vulnerable to naturally sourced shear stress;

however, willow regeneration is high. The area appeared to be recovering from heavier grazing in the past.

Stream assessments conducted for TMDL monitoring during 2003 rated reaches as fair condition (68-76%), with lowest scores related to riparian vegetation variables of the SRAF assessment. These assessments were completed on the lower 1.3 miles of Shovel Creek. Sediment-related data collected during the 2003 assessments are summarized in Table 5-55. Average bank stability was only 58%, reflecting the high natural erosion in this system. Width/depth ratio and percent surface fine sediment were low, even given the bank erosion documented in assessment notes.

Table 5-55. Summary of Sediment Impairment Based on Physical Indicators for Shovel Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**% Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	E4	≥5	≤9.1	≤38	NA	≤23.4	≥85
Existing	E4	ND	5 S	22 S	30 S	11.9 S	55 S
Percent Departure	No Departure	ND	**NE**	**NE**	NA	**NE**	35%
Target	E4a	≥2.5	≤8.3	≤44	≤7	≤23.6	≥85
Existing	E4a	ND	4 S	10 S	1 S	14.8 S	ND
Percent Departure	No Departure	ND	**NE**	**NE**	**NE**	**NE**	ND

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

The TMDL sediment source characterization was completed on this stream because of the apparent large sediment loads (Section 7.0). The anthropogenic sediment load for Shovel Creek was estimated at 32%, 100% of which was attributed to grazing. The upland sediment source assessment may have overestimated the influence of grazing on sediment yield. Nevertheless, there was a documented influence from recent grazing in a number of riparian sections at the time of the assessment.

5.3.23.1.4 Summary

Shovel Creek is recovering from heavier grazing in the past. Moderate grazing related sediment sources are present and biological communities are not clearly indicating full health. The channel appears to be capable of effectively assimilating fine sediment loads but sediment may be impacting beneficial uses. Benthic fine sediment and channel geometry appear to be comparable or better than regional USFS reference conditions. The stream appears to have high embeddedness but this was not measured, only observed. It is unclear if the embeddedness condition is natural or human caused. Macroinvertebrate metrics and riparian vegetation conditions are borderline when compared to criteria. Although there is low confidence in determining sediment impairment because of borderline and conflicting biological and sediment indicators, a good cause for delisting can not be justified. A sediment TMDL will be completed with adaptive management components for a better understanding of impairment linked to sediment conditions.

5.3.24 Sweetwater Creek

Sweetwater Creek drains mostly a hilly grassland south of the Ruby Range, east of Blacktail Deer Creek and northwest of Rob Creek. There are very limited areas of conifers that grow on steep north slopes. This watershed has a larger, lower lying area than most of the other listed tributaries to the ruby river. The stream flows through hilly terrain most of its length that includes a canyon area in its midsection.

Sweetwater Creek was included on the 1996 303(d) List for threatened support of coldwater fisheries. Probable causes were flow alteration and siltation, and probable sources were agriculture, hydromodification, and natural sources. Sweetwater Creek was listed in 2004 for partial support of aquatic life, coldwater fisheries, and primary contact (recreation). Probable causes of impairment are siltation, dewatering, bank erosion, fish habitat degradation, flow alteration, nutrients, algal growth/chlorophyll a, other habitat alterations, and riparian degradation. Probable sources specified for 2004 are agriculture and grazing related sources. Sweetwater Creek is considered a Chronically Dewatered stream by Montana FWP.

5.3.24.1 Sediment

5.3.24.1.1 Total Suspended Solids

Data for TSS collected by NRCS in 1997 and 1998 for Sweetwater Creek show only one sample in excess of 403 mg/L. On Sweetwater Creek 63% of the samples fall below the guidance value of 148 mg/L TSS, which at a weekly concentration could cause major physiological stress to juvenile and adult salmonids, and at a daily concentration can cause moderate habitat impairment (Newcombe and Jensen, 1996). TSS data from 2001 and 2003 for Sweetwater Creek are relatively low, ranging from <10 mg/L to 37 mg/L (Appendix A – Map 10). One sample was collected from Sage Creek, a tributary to lower Sweetwater Creek, in 2003. This sample had a TSS concentration of 206 mg/L, which is high enough to impair aquatic life in some cases. Flow of Sage Creek at the time of sampling during high flow was 0.35 cfs, or roughly one-third the flow of Sweetwater Creek. This information indicates that instream suspended sediment concentrations reach levels that likely impact fish and aquatic life. Other information will be used to determine the extent of natural and human caused influences to the suspended sediment yields.

5.3.24.1.2 Biology

Macroinvertebrate data from 2001 indicate impairment due to fine sediment deposition, with the greater impairment at the lowest site. The MVFP index for the 2001 samples ranged from 33 to 56, also indicating impairment (Table 5-56). Macroinvertebrate data from 2003 at the downstream site just above the Sage Creek confluence indicated non-support of aquatic life due to siltation. The MVFP score for this sample was 22, while the score for the 2003 sample taken upstream at the base of the canyon was 44. Clinger richness from the 2003 samples was also low, indicating possible impairment due to sediment.

Table 5-56. Summary of Impairment Based on Macroinvertebrate Metrics for Sweetwater Creek (2001, 2003 Data).

	Clinger Richness	MVFP Index
Site	**SW1 (2001)**	
Target Value	≥14	≥75
Existing Value	12	56
Percent Departure	14%	25%
Site	**SW4 (2001)**	
Target Value	≥14	≥75
Existing Value	3	33
Percent Departure	79%	56%
Site	**SW-1 (2003)**	
Target Value	≥14	≥75
Existing Value	8	22
Percent Departure	43%	71%
Site	**SW-2 (2003)**	
Target Value	≥14	≥75
Existing Value	11	44
Percent Departure	21%	41%

5.3.24.1.3 Physical Conditions and Sediment Sources

Out of eight reaches assessed on Sweetwater Creek in 2003, six rated poor to very poor condition in the SRAF stream assessment. Stream assessments document severe bank erosion and riparian vegetation removal and alteration on lower reaches of Sweetwater Creek, as well as in headwaters reaches. Assessment data from 2003 indicate that most reaches of Sweetwater Creek show impairment related to excess surface fine sediment (<6 mm) and bank stability (Tables 5-57 and 5-58). Surface fine sediment measured by Wolman pebble count ranged from 42% to 65% in reaches of E4 and C4 stream type, exceeding criteria for those types. Estimated bank stability ranged from 20% to 90%, and bank erosion potential (BEHI) scores ranged from 10.5-39.2. Bank stability was low for all stream types. Several reaches exhibit departure from natural stream type, due primarily to increased entrenchment. The highly erodible soils in this drainage, especially at the lower end (Appendix A - Map 3) are susceptible to erosion, and riparian vegetation removal can have severe affects on bank erosion (Appendix F – SWC #6 and #20). These data indicate conditions are variable, but also indicate impairment from sedimentation for most reaches when compared to sediment criteria.

Table 5-57. Summary of Sediment Impairment Based on Physical Indicators for Sweetwater Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**% Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	C4	≥3.2	≤25.6	≤29	≤6	≤29	≥85
Existing	B5c	1.6 S	19 S	68 S	ND	32.5 S	20 S
Percent Departure	Departure	50%	**NE**	134%	ND	12%	76%
Target	E4	≥5	≤9.1	≤38	NA	≤23.4	≥85
Existing	G4, G5	1.5 M	9 M	58 M	22 S	29.4 M	20 M
Percent Departure	Departure	70%	**NE**	53%	NA	26%	76%
Target	E5	≥5	≤9.1	NA	NA	≤23.4	≥85
Existing	E5, G5	2.3	9.5	88.8	22 S	37.2	63
Percent Departure	Departure in some reaches	54%	4%	NA	NA	59%	26%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given (minimum for % stable bank)

Table 5-58. Summary of Sediment Impairment Based on Physical Indicators for North Fork Sweetwater Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**% Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	E5	≥5	≤9.1	NA	NA	≤23.4	≥85
Existing	E5	5.5 S	10 S	94 S	ND	25.8 S	35 S
Percent Departure	No Departure	**NE**	9%	NA	ND	10%	59%

NA = Target parameter not applicable to this stream type
ND = No data
S = Single value
M = Two values – maximum given

The TMDL sediment source characterization an estimated 78% of the total sediment load was anthropogenic; 80% of this was attributed to grazing and 20% was attributed to roads. In addition, a ditch dumps water from the Ruby River into the channel of Sweetwater Creek below the downstream-most water quality sampling site (Appendix F – SWC#17, and #20). The channel above and below the irrigation water return is incised, and exhibits signs of active channel adjustment. This site was not on an assessed reach and was not considered in the sediment source inventory. Flow manipulation affects stream energy in Sweetwater Creek. The flow of Sweetwater Creek at the Sage Creek confluence was the same in August as in June, and appears to be greatly affected by irrigation. Much of the flow of Sweetwater Creek is diverted below the canyon reach. Water use will be considered in the source assessment because it promotes energy conditions that perpetuate bank erosion and affects sediment build-up in the channel.

5.3.24.1.4 Summary

Impairment of uses, exceedence of sediment criteria, and the presence of human influenced sediment sources indicate that sediment supply, transport and deposition are affecting instream uses. Human caused sources are present and contribute a significant amount of sediment. A sediment TMDL will be written for Sweetwater Creek.

5.3.24.2 Nutrients

The few data available from 2001 indicate that Sweetwater Creek has high total phosphorus and high nitrite+nitrate concentrations when compared to nutrient targets (Section 4.0) (Appendix A – Maps 14, 15). All three values for total nitrite+nitrate collected in June through August of 2003 at lower Sweetwater creek are greater than 1000 µg/L, which is roughly three times the level found in any of the other samples collected from the watershed in 2000-2003, and much greater than regional reference values of 30 µg/L or less. The concentration of TKN from all 2003 samples was average compared to other samples over the Ruby watershed. Soluble reactive phosphorus (bioavailable phosphorus) was below detection for this water body. Chlorophyll a was low in samples collected in 2001 and 2003; the two samples taken near the mouth just above the Sage Creek confluence ranged from 30.8 to 46.6 mg/m^2, still below the target level of 100 mg/m^2. Chlorophyll a data collected during 2004 exceeded targets (Table 5-59).

Physical and sediment conditions are impacting aquatic insects and nutrient enrichment at the sampled sites cannot be excluded as a stressor. Macroinvertebrate data from sampling in 2003 measured aquatic insect communities that indicated nutrient enrichment. Periphyton assemblage structure assessed during 2003 indicated that site SW-1 (above Sage Creek confluence) is potentially influenced by organic loading. Algal blooms were observed primarily in the lower reaches of Sweetwater Creek in 2001 and 2003 stream assessments. Results from 2004 data indicate impairment based on TP, TN, and benthic chlorophyll a (Table 5-59).

Table 5-59. Summary of Impairment Based on Nutrient Indicators for Sweetwater Creek (Data from 2001, 2003, and 2004).

	Target Indicator				Supplemental Indicator
	TP (µg/L)	**TN (µg/L)**	**NO_2+NO_3 (µg/L)**	**Benthic Chlor *a* (mg/m^2)**	**Macroinvertebrate HBI**
Target Value	20	300	20	Yearly Avg 50/ Max. 150	<4
2001					
Existing (avg)	149	810	11.7		5.34
Existing (max)	338	1100	20		5.95
Exceedence	Exceeds	Exceeds	NE	ND	Exceeds
2003[a]					
Existing (avg)		1510	1106	38.7	4.9
Existing (max)		1610	1210	46.6	5.24
Exceedence	ND	Exceeds	Exceeds	NE	Exceeds
2004					
Existing (avg)	39	325	<0.0006	52.8	
Existing (max)	56	336	0.0007	117.7	
Exceedence	Exceeds	Exceeds	NE	Exceeds	ND

[a] Water chemistry data from 2003 are from the lower site only; macroinvertebrates were collected at both sites
ND = No Data
NE = No Exceedence

5.3.24.2.1 Summary

Based on elevated nitrite/nitrate and total phosphorus levels and indications of nutrient enrichment from bioindicators, Sweetwater Creek is judged impaired due to nutrient inputs and related algae growth. Human influenced sources are present; therefore a nutrient TMDL will be completed.

5.3.25 Warm Springs Creek

Warm Springs Creek watershed encompasses the extreme southern portion of the Greenhorn Mountains and the northern portion of the Gravely Mountain Range. Warm Springs Creek flows into the Ruby River half way between the headwaters and Ruby Reservoir. Headwater areas are forested. Large springs upwell downstream of the confluence of the south and middle forks. Select areas of the watershed are landside prone.

Warm Springs Creek was listed in 1996 for partial support of aquatic life and coldwater fisheries. Probable causes of impairment are flow alteration, habitat alterations, and siltation. Probable sources of impairment include agriculture, flow regulation/modification, removal of riparian vegetation, streambank modification and destabilization, and highway maintenance and runoff. It should be noted that only unpaved roads are present near Warm Springs Creek. Warm Springs Creek was listed in 2004 for partial support of aquatic life and coldwater fisheries. Probable causes of impairment are riparian degradation and bank erosion.

5.3.25.1 Sediment

5.3.25.1.1 Total Suspended Solids

There is only one sample for TSS from Warm Springs Creek, which had a concentration of 3.4 mg/L. No conclusions can be made from this data point.

5.3.25.1.2 Biology

Macroinvertebrate data from the sample site near the downstream end of public land indicated severe impairment and non-support of aquatic life, but metrics related to sediment are not extreme. The MVFP index score for this sample was 17, the lowest of any score in the Ruby watershed (Table 5-60). Geothermal activity and high levels of sediment production in the watershed are likely large influences on the aquatic insect community (Bollman, 2002). Some of the headwaters of Warm Springs Creek support 100% pure westslope cutthroat trout.

Table 5-60. Summary of Impairment Based on Macroinvertebrate Metrics for Warm Springs Creek (2002 Data).

	Clinger Richness	MVFP Index
Site	MO4WARMSC01	
Target Value	≥14	≥75
Existing Value	8	17
Percent Departure	43%	77%

5.3.25.1.3 Physical Conditions and Sediment Sources

Several targets and supplemental indicators show exceedence of target values for B4 stream reaches of Warm Springs Creek (Table 5-61). Fine sediment in gravel (49-point grid fines) was variable, and ranged from 7% to 56% in assessment reaches on Warm Springs Creek. Reference reach data are not adequate to determine impairment for 49-point grid fines on most reaches. Fine sediment less than 6 mm was high in B and C stream types. Bank stability was also variable, ranging from 17% to 90%. Assessment reaches of E4 and E5 type exceeded targets for percent stable bank, indicating a need for improving cover of riparian vegetation. No departure from natural Rosgen stream type was noted for Warm Springs Creek reaches. E4b is not considered a departure because it is not entrenched due to young geology. An E4b has stream slope and sinuosity characteristics of a B type stream but cross section attributes of an E stream and is compared to an E stream to remain consistent with reference summary data from BDNF. Some C and E channel types are slightly entrenched, probably due to a combination of past beaver removal and historic grazing.

Table 5-61. Summary of Sediment Impairment Based on Physical Indicators for Warm Springs Creek.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**% Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	B4	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4	1.9 M	12 M	30 M	17 M	29.5	85 S
Percent Departure	No Departure	19%	**NE**	50%	112%	**NE**	**NE**
Target	E4	≥5	≤9.1	≤38	NA	≤23.4	≥85
Existing	E4, E4b	7.1 M	11 M	33 M	16 M	25.7 M	50 M
Percent Departure	No Departure	42%	21%	**NE**	NA	10%	41%
Target	E5	≥5	≤9.1	NA	NA	≤23.4	≥85
Existing	E5	4.8	8	67	56	22	60
Percent Departure	No Departure	4%	**NE**	NA	NA	**NE**	18%
Target	C4	≥3.2	≤25.6	≤29	≤6	≤29	≥85
Existing	C4	2.3	10	27	16	18.3	90
Percent Departure	No Departure	28%	**NE**	**NE**	167%	**NE**	**NE**

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given (minimum for % stable bank)

Most reaches on Warm Springs Creek were rated Fair during the SRAF stream assessments, and one reach could be considered as a reference reach except for high fines compared to reference conditions. This reach displays high fine sediment levels partly due to recent beaver activity and partly to natural landslide inputs. Riparian vegetation has been all but removed from the middle stretch of Warm Springs Creek, but the channel has maintained its meander pattern and morphology, probably due to the high clay content of the streambank soils (Appendix F – Warm Springs #7 and #8).

High natural inputs of sediment from landslide-prone hillslopes have been documented in 2002 and 2003. Several landslides deliver sediment to Warm Springs Creek. One landslide temporarily plugged the channel in a canyon area, which subsequently eroded and was deposited downstream. A few stream reaches are recovering from recent landslide activity.

According to the Forest Service assessments conducted in the mid 1990s there was little evidence that current grazing practices are adversely affecting streams in the Warm Springs drainage. Heavy streambank trampling has been documented on tributaries to Warm Springs by USFS, but according to those surveys there is no evidence of trampling causing channel widening in most areas. Assessments from 2003 documented some streambank trampling on the main channel of Warm Springs. Past grazing probably has reduced the amount of riparian vegetation, which today is also leading to increased streambank erosion.

The majority of the sediment load to Warm Springs Creek is natural. According to sediment source assessment results 18% of the total sediment load is related to human causes. Much of the anthropogenic load (83%) is attributed to grazing. The sediment contributions from other human causes and roads are estimated at 11% and 5%, respectively. Other human causes include recreation and minor inputs from small private crossings or fencing. The upper reaches of Warm Springs Creek have been altered by placer mining in the past, but these areas are mostly healed over and have been reclaimed by beaver activity; therefore, less than 1% of the sediment load is attributed to placer mining.

Vegetation removal, combined with channel incisement, has made streambanks very susceptible to erosion on the Middle Fork and South Forks of Warm Springs Creek. SRAF scores from 2003 assessments for the downstream end of these two tributaries were 64 and 72, respectively, indicating some habitat impairment. Bank erosion was high on both streams. Meadows in the surveyed areas on tributaries would have had much less streambank erosion historically, as beaver activity would have allowed the stream to access its floodplain. Remnants of beaver activity are especially apparent on the South Fork, and adjustment after beaver activity may be one cause of incisement (Appendix F – Warm Spring #5 and #6).

5.3.25.1.4 Summary

Most of Warm Springs Creek is not impaired due to human caused sediment conditions because natural loading is very high or human influenced sources are not affecting sediment production significantly in upper elevations. Some key areas need to be addressed by a TMDL because human influences are likely impacting aquatic life in specific locations. These include the lower reaches of the Middle Fork and South Fork and reaches WS3F and WS4E, where degradation of riparian vegetation is severe (Appendix A – Map 10). These areas are large enough portion of the stream to warrant a TMDL. Impairment of uses, exceedence of sediment criteria, and the presence of locally significant human influenced sediment sources indicate that increased sediment supply, transport and deposition are likely affecting instream uses. A sediment TMDL will be written for Warm Springs Creek.

5.3.26 West Fork Ruby River

The West Fork of the Ruby River is located in the headwaters area of the Ruby River. The watershed is entirely managed by the USFS. The headwaters of this tributary are forested and flow from the Snowcrest Mountains. In mid and lower elevations many north-facing slopes are forested while the rest of the area is composed of grass and shrub land.

West Fork Ruby River was included on the 1996 303(d) List for non-support of aquatic life and coldwater fisheries beneficial uses. Probable Causes listed were habitat alterations, siltation, and suspended solids. Probable sources of impairment were agriculture, natural sources, and rangeland grazing. The West Fork Ruby River was listed as fully supporting all beneficial uses in 2004.

After further monitoring during the TMDL process, the West Fork of the Ruby River was closely scrutinized for good cause delisting but didn't meet criteria based on the newly collected data.

There is low certainty about the impairment condition of the West Fork Ruby River because a compilation of biological, physical and source assessment data for sediment impairment indicates no clear indication of fully supporting uses nor a clear indication that uses are impaired by siltation. It is also possible that suspended solids are a source of impairment although TSS and biological data to make the linkage are not robust. There are controllable sediment sources in the watershed. To be conservative, a TMDL will be written because of the uncertainties about impairment status. The sediment TMDL will address sources of suspended sediment as well as settled sediment.

5.3.26.1 Sediment

5.3.26.1.1 Total Suspended Solids

TSS data are limited. There is one recent TSS sample from 2002, which had a concentration of 2 mg/L. There are no other existing data for TSS. Little can be concluded from this one sample.

5.3.26.1.2 Biology

The one macroinvertebrate sample from the West Fork showed full use support and had a MVFP index score of 83, indicating Non-Impaired condition and Full-Support of aquatic life uses. The Montana DEQ metrics indicate full-support of aquatic life uses. Clinger taxa richness was high (17), indicating fine sediment did not obscure hard substrate habitat (Table 5-62). Good water quality and habitat conditions support a sensitive, functional benthic invertebrate assemblage (Bollman, 2002). The periphyton community structure assessment indicated some impacts potentially from sediment and organic enrichment.

Table 5-62. Summary of Impairment Based on Macroinvertebrate Metrics for West Fork Ruby River (2002 Data).

	Clinger Richness	MVFP Index
Site	MO4RURWF01	
Target Value	≥14	≥75
Existing Value	17	83
Percent Departure	NE	NE

5.3.26.1.3 Physical Condition and Sediment Sources

MDEQ conducted physical habitat assessments for this water body in 2002. The Stream Reach Assessment score was 83%, indicating a healthy status. The Riparian Assessment score was 92%, indicating sustainable condition and improving trend. The area is currently lightly grazed. Cattle were present at the time of the assessment, and some hoof shear was noted in assessments. Increased grazing could easily trigger increased bank instability and increased sediment. The USFS has implemented a protective grazing management plan, which has helped improve conditions. Willows and undercut streambanks provide localized trout habitat (Appendix F - WFR #3). Clean spawning gravels for trout are somewhat reduced due to the amount of fine sediment embedding the gravel and cobble substrate, though clean gravels are available in riffles.

Old vegetated landslides and hill slopes cut by the stream channel are the predominant sources of sediment to the channel. The drainage produces large volumes of sediment, much of it fines, which are quite evident in substrate. Sediments are also transported through the system and are deposited in the form of point bars opposite eroding banks. Notes from MDEQ assessments specify that active areas of bank erosion seem mostly to be balanced by depositional areas, specifically point bars where bank building occurs. This stream appears to have a high level of active lateral movement and a high width-depth ratio, but it may have reached dynamic equilibrium, considering the erodible nature of the soils on this water body. Willows are regenerating on the point bars. Upper reaches have beaver ponds, according MFWP data. The stream is entirely on USFS land and there are no diversions of flow.

A pebble count was conducted during 2002 monitoring but caution should be used when comparing this result to the targets provided in Table 5-63 because it was only collected within a riffle. Percent fines < 6 mm were 47% and percent fines < 2 mm were 30%, which are both quite high compared to reference conditions. Fine sediment conditions within a riffle are usually quite a bit lower than average reach conditions, which the Rosgen pebble count method estimates. Targets and data presented in Table 5-63 are based on average reach conditions and are discussed in more detail in the paragraphs below.

Limited sampling was conducted in 2003. Bank stability averaged 55% from 2003 stream assessment reaches on West Fork Ruby River, which is below regional reference conditions. Assessments from 2003 also noted high eroding banks providing natural sediment inputs. The sediment source characterization estimated anthropogenic sediment sources at 12%, 100% of which was attributed to grazing. At the time of the assessment there were signs of grazing. In many areas steep banks and good shrub cover limit cattle access to the stream.

Additional monitoring in 2004 included measuring channel morphology at two reaches on the West Fork Ruby River. Width/depth ratio was slightly higher than the target values for the E4a stream type, but not high enough to cause a departure from natural stream type (Table 5-63). Fine sediment in gravels was very high in this reach based on 49-point grid data, which measures surface fines in pool tail-outs. Fine sediment has built up in the channel in many areas with recent beaver activity that is no longer active. Parts of the channel are in adjustment to recent beaver activity. Banks are very sensitive due to the high silt content, but are high and steep in many areas and do not show signs of widespread trampling although cattle grazing activity is evident.

Table 5-63. Summary of Sediment Impairment Based on Physical Indicators for West Fork Ruby River.

	Sediment Criteria						
	Rosgen Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**%Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	E4	≥5	≤9.1	≤38	NA	≤23.4	≥85
Existing	E4	13.6 S	5 S	21 S	55 S	14.3 S	50 S
Percent Departure	No Departure	**NE**	**NE**	**NE**	NA	**NE**	41%
Target	E4a	≥2.5	≤8.3	≤44	≤7	≤23.6	≥85
Existing	E4a	5.6 M	12 M	23 M	63 M	15 M	60 S
Percent Departure	No Departure	**NE**	45%	**NE**	800%	**NE**	29%

NA = Target parameter not applicable to this stream type
NE = No Exceedence
S = Single value
M = Two values – maximum given

5.3.26.1.4 Summary

The only observed anthropogenic sources of sediment to the West Fork Ruby River are slight to moderate impacts from grazing. This is in the form of occasional hoof shear, bank trampling and vegetation impacts in the form of browsing of woody species (mostly willows). The presence of some high levels of sediment in fish spawning areas and riffles may impact spawning success. Over widened areas and eroding banks may be impacted by past and current grazing. The sediment reduction for the TMDL will only equate to a small portion of the overall sediment load because much of the siltation in the stream is likely attributable to natural sources. An adaptive management strategy is provided to improve the linkage of sediment conditions and impairment of the fishery. The sediment TMDL will address sources for both deposited and suspended sediments.

5.3.27 Wisconsin Creek

Wisconsin Creek is located in the northeast portion of the Ruby River watershed. The timbered headwaters are in the Tobacco Root Mountains. Lower areas of the watershed are a mix of grassland and cropland. The upper portion of the watershed consists of National Forest land. Private landowners own most of the middle and lower portions of the watershed except for small areas of State and BLM land. Land use in the Wisconsin Creek watershed includes crop production, grazing, and recreation.

Wisconsin Creek was included on the 1996 303(d) List for partial support of aquatic life and coldwater fisheries and threatened support of drinking water and primary contact recreation. Probable causes of impairment listed were flow alteration, habitat alterations, and siltation. Probable Sources of impairment were agriculture, channelization, flow regulation/modification, highway maintenance and runoff, and streambank modification and destabilization. Wisconsin Creek is listed on the 2004 303(d) List for partial support of aquatic life, coldwater fisheries, and primary contact recreation. Probable causes are arsenic, dewatering, fish habitat degradation, flow alteration, lead, metals, other habitat alterations, riparian degradation, and siltation. Probable sources are agriculture, resource extraction, mine tailings, hydromodification, channelization, flow regulation and modification, and bridge construction. Wisconsin Creek is listed as chronically dewatered from the National Forest boundary to the mouth. Wisconsin Creek below reach WIS3F is often dry until ground water recharge near the confluence (Appendix A – Map 2).

5.3.27.1 Metals

5.3.27.1.1 Sediment Metals

Montana DEQ Mine Waste Cleanup Bureau collected samples near Lakeshore Mine in Crystal Lake and downstream in Wisconsin Creek. Sediment data from this study show copper, mercury, lead, zinc, and cadmium were elevated at least 3 times background levels in tailings and waste rock in this area.

MDEQ also conducted sediment sampling on Wisconsin Creek in 2000. Several sediment data from this sampling effort exceed guideline values, shown in bold in Table 5-64. These data indicate an increase in metals sediments from above Leiterville downstream to below the confluence of Noble Fork. However, the duplicate samples (W-4 and W-5) show a high degree of variability in sediment metals analysis results (Table 5-64) therefore the sediment concentrations should only be considered in conjunction with other factors.

Table 5-64. Sediment Sampling Results from Monitoring by MDEQ in 2000. Bolded Values Exceed Sediment Metals Guidelines.

Site #	Site Description	Arsenic (ppm)	Copper (ppm)	Iron (ppm)	Lead (ppm)
W-1	ABOVE LEITERVILLE	19	47	14500	**67**
W-2	BELOW LEITERVILLE	**40**	**92**	26700	**155**
W-4	UPSTREAM OF BRIDGE AT FOREST SERVICE BOUNDARY	**109**	**136**	25900	**141**
W-5	FIELD DUPLICATE OF W-4	**121**	30	5800	31
W-7	DOWNSTREAM OF NOBLE CR	**54**	**174**	34100	**172**
W-11	UPSTREAM OF CITY ROAD	11	42	17500	29

5.3.27.1.2 Water chemistry

Water quality data collected in 1993 by the MDEQ Mine Waste Cleanup Bureau did not pass data quality objectives for this project due to laboratory data analysis variability, and are considered unreliable. MDEQ Water Quality Data collected during a 2000 303(d) assessment showed no metals exceedences in surface water. Samples collected in June and August of 2003 all reflected metals concentrations below detection.

5.3.27.1.3 Biology

The report from periphyton monitoring conducted in 2000 indicated metals are the most likely cause of abnormal diatom cells at the sample site above the Forest Service boundary, although cool water conditions could affect diatom cell formation. This sample is from the same area in which MDEQ sampling found high sediment metals concentrations. The percentage of abnormal diatoms is just below the criteria of 3%. Three other samples do not indicate any abnormal cells.

5.3.27.1.4 Summary

There is possible evidence of impairment to aquatic life due to metals on Wisconsin Creek. There are no water chemistry metals standard exceedences found during recent monitoring efforts. Abnormal diatoms were found at one site but equaled toxicity criteria provided in Section 4.0. Sediment metals were above criteria downstream of Crystal Lake, the origination source of Wisconsin Creek. Considering existing data and the decision criteria to link metals to a use impairment provided in Section 4.0, no arsenic or lead TMDLs are provided at this point. However, the possibility of risks to aquatic life due to metals may exist; therefore a monitoring plan for metals will be provided for Wisconsin Creek and Crystal Lake in Section 11.0 and Wisconsin Creek will stay on Montana’s 303(d) list for metals impairments.

5.3.27.2 Sediment

5.3.27.2.1 Total Suspended Solids

MDEQ staff collected TSS data on Wisconsin Creek in 2000. TSS was less than the detection limit of 10 mg/L. Too few TSS data exist to determine impairment due to suspended sediment for Wisconsin Creek.

5.3.27.2.2 Biology

Macroinvertebrate samples from 2000 indicate a trend toward more sediment-tolerant taxa from the upstream site (W01) to the lower site (W11). The MVFP index score for the upper sample was 100, but the score at the lower site was 44 (Table 5-65). Sample sites are mapped in Map 2 of Appendix A. The sample collected during 2003 just downstream of Leiterville yielded no values exceeding sediment targets (Table 5-65).

Table 5-65. Summary of Impairment Based on Macroinvertebrate Metrics for Wisconsin Creek (2000, 2003 Data).

	Clinger Richness	MVFP Index
Site	**W01 (2000)**	
Target Value	>14	>75
Existing Value	16	100
Percent Departure	NE	NE
Site	**W11 (2000)**	
Target Value	>14	>75
Existing Value	9	44
Percent Departure	36%	41%
Site	**WIS-1 (2003)**	
Target Value	>14	>75
Existing Value	23	100
Percent Departure	NE	NE

5.3.27.2.3 Physical Conditions and Sediment Sources

Two stream surveys were conducted on Wisconsin Creek by the US Forest Service in 1991 (BDNF, n.d.). According to the survey report timber harvest conducted in the middle reaches of Wisconsin Creek prior to 1985 damaged streambanks and caused sediment delivery to the channel in a number of places. Channel stability and overall condition were ranked "good" at the time.

All Rosgen stream types reflect exceedence of sediment targets due to at least two indicators (Table 5-66). Most reaches exceeding targets are at the downstream area of Wisconsin Creek in the alluvial valley and lower pediment landscapes. Width/depth ratio was higher than the target value for all stream types, although only marginally so for the E4a reaches found in the headwater areas. Fine sediment was higher than target values for lower reaches. Bank stability was relatively high for Wisconsin Creek, probably due to well-armored, cobble-dominated channels. Only minor exceedence for bank stability indicates that high width/depth ratios may be due partly to aggradation from excessive fines or due to large channel substrate keeping the channel relatively shallow.

Table 5-66. Summary of Sediment Impairment Based on Physical Indicators for Wisconsin Creek.

	Sediment Criteria						
	Potential Stream Type	**Entrench. Ratio**	**Width / Depth Ratio**	**% Fines <6 mm**	**Fines 49 pt Grid**	**BEHI**	**Estimated % Stable Bank**
Target	C3a	≥3.2	≤25.6	≤14	≤6	≤29.0	≥85
Existing	C3a	3.3 S	23 S	11 S	ND	10.4 S	85 S
Percent Departure	No departure	**NE**	**NE**	**NE**	ND	**NE**	**NE**
Target	E4a	≥2.5	≤8.3	≤44	≤7	≤23.6	≥85
Existing	E4a	4.2 S	9	16	6	16.5	80
Percent Departure	No Departure	**NE**	8%	**NE**	**NE**	**NE**	6%
Target	B4	≥1.6	≤15.8	≤20	≤8	≤29.8	≥85
Existing	B4, E4b, C4b	1.6	25	23	17.2	19.6	79
Percent Departure	Not considered departure	**NE**	58%	63%	115%	**NE**	7%

NA = Target parameter not applicable to this stream type
ND = No data
NE = No Exceedence
S = Single value
M = Two values – maximum given

Several reaches had a higher entrenchment ratio than their potential stream type. These reaches are most similar to the B type in character but are less entrenched due to the well-armored channels and relatively young geology. These variances in stream type are natural, and are not considered a departure.

The sediment source characterization estimated anthropogenic loading at 61%. Of the human-caused sediment loading 96% was attributed to grazing; 2% was attributed to other human causes such as failing water gaps or other sources, and 2% was attributed to roads (Appendix F – Wis #21). Flow manipulation likely has an effect on the aquatic habitat of Wisconsin Creek. Wisconsin Creek is dewatered and re-watered with irrigation return water (Appendix F – Wis #14 and #18). The return water contributes sediment but was not distinguished from other human causes. In addition, flow manipulation affects sediment deposition and scour. The sediment TMDL will address flow manipulation along with grazing and other agricultural influences.

5.3.27.2.4 Summary

Wisconsin Creek is not impaired in the Tobacco Root and Pediment areas, above irrigation withdrawals. The lower half of Wisconsin Creek (downstream of reach WIS3F) is impaired for sediment, therefore a sediment TMDL will be completed (Appendix A – Map 2). In the lower half of Wisconsin Creek results of biological, instream sediment, stream channel geometry and sediment source monitoring suggest that human influenced sediment production and transport are affecting uses. The TMDL will consider the whole watershed as a source of sediment production. Dewatering will also be assessed as a potential impact to sediment transport.

5.4 Other Streams

Robb Creek and Ledford Creek are recommended for 303d assessment. These streams are not listed for sediment but were noted as sources of sediment in the Snowcrest Ranch study. These streams are identified for follow up monitoring in Section 11.0.

SECTION 6.0 TEMPERATURE

Two water bodies identified on Montana's 1996 303(d) List for thermal impairments are Mill Creek and the lower Ruby River. Coal Creek was listed for thermal modifications on the 2004 list, but the current TMDL project budget and time constraints do not allow this recent temperature listing to be addressed at this time. The Coal Creek thermal modification listing will be addressed in future TMDL planning efforts. Existing data and impairment status for each of these streams are reviewed in Section 5.0.

6.1 Source Assessment Methods

Potential human caused sources of increased stream temperatures on the listed water bodies are alteration of riparian zone vegetation that affects stream shade, channel geometry, water diversion, warming in created ponds, and irrigation return flows. Almost all of the influences that cause these conditions relate to agricultural use of the land and water. Along Mill Creek some urban influences are present near the town of Sheridan. The following assessments are used to evaluate heat sources for the TMDLs.

Previous surface and ground water studies have been conducted in the lower Ruby River valley. These include USGS gauge data, Payne (2004), and Montana Fish Wildlife and Parks fishery and temperature data. These studies are useful for understanding the basic hydrologic, hydrogeologic, and water temperature conditions in the area.

Thermal loading was modeled in 2004 using the Stream Network Temperature Model (SNTEMP). Data used to calibrate the SNTEMP model was collected during 2004. Measurements included stream flow, stream canopy density, riparian vegetation surveys, stream morphology, and collection of temperature data using continuous recording temperature loggers. SNTEMP modeling and associated field monitoring were conducted for both the Ruby River below Ruby Reservoir and Mill Creek. The modeling effort assessed the influence of instream discharge rates, shading factors and channel dimensions upon stream temperatures. The detailed SNTEMP methods, assumptions and results are provided in Appendix C.

Additionally, forward-looking infrared (FLIR) imagery was collected in 2004 for the lower Ruby River to map a longitudinal temperature profile and help locate sources of warming or cooling from the lower Ruby River. FLIR is used to assess tributary and any surface water irrigation water return temperatures. FLIR could not be used on Mill Creek because of the combination of its smaller size and taller riparian canopy. The detailed FLIR methods, assumptions and results are provided in Appendix G.

6.2 Mill Creek

6.2.1 Source Assessment Results

Stream temperature on Mill Creek warmed an average of 17°F from the upstream thermister site located between Smuggler mine and Brandon down to the Middle road site during 2002-2003. The elevation difference between these two sites is roughly 1180 ft. This same trend is reflected in the 2004 thermister data, although the temperature difference is not as great. Two loggers were placed in the reaches below Middle Road in 2004, and these revealed that temperature decreased again by approximately 3°F from Middle Road to the mouth of Mill Creek. The decrease in temperature is mostly affected by ground water, along with other influences in this area.

6.2.1.1 Point Sources

There are no point source discharge permits that identify Mill Creek or tributaries as receiving water bodies.

6.2.1.2 Nonpoint Sources

Based on initial investigations, the influences that likely affect temperature of Mill Creek are water withdrawals for irrigation, irrigation water return flow, shifts in stream channel geometry, and riparian degradation that decreases shade. Each of these sources was further assessed. Results are described in the following sections.

6.2.1.2.1 Irrigation Water Management and Ground Water

Irrigation withdrawals and natural loss to subsurface flow reduce the amount of water in Mill Creek. Stream flow declines sharply from the top of the pediment and continues down to Middle Road because of natural and irrigation influences. According to the water commissioner (Hamler per comm., 2005), Mill Creek is often nearly dry right below Sheridan due to irrigation withdrawals, and most of the water in Mill Creek below Sheridan is surface or ground water derived mostly from irrigation return water. Figure 6-1 illustrates trends in stream flow from steeper, upstream, forested sites to sites in the alluvial valley of the Ruby River. Table 6-1 provides descriptions for site names in Figure 6-1. Discussion of flow conditions will identify significant natural and irrigation influences in relation to monitoring sites identified in Figure 6-1.

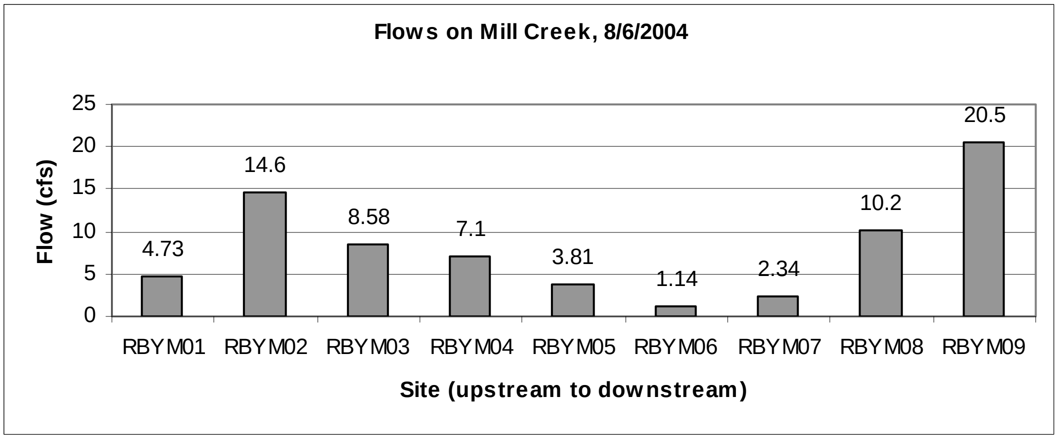

Figure 6-1. Flows for Mill Creek Based on Monitoring Completed in Early August 2004 for SNTEMP Modeling.

Table 6-1. Site Descriptions for Site Names in Figure 6-1.

Site ID	Site Description
RBYM01	Headwaters- near confluence of forks
RBYM02	Lower end coniferous forest area; below several small tributaries and above any diversions
RBYM03	Above uppermost large diversion and upstream of Brandon
RBYM04	About halfway between Brandon and Sheridan
RBYM05	Above Sheridan
RBYM06	In alluvial valley between Sheridan and Middle Rd
RBYM07	100 ft upstream of Middle Road
RBYM08	At springs area- Below inflow/GW return
RBYM09	Above confluence with Ruby but above large diversion

Results of a ground water and irrigation study in the lower ruby River (Payne, 2004) indicate that natural loss to subsurface flow is a significant cause of dewatering in middle portions of Mill Creek (sites RBYM3-M6). Flows collected on April 6, when water was not taken out for irrigation, show the same trends in stream flow as on other dates when water was being diverted (Figure 6-2). The amount of stream water lost to ground water in the middle reaches of Mill Creek compared to irrigation use during the summer is only generally understood at this point, and could be the topic of further investigation.

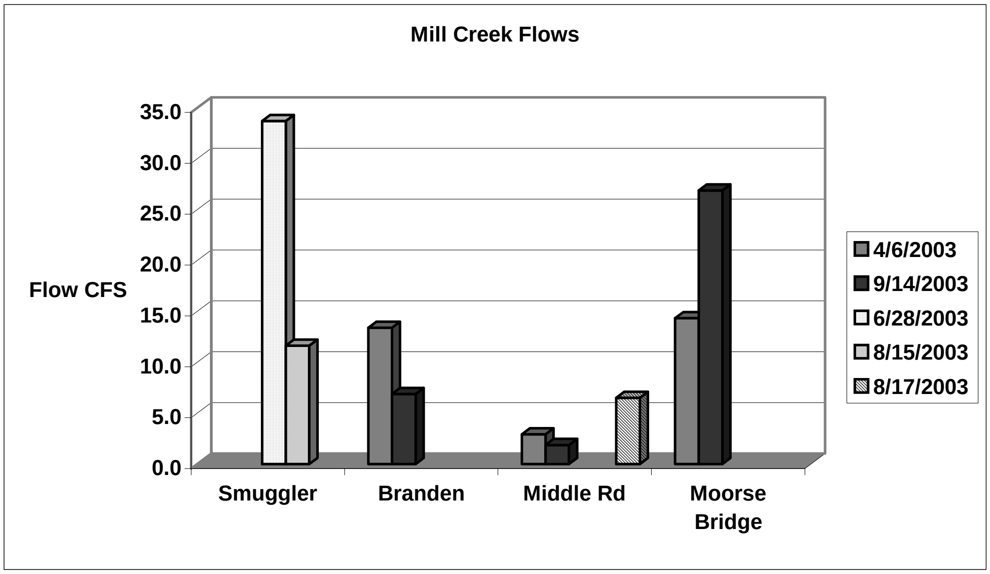

Figure 6-2. Trends in Stream Flow for Mill Creek. Left to Right is Upstream to Downstream (Adapted from Payne, 2004). Data are From the 2003 TMDL Monitoring (6/2003 and 8/2003) and Payne (2004) (4/2003 and 9/2003).

Water withdrawals reduce the temperature buffering capacity of the stream. Irrigation diversions were noted in all aerial photo interpretation reaches on Mill Creek in the Pediment and Alluvial Valley management areas, below monitoring site RBYM02 (Figure 6-1). A large irrigation withdrawal above Brandon, above site RBYM03, is one likely cause of the large drop in stream flow from Smuggler mine to Brandon. A large diversion takes approximately 80% of the flow out of Mill Creek below the lowest monitoring site RBYM09 before it reaches the Ruby River. Many smaller diversions are present but not discussed in detail in this discussion. Points of diversion and ditches are mapped in Appendix A – Map 12.

Irrigation returns are a discrete source of warm water entering Mill Creek. The Thompson Ditch and the Bullerdick-Hyndman-Moulton Ditch cross Mill Creek above Middle Road, between monitoring locations RBYM06 and RBYM07 (Figure 6-1). Although these sources were not directly measured, they likely contribute warm water during certain timeframes when ditch water is let into Mill Creek. The SNEMP modeling indicates that these sources are warm water influences to Mill Creek. A small amount of warm water entering the stream in this area can impact stream temperature because this reach is severely dewatered. Water is contributed to lower Mill Creek via an irrigation ditch originating from the Ruby River between monitoring locations RBYM08 and RBYM09 (Figure 6-1). Most of this water is diverted out again just upstream of the confluence with the Ruby River.

SNTEMP modeling simulated temperature according to a scenario that assumed a 43% increase to instream stream flow due to a 15% increase in irrigation efficiency based on reasonable irrigation water management restoration practices (Appendix C). In this scenario, ground water recharge to the stream was decreased the same percentage as water savings within the irrigation system based on the estimated premise that less ground water would enter the stream if irrigation efficiency is improved. In the case of Mill Creek, the simulated reduction in cold ground water inputs negated the effect of retaining irrigation water savings in the stream and resulted in estimated temperature increases below site RBYM-3 with a maximum of 1.4ºF temperature increase at site RBYM-8.

Leasing irrigation water savings from reasonable irrigation water management practices to instream uses would increase the temperature buffering capacity in Mill Creek, but the currently inefficient irrigation system provides cool thermal inertia associated with more ground water influence. The SNTEMP modeling indicates that irrigation efficiencies and associated water savings applied to Mill Creek will increase stream temperatures because there would be less ground water input due to a more efficient irrigation system. Further downstream, the temperature buffering from the higher flows eventually would overpower the loss of cool ground water and would produce a cooling effect to the downstream river network.

Because of the downstream thermal affects and the increased habitat potential associated more water in Mill Creek, reasonable irrigation water management savings and water leasing activities will be incorporated into the restoration approach for Mill Creek. Although important in overall restoration of beneficial uses, reasonable irrigation water management savings and water leasing activities are not part of Mill Creek's temperature TMDL allocation process at this time because modeling indicated that they would not likely reduce temperatures in Mill Creek. Allocations for downstream water bodies may call for thermal allocations associated with irrigation water management activities from the Mill Creek watershed in the future.

The modeling did not fully address another irrigation management scenario that is considered a reasonable irrigation water conservation practice. Modeling indicated that reducing the influence of warm surface irrigation water return flow to the stream would likely reduce instream temperatures. This modeling scenario could not flawlessly be completed because of the resolution of monitoring that the current TMDL budget allowed. The modeling indicated a couple potentially significant warm water influences that will be identified in the allocation process. Warm water, surface return flow from irrigation practices will be identified in Mill Creek's thermal allocation.

Another water management scenario, which was not considered by modeling, is leasing water for instream use that would otherwise be used for agriculture. This situation, although possible, is not considered a reasonable land use practice from the perspective of TMDL development because it would implies taking irrigated land out of production to satisfy the water quality standards for temperature. Montana's water quality law specifically prohibits the water quality laws to divest, impair or diminish water rights.

6.2.1.2.2 Channel Widening

Three reaches on Mill Creek, two in the alluvial valley, and one in the Tobacco Root landscape were nearly double the width/depth ratio expected for their corresponding stream types, but most reaches were not over widened. A preliminary modeling sensitivity analysis indicated that channel widening did not significantly affect stream temperatures, therefore no calibrated modeling scenarios considered this influence. Although channel widths do not appear to be a significant influence to temperature, there is already a mechanism in this document that addresses this influence. Width to depth ratio is used as a target in the Mill Creek sediment TMDL.

6.2.1.2.3 Shade Provided by Riparian Vegetation

Canopy density and riparian canopy type were used to estimate effective shading by the SNTEMP model. Reference conditions for canopy density were broken out by landscape, which included consideration of dominant riparian vegetation representing different offset and canopy height. Canopy density is a practical way to monitor riparian vegetation canopy and can be used as an interim measure for monitoring, but estimating effective shade using a solar pathfinder should be included in during future monitoring for stream shading.

Several reaches in the alluvial valley and pediment management areas have moderate riparian clearing. Stream canopy densities at two sites in the alluvial valley landscape of Mill Creek were lower than the target value for the same landscape. Two sites in the pediment/foothills landscape also had low canopy density compared to reference areas. Timber harvest in the headwaters has not reduced canopy cover along Mill Creek. Very minor reductions in canopy cover in the Tobacco Root landscape are mostly due to road crossings or road segments built within 50 ft of the stream, but most road influences are well north of the stream channel and do not reduce effective shading in this landscape enough to influence temperature, at least according to the SNTEMP modeling.

Causes of reduced riparian canopy along Mill Creek are primarily agricultural, and are mostly the result of long-term grazing impacts by livestock. An estimated 20% of canopy cover reduction on Mill Creek is due to non-agricultural causes. Non agricultural impacts to shade are mostly composed of riparian clearing from channel armoring and landscaping in and near the Town of Sheridan but also include small areas of canopy reduction due to road construction and past mining.

SNTEMP modeling included a shading scenario, where target levels of shading were assumed along all of Mill Creek to determine the effect of increased shade on stream temperature. Increasing shade to reference conditions alone, without increases in flow, predicted a temperature reduction of 0.76ºF in reach M8, the most downstream reach. This result indicates that Montana's water quality temperature standards for situations naturally above 66ºF are likely exceeded (<0.5ºF increase) in Mill Creek. In all other reaches the temperature is likely not influenced a great deal by human caused stream canopy alterations. Increases in temperature at site RBYM-8 are a culmination of all shade influences upstream. Improving riparian shade along Mill Creek is a relatively easy and cost effective restoration approach compared to other temperature influencing factors. Improving riparian shade through riparian management will be addressed in the temperature allocation approach.

6.2.1.2.4 Source Assessment Summary

The cumulative impacts of shade reduction due to agricultural and urban activities in the watershed increase water temperature above the standard in the lower most reach of Mill Creek. Modeling efforts indicate that warm water irrigation return flows increase water temperatures in the mid and lower reaches of Mill Creek. Increasing irrigation efficiencies in the watershed will likely warm Mill Creek, but would cool downstream water bodies. The results of the source assessment indicate that a temperature TMDL is needed for Mill Creek.

6.2.2 Mill Creek Temperature TMDL and Allocations

A TMDL is the sum of waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources (Equation 6-1). In addition, the TMDL includes a margin of safety (MOS) that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving stream.

Equation 6-1. $$TMDL = \Sigma WLA + \Sigma LA + MOS.$$

Total maximum daily loads are based on the loading of a pollutant to a water body. Federal Codes indicate that for each thermally listed water body the total maximum daily thermal load cannot be exceeded in order to assure protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife. Such estimates shall take into account the water temperatures, flow rates, seasonal variations, existing sources of heat input, and the dissipative capacity of the identified waters. Under the current regulatory framework for development of TMDLs, flexibility is allowed for specifying allocations since *"TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure."* This TMDL does use other measures to fulfill requirements of Section 303(d) of the Clean Water Act. Although a loading capacity for heat can be estimated [e.g. BTU/ft2 per day], it is of limited value in guiding management activities needed to solve identified temperature problems. Development of surrogate allocations and an implicit margin of safety following U.S. EPA guidance (U.S. EPA, 1999) is appropriate in this case because a loading based approach would not provide additional utility and the intent of the TMDL process is achieved by using other appropriate measures.

Development of an average daily thermal load using British thermal units or calories is of little to no use for achieving Montana's temperature standards in the Ruby Watershed. Although this type of analysis could be constructed, it is meaningless to stakeholders and technical assessors. If a number of point sources had a large influence on temperatures in a watershed, an average daily thermal load may be of use, but heat sources in the Ruby watershed are dominated by diffuse nonpoint sources. Also a consideration in the Ruby watershed are water diversions that reduce the assimilative capacity of the stream, the alternative temperature TMDL using a surrogate approach assesses an allocation to increasing assimilative capacity. Integrating an allocation to increased assimilative capacity into an average daily thermal loading approach would prove difficult.

Modeling results provided much of the technical framework for developing a surrogate-based temperature TMDL and allocation. Influences to instream temperatures are not always intuitive at a watershed scale and the modeling helped estimate the relative effects that stream shading, channel geometry and stream flow have on temperature during the hottest time of year. Field assessment data and best professional judgment from a team of professionals are also incorporated into the temperature allocation process because there are inherent uncertainties and assumptions associated with modeling results.

The temperature TMDL is the thermal loading reduction necessary to obtain compliance with Montana's temperature water quality standards. The applicable standard for Mill Creek is <0.5ºF during timeframes that are naturally above 66ºF. There are no permitted point sources on Mill Creek, therefore thermal loading reduction is related to increased shade along the stream corridor and reduction in thermal loading associated with warmed irrigation water entering the stream. The allocations for thermal load reduction will be expressed as surrogate measurements. The surrogates for thermal load are:

- The percent change in effective shade that will achieve reference potential, applied to the sources that are currently limiting shade.
- A reduction in warmed irrigation water entering Mill Creek.

Development of a temperature TMDL and allocations for Mill Creek identify human activities that influence the surrogate temperature factors. The allocations indicate the relative change needed for each temperature influencing factor that, in combination, will likely achieve Montana's temperature standards (Table 6-2). This approach allows for prioritization of restoration activities for meeting water quality standards through an adaptive approach informed by long-term monitoring. Information presented in Table 6-2 allows for a surrogate based allocation strategy. The allocations may be refined or modified with additional data collected through an adaptive management approach (Section 11.0).

The surrogate allocation to canopy density is justified by meeting reference conditions identified for each landscape type the stream flows through. The allocation for reducing warm irrigation water entering Mill Creek is assessed using BPJ on the amount of irrigation water that can be controlled by irrigation water management BMPs during application on fields, on irrigation ditch stream crossings, or the use of Mill Creek to move irrigation water. The irrigation related allocation may need adjustment when more information is gathered about specific irrigation influences.

Table 6-2. Temperature Allocations for Mill Creek.

Temperature Surrogates	Area/ Landscape	Allocation	Human Influences	Linkage to instream temperatures
Instream Flow (Surrogate)	Mill Creek Watershed	**65% reduction of warm irrigation water entering Mill Creek**	Agricultural irrigation practices	Reduction in thermal load
Canopy Density (Surrogate)	Forested Headwaters (Sites RBY1-RBY3)	**No change needed.**		
	Pediment/Foothills (RBYM4-RBYM6)	**Increase average canopy density by 7.6 %**	Riparian grazing Urban activities Crop encroachment	Reduction in thermal load
	Alluvial Valley (RBYM7-RBYM9)	**Increase average canopy density by 22.9 %**	Riparian grazing Crop encroachment	Reduction in thermal load

6.2.3 Seasonality and Margin of Safety

All TMDL/Water Quality Restoration Planning documents must consider the seasonal variability, or seasonality, on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and load allocations. TMDL development must also incorporate a margin 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 describes in detail considerations of seasonality and a margin of safety in the Mill Creek watershed temperature TMDL development process.

6.2.3.1 Seasonality

Seasonality addresses the need to ensure year round beneficial use support. The TMDL should include a discussion of how seasonality was considered for assessing loading conditions and for developing restoration targets, TMDLs, and allocation schemes, and/or the pollutant controls. Seasonality is addressed in this TMDL document as follows:

- Temperature conditions were monitored by data logging devices during a range of seasons over a number of years.
- Temperature modeling simulated heat of the summer conditions when instream temperatures are most stressful to the fishery.
- Temperature targets apply year round but are most applicable to summer conditions.
- Restoration approaches will help to stabilize stream temperatures year round.

6.2.3.2 Margin of Safety

The margin of safety may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (U.S. EPA, 1999). The margin of safety is addressed in several ways as part of this document:

- Targets provide guidance on both temperature conditions in relation to state temperature standards and to surrogate measures that will influence temperatures.
- Sources that affect assimilative capacity were assessed.
- Compliance with targets and refinement of load allocations are all based on an adaptive management approach that relies on future monitoring and assessment for updating planning and implementation efforts.

6.2.4 Restoration Schedule

Restoration recommendations focus on increasing riparian shade. Significant time is needed for riparian vegetation re-growth. Different riparian vegetation communities will take different amounts of time to grow after riparian BMPs have emplaced. Load reductions derived from grazing management may take decades to fully respond because of vegetation growth timeframes. Irrigation water management restoration activities would include reducing irrigation water entering the stream from ditch/stream crossings, runoff from fields, and from the use of Mill Creek to transport irrigation water. See Section 10.0 of this document for a more detailed restoration approach.

6.2.5 Monitoring Recommendations and Adaptive Management Plan

Additional monitoring is required to better delineate both surface and ground water irrigation return flow impacts. This information would be used to support allocation of loads, and for restoration planning. In addition, environmental monitoring will be required to assess the effectiveness of future restoration actions and attainment of restoration targets. Implementation monitoring to assess progress toward meeting restoration targets is required by the TMDL rules (75-5-703(7) & (9)), and is also an integral component of the implicit margin of safety incorporated in the metals TMDLs developed in this restoration plan. Effectiveness monitoring must have a long-term focus to track BMP implementation and to track water quality and stream condition over time. Recommended monitoring includes monitoring temperature and flow at a number of sites along Mill Creek using data logging devices and assessing water use in the watershed at a finer scale than previous study afforded. Further monitoring recommendations are described in Section 11.0.

6.3 Ruby River Below Ruby Reservoir

6.3.1 Source Assessment

Potential human influenced thermal sources on the lower Ruby River include irrigation activities, potential return flows from created ponds, and channel widening due to past vegetation removal. The following sections review each of these sources to evaluate their affects to temperature in the lower Ruby River.

6.3.1.1 Review of General Temperature and Flow Conditions in the Lower Ruby River

The lower Ruby River is dewatered in some reaches but is recharged by ground water in many other areas (Figure 6-3). Data from April 2003 indicate losing areas are at Coy Brown Bridge and at Harrington and Wheatly Bridge. Flow is recharged at Wheatly Bridge later in the year due to irrigation return flows through shallow ground water.

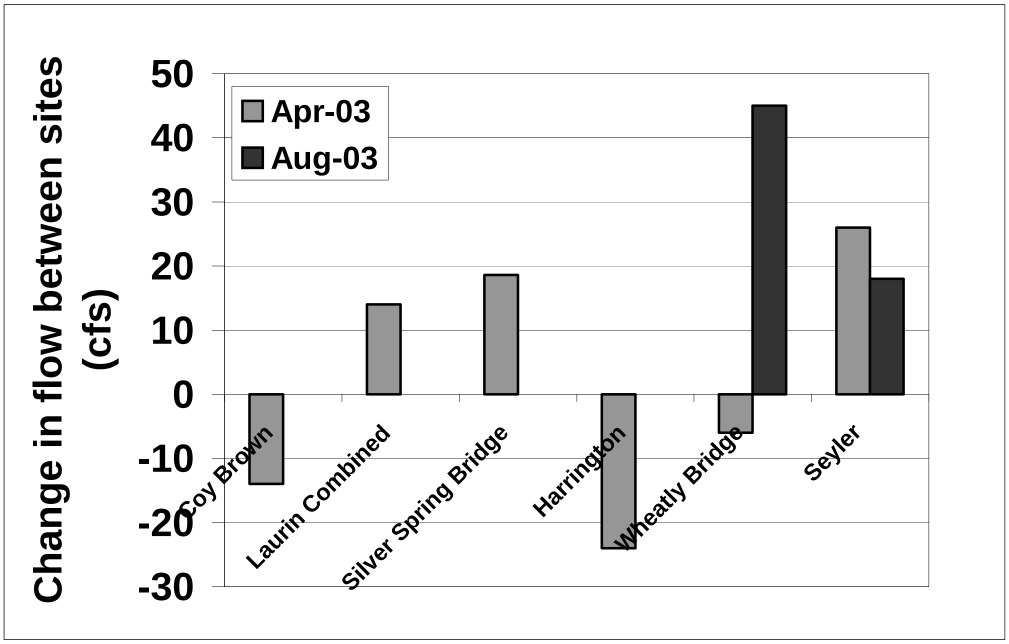

Figure 6-3. Water Gains and Losses in the Lower Ruby River (Payne, 2004).

Water temperature generally increases in a downstream direction except near the confluence with Alder Creek (Figure 6-4). Water temperature is lowest near Alder, where subsurface water from the Alder Creek drainage likely contributes a sufficient amount of cold water to the river to reduce the temperature locally (Payne, 2004). A steady increase in temperature is seen from Alder down to the mouth. Forward Looking Infrared Flight (FLIR) results also indicate the same spatial temperature trends as Payne, 2004 and identify specific areas of cool ground water influence along the Ruby River corridor (Appendix G).

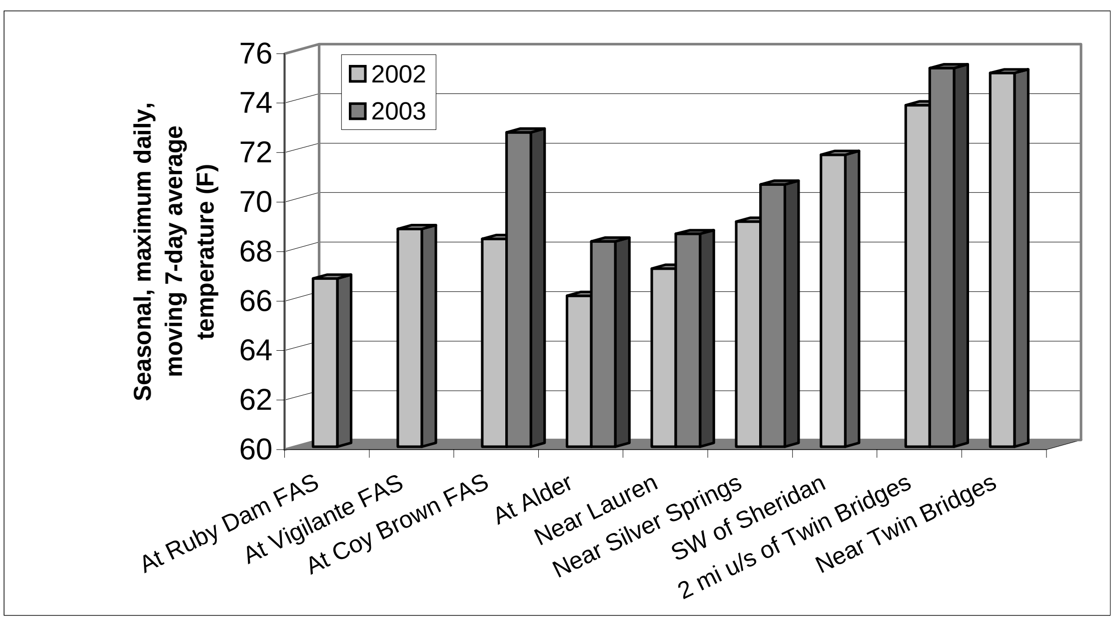

Figure 6-4. Water Temperature Trends on the Lower Ruby River (2002-2003 Summer Data).

6.3.1.2 Tributary and Surface Water Irrigation Returns

FLIR analysis revealed that most tributaries and surface water irrigation returns to the Ruby River were generally colder than the River (Appendix G). Two notable exceptions are Mill Creek and Ramshorn Creek, both of which are primarily irrigation return water above their confluence with the Ruby. Ground water inflow from natural and irrigation influences also likely affect ditch return water and tributary temperatures. Many of the fields next to the Ruby River are sub-irrigated by ground water. Some of the irrigation returns identified in the FLIR are actually spring seeps in sub-irrigated fields that are not easily discerned from ditches.

6.3.1.3 Created Ponds and Wetlands

Off-stream wetlands and shallow ponds have been created throughout the floodplain in the lower Ruby valley. These ponds have been created for habitat enhancement and aesthetic purposes. While these ponds are likely to provide ecological benefits for migratory waterfowl and other wildlife, they may be contributing to warming of the lower Ruby River. FLIR analysis revealed warmer temperatures in several impoundments and filled oxbows bordering the Ruby. FLIR analysis measures surface temperature, and in still, poorly-mixed water the surface temperature may not be representative of the whole pond. Water stored on the floodplain in oxbows was generally warmer than the Ruby River, but over half the impoundments mapped were cooler than the Ruby. Some of the ponds appear to stratify and some do not. Connectivity of these side features varies, but they may have an influence on stream temperature. Discrete warming influences of oxbows and ponds are not evident based on the FLIR flight data, but they may contribute to warming trends due to a warming influence on shallow ground water that could not be detected by FLIR analysis. These man made reservoirs cannot be ruled out as an indirect source but are not directly contributing warm surface water. Created ponds and impounded oxbows will not be considered in the allocation process because they do not appear to directly affect the temperature of the lower Ruby River using existing data.

6.3.1.4 Flow Alterations

6.3.1.4.1 Reservoir Operations

Outflow from the Ruby Reservoir is bottom-drawn, and therefore is contributing relatively cold water to the river downstream of the dam. Agreements to keep a minimum reservoir pool resulted from a drawdown and associated fish kill during 1994. Since that time, temperature of released water when the reservoir is drawn down near the minimum pool agreement is protective of the fishery in the lower Ruby River. Temperature data from 2002 indicate stream temperature is generally lower just below the reservoir than above it. Table 6-3 shows temperature data collected from directly above and below the reservoir. Because of the these reasons, operation of the Ruby Dam is not considered in a source assessment, although dam releases would need to be coordinated with downstream improvements in irrigation efficiency to achieve flow targets.

Table 6-3. Seven-Day Maximum Daily Average and Seasonal Maximum Temperatures Above and Below Ruby Reservoir, 2002.

Station Location	Warmest 7-Day Moving Average, Daily Maximum Temperature (ºF)	Seasonal Maximum Temperature (ºF)
Above Ruby Reservoir	73.6	76.8
Below Ruby Dam	66.8	67.2

6.3.1.4.2 Irrigation Water Use

SNTEMP modeling and associated monitoring data collected during 2004 was used to predict changes in stream temperature based on an estimated increase of instream flow due to increased irrigation efficiency. This scenario consisted of modeling temperature during the hottest summer timeframe and applying a 15% irrigation system water savings to instream flows during the summer months for the two largest irrigation diversions. A corresponding 15% percent decrease in ground water return flow was simulated at the same time to reflect less ground water recharge due to more efficient irrigation. Results indicate that increasing irrigation efficiency in the Ruby Valley will increase stream temperatures in the upper portion of the lower Ruby River but reduce temperatures in the lower half of the segment. The warming effect in the upper portion of this river segment is about the same magnitude as the cooling effect in the lower half of the segment (Figure 6-4, Appendix G). Added benefits to this scenario are reduced temperatures in the Jefferson River and additional fish habitat because of higher water levels. Details of methods used for the SNTEMP modeling and model results are included in Appendix C. Because of benefits to the lower Ruby River and the Jefferson River that out weigh increases in temperature around town of Alder in the Ruby River, increasing irrigation efficiency will be identified as an allocation strategy that will increase stream buffering capacity.

The investigators understand that a 37% increase in instream flow would only be feasible through securing instream water rights or water leasing for instream use, in addition to improvements in irrigation efficiency. Voluntary landowner, ditch company, DNRC and FWP participation is necessary to obtain this goal. There is no regulatory authority to implement this objective.

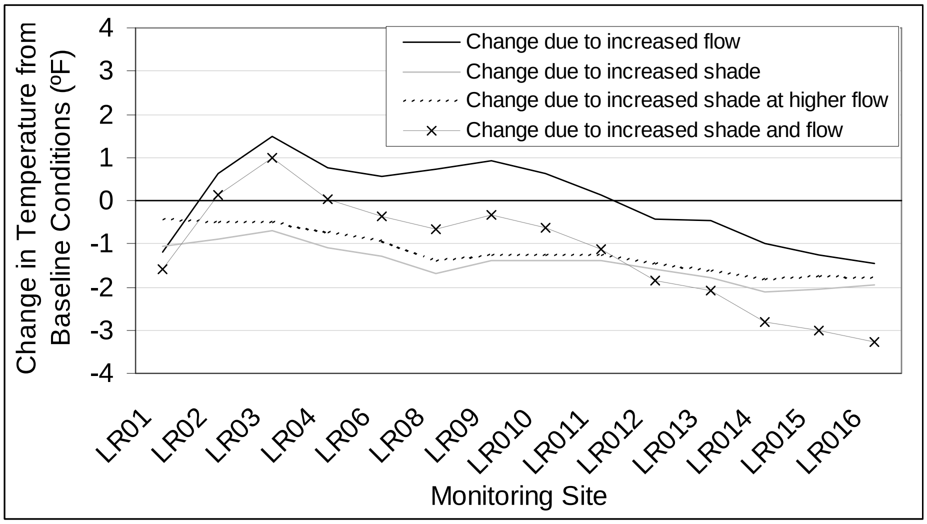

Figure 6-5. SNTEMP Modeling Scenario Results.

6.3.1.4.3 Channel Widening

Alteration of the channel morphology due to flow modification, channel alterations, and vegetation removal was identified on a number of reaches (see Section 7.0). The primary type of departure in channel morphology on reaches on the lower Ruby River is width/depth ratio, indicating the lower Ruby River is over widened in several areas. Current riparian management in most areas of the Lower Ruby does not appear to be contributing to channel widening. In fact, streambanks appear to be recovering on many reaches, although canopy cover is still low. Channel widening is more likely a product of flow manipulation and past vegetation clearing, natural causes and past channel manipulation. Flooding in 1984 heavily scoured the channel, potentially contributing to the greater width/depth ratio and scouring vegetation from the riverbanks. Floods of this magnitude are damaging partially because of prior alterations to the system that have resulted in high banks not adequately armored with woody vegetation and an incised channel not permitting higher flows to escape onto the floodplain to the extent seen in the past. A preliminary modeling sensitivity analysis indicated that channel widening did not significantly affect stream temperatures, therefore no calibrated modeling scenarios considered this influence. Although channel widths do not appear to be a significant influence to temperature, there is already a mechanism in this document that addresses this influence. Width to depth ratio is used as a target in the lower Ruby River sediment TMDL in a way that could slightly favor lower temperatures.

6.3.1.4.4 Riparian Vegetation and Channel Alteration

On the lower Ruby River, riparian vegetation degradation is associated primarily with past land clearing activities, current grazing impacts and flow modification. Each of these sources will be described in the following section.

Reservoir operations and irrigation diversions can lower water tables and change natural flooding patterns essential for riparian overstory species recruitment. The reservoir installation likely has an affect on cottonwood regeneration. Cottonwood trees depend on floods to rework and expose soils were seedlings then begin to grow. Currently, only a few areas of decadent cottonwood stands are present adjacent to the lower Ruby River. The TMDL and allocation does not consider reverting back to a historic pre dam cottonwood canopy cover. This should not preclude restoration approaches that could include planting and protecting areas of cottonwood trees or even potentially consider flooding flows from the Ruby Dam as a restoration strategy.

A reduction in streamside vegetation on the Ruby River has resulted in a reduction in the canopy, or surface shading. The reduction in shading allows the stream channels to absorb additional solar radiation that would have been intercepted by vegetation, which results in elevated water temperatures. Also, near-stream vegetation will evapotransporate water that cools the immediate environment.

SNTEMP modeling was conducted for Ruby River below Ruby Reservoir in 2005 to determine if stream temperature could be reduced in response to increased stream shading and increases in instream flow due to improved irrigation efficiency. Modeling an increase in stream shading to reference levels resulted in a predicted average decrease in stream temperature of 1.5ºF and a maximum decrease of 2.1ºF (Figure 6-4). This result indicates that reduced riparian shading creates temperature conditions in excess of Montana’s water temperature standard for the Ruby River.

6.3.1.4.5 Sheridan WWTP

The Sheridan WWTP effluent drains into Indian Creek, a tributary to the Ruby River. Although no temperature data exists for the Sheridan WWTP, a relative worst-case scenario assessment was conducted. The effluent temperature during hot summer afternoons would likely reach 85-88ºF, which is slightly lower than ambient air temperatures during hot summer afternoons. The effluent draws from the surface of a lagoon. This estimate is based on MDEQ permitting and compliance and TMDL project manager BPJ. The average effluent rate during July-September is 0.29 cfs with a maximum rate of 0.36 cfs. For the worst-case scenario, the estimations of influence from this source will use the upper flow and temperature values provided above. The 7-day average maximum daily temperature at a monitoring site on the Ruby River downstream of the Indian Creek confluence was 75ºF. Modeling estimates this temperature and flow could be about 3 degrees cooler and 42 cfs higher than current conditions in this area of the Ruby River if irrigation efficiencies and riparian management were to occur. Equation 6-2 is a heat mixing balance calculation used to determine the influence of the Sheridan WWTP to Ruby River temperatures at both existing conditions and estimated conditions after nonpoint sources are remedied (Theurer et al., 1984). Results of the analysis indicate that for the current condition and a scenario where nonpoint sources are addressed by restoration practices, Sheridan contributes thermal loading during worst-case conditions that would increase temperatures in the Ruby River a little over $1/10^{th}$ of a degree Fahrenheit.

Equation 6-2. $Tj = (T_b*Q_b+T_tQ_t)/(Q_b+Q_t)$

Where:
T_j = water temperature below junction
T_b=water temperature above junction on the mainstem
T_t=water temperature above junction on the tributary (or effluent)
Q_b=discharge above junction on the mainstem
Q_t=discharge above junction on the tributary (or effluent)

Existing Condition Scenario: ((88*0.37)+(75*39.63))/ (39.63+0.37) = 75.12ºF
Nonpoint sources remediation Scenario: ((88*0.37)+(72*81.71))/ (81.71+0.37)= 72.14ºF

The analysis above assumes a direct flow path from the effluent to the stream network and ultimately to the Ruby River. If all irrigation diversions are shut, this situation could occur, but the situation is unlikely. It is likely that the water from the effluent is inadvertently used for irrigation during most timeframes of the summer before it reaches Indian Creek, but no investigation as to the timing of irrigation use has been conducted. Also, irrigation diversions occur on Indian Creek and therefore at least a portion of the effluent is likely not directly flowing via the stream network to the Ruby River in the heat of the summer. Sheridan WWTP has a very minor heating impact to the Ruby River.

6.3.1.4.6 Natural Sources

There are no known geothermal inputs increasing the water temperature of the lower Ruby River or Mill Creek. Beaver activity is currently limited on both of these streams. Some active dams were observed in 2003 at the confluence of Mill Creek and just above the highway crossing at Sheridan. Water temperature naturally increases with a drop in elevation and associated warmer air temperatures, therefore some increase from upstream to downstream sites is expected.

Water temperature of the lower Ruby River does not increase steadily from upstream to downstream due to a drop in elevation. Temperature is plotted in relation to stream elevation in Figure 6-5. This chart reflects the cooler temperatures in mid-reaches of the lower Ruby River near Alder, likely due to larger ground water input in this area that are composed of both natural and irrigation derived water.

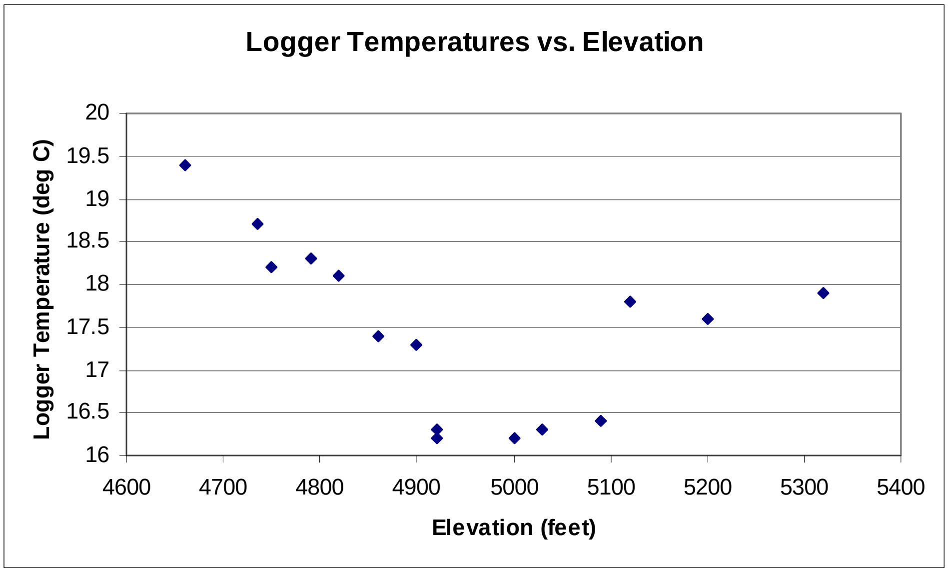

Figure 6-6. Temperature vs. Elevation on the Lower Ruby River (2004 Data).

6.3.2 Lower Ruby River Temperature TMDL and Allocations

A TMDL is the sum of waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources (Equation 6-1). In addition, the TMDL includes a margin of safety (MOS) that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving stream.

Total maximum daily loads are based on the loading of a pollutant to a water body. Federal Codes indicate that for each thermally listed water body each State shall estimate the total maximum daily thermal load, which cannot be exceeded in order to assure protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife. Such estimates shall take into account the water temperatures, flow rates, seasonal variations, existing sources of heat input, and the dissipative capacity of the identified waters. Under the current regulatory framework for development of TMDLs, flexibility is allowed for specifying allocations in that *"TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure."* This TMDL does use other measures to fulfill requirements of Section 303(d). Although a loading capacity for heat can be estimated [e.g. BTU/ft_2 per day], it is of limited value in guiding management activities needed to solve identified temperature problems. Development of surrogate allocations and implicit margin of safety following U.S. EPA guidance (U.S. EPA, 1999) is appropriate in this case because a loading based approach would not provide additional utility and the intent of the TMDL process is achieved via alternative methods.

Development of an average daily thermal load using British thermal units or calories is of little to no use for achieving Montana's temperature standards in the Ruby Watershed. Although this type of analysis could be constructed, it is meaningless to watershed stakeholders and technical advisors. If a number of point sources had a large influence on temperatures in a watershed, an average daily thermal load may be of use, but heat sources in the Ruby watershed are dominated by diffuse nonpoint sources. Also a consideration in the ruby watershed are water diversions that reduce the streams assimilative capacity, the alternative temperature TMDL using a surrogate approach assesses an allocation to increasing assimilative capacity. Integrating an allocation to increased assimilative capacity into an average daily thermal loading approach would prove difficult.

Modeling results provided much of the technical framework for developing a surrogate-based temperature TMDL and allocation. Influences to instream temperatures are not always intuitive at a watershed scale and the modeling helped estimate the relative effects that stream shading, channel geometry and stream flow have on temperature during the hottest time of year. Applicable sediment source assessment information and best professional judgment from a team of professionals are also incorporated into the temperature allocation process because there are inherent uncertainties and assumptions associated with modeling results.

The temperature TMDL is the thermal loading reduction necessary to obtain compliance with Montana's temperature water quality standards. The thermal loading reduction is related to increased shade along the stream corridor and the reduction in thermal loading associated with warm water irrigation return flows. The allocations for thermal load reduction will be expressed as surrogate measurements. The surrogates for thermal load will be:

- The percent change in effective shade that will achieve reference potential, applied to the sources that are currently limiting shade.
- A reduction in warmed irrigation water entering the Ruby River and tributaries.
- An increase in summer time stream flow due to irrigation water management restoration activities, water leasing program, and varying Ruby Dam operations.

Development of a temperature TMDL and allocations for Ruby River identifies human activities that influence the surrogate temperature factors. The allocations indicate the relative change needed for each temperature influencing factor that, in combination, are likely to achieve Montana's temperature standards (Table 6-4). This approach allows for prioritization of restoration activities for meeting water quality standards through an adaptive approach informed by long-term monitoring. Information presented in Table 6-4 provides a useful set of allocations. These may be refined or modified with additional data through an adaptive management approach (Section 11.0).

The surrogate allocation to canopy density is justified by meeting riparian vegetation reference conditions based on monitored sites along the Ruby River that were managed well under agricultural land use conditions. The allocation for reducing warm irrigation water entering Mill Creek is assessed using BPJ on the amount of irrigation water that can be controlled by irrigation water management BMPs during application on fields, on irrigation ditch stream crossings, or the use of Mill Creek to move irrigation water. The warm irrigation return flow allocation may need adjustment when more information is gathered about specific irrigation influences. The allocation to increase assimilative capacity is based on an annual irrigation water savings estimates provided in Payne, 2004 and other regional irrigation studies applied to instream water use via water leasing during a six-month timeframe. Ruby River reservoir operations would need to be coordinated with this effort to release water during the appropriate timeframes for instream use. Before any restoration efforts for increasing irrigation efficiency are started, a more detailed assessment of their affects to specific surface water recharge should be conducted to avert a situation where the irrigation efficiency efforts may reduce flow in important fishery spawning areas.

Table 6-4. Temperature Allocations for the Lower Ruby River.

Temperature Surrogates	Area/ Landscape	Allocation	Human Influences	Linkage to Instream Temperatures
Instream Flow (Surrogate)	Ruby River Watershed below Ruby Reservoir	**Reduce average daily warm irrigation water entering the Ruby River and its tributaries by 65%**	Agricultural irrigation practices	Reduction in thermal load
		Increase summer time daily instream flow by 37%	Agricultural irrigation practices	Increase in assimilative capacity
Canopy Density (Surrogate)	Ruby Main Stem	**Increase average stream bank canopy density by 130%**	Riparian grazing Crop encroachment	Reduction in thermal load
Sheridan WWTP	Indian Creek (Tributary)	**Do not exceed 0.7 cfs at an estimated daily maximum of 88 ºF any given day from July – September. (do not exceed 2219248 kcal/hr above 32 ºF)**	Lagoon treatment system	Limit thermal loading

6.3.3 Seasonality and Margin of Safety

All TMDL/Water Quality Restoration Planning documents must consider the seasonal variability, or seasonality, on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and load allocations. TMDL development must also incorporate a margin 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 describes in detail considerations of seasonality and a margin of safety in the Ruby River watershed temperature TMDL development process.

6.3.3.1 Seasonality

Seasonality addresses the need to ensure year round beneficial use support. The TMDL should include a discussion of how seasonality was considered for assessing loading conditions and for developing restoration targets, TMDLs, and allocation schemes, and/or the pollutant controls. Seasonality is addressed in this TMDL document as follows:

- Temperature conditions were monitored by data logging devices during a range of seasons over a number of years.
- Temperature modeling simulated heat of the summer conditions when instream temperatures are most stressful to the fishery.
- Temperature standards were assessed during heat of the summer conditions.

- Restoration approaches will help to stabilize stream temperatures year round. The restoration approaches that reduce stream temperature in the summer will avoid excessive cooling and anchor ice during the winter.

6.3.3.2 Margin of Safety

The margin of safety may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (U.S. EPA, 1999). The margin of safety is addressed in several ways as part of this document:

- Targets provide guidance on both temperature conditions in relation to state temperature standards and to surrogate measures that will influence temperatures.
- Sources that affect assimilative capacity were assessed.
- Compliance with targets and refinement of load allocations are all based on an adaptive management approach that relies on future monitoring and assessment for updating planning and implementation efforts.

6.3.4 Restoration Schedule

There are three major temperature influencing factors that affect the Ruby River; stream shade, instream flow conditions, and ground and surface water influences. MDEQ understands that in specific areas and timeframes, inefficient irrigation contributes to cooling of the Ruby River. Alternatively, irrigation efficiency and water leasing would increase stream flow and provide a thermal buffering capacity in the stream. The balance between these two mitigating factors should be considered during irrigation efficiency project installation. The document indicates that site specific ground water modeling should be considered before irrigation efficiency BMPs are installed. The State of Montana, along with U.S. EPA, funded a ground water modeling effort sponsored by the Ruby Valley Conservation District that should address this need. Cooperative management will be a critical component for attaining irrigation efficiency and leasing water savings to instream use on the lower Ruby River. Restoration recommendations include maintaining existing partnerships and establishing new partnerships with landowners to build on current voluntary flow protection efforts. Projects aimed at improving irrigation efficiency and leasing saved water should be completed as part of a long-term irrigation management plan for the lower Ruby and its major tributaries.

Source assessment efforts for irrigation efficiency included mostly the large irrigation diversions along the Ruby River because the associated ditch networks and irrigated areas compose most of the irrigation water transport and use in the Ruby Valley. These areas should be the priority for restoration work that relates to irrigation efficiency, but other areas should not be precluded from restoration work. Although most of the tributaries were not assessed by the temperature source assessment due to budget and time constraints, irrigation management on tributaries will be an important component of temperature restoration of the lower Ruby River. For example, Wisconsin and Indian Creeks are severely dewatered and have dry channels over part of their length during certain times of the year. Indian Creek is dewatered year-round in some areas. Mill Creek is also dewatered, and most of the ground water returning to the channel is taken out before it reaches the Ruby River. Restoring stream flow and streamside shade in these lower tributaries is a secondary priority for addressing thermal impairment on the Ruby River, but could be viewed as a priority from the perspective of improving aquatic life and fishery conditions in the tributaries.

Restoration recommendations also focus on increasing riparian shade. Significant time is needed for riparian vegetation re-growth. Different riparian vegetation communities will take different amounts of time to grow after riparian BMPs have practiced or installed. Load reductions derived from grazing management may take a decades to fully respond. See Section 10.0 of this document for a more detailed restoration approach.

6.3.5 Monitoring Recommendations and Adaptive Management Plan

Additional monitoring is required to better delineate both surface and ground water irrigation return flow impacts. This information would be used to support allocation of loads, and for restoration planning. In addition, environmental monitoring will be required to assess the effectiveness of future restoration actions and attainment of restoration targets. Implementation monitoring to assess progress toward meeting restoration targets is required by the TMDL rules (75-5-703(7) & (9)), and is also an integral component of the implicit margin of safety incorporated in the metals TMDLs developed in this restoration plan. Effectiveness monitoring must have a long-term focus to track BMP implementation and to track water quality and stream condition over time. Recommended monitoring includes monitoring temperature and flow at a number of sites along Ruby River using data logging devices and assessing water use in the watershed at a finer scale than previous study afforded. Assessment of the fate of the Sheridan WWTP water along with effluent temperatures is also needed. Before any restoration efforts for increasing irrigation efficiency are started, a more detailed assessment of their affects to specific surface water recharge should be conducted to avert a situation where the efforts may reduce flow in important spawning areas. Further monitoring recommendations are described in Section 11.0.

SECTION 7.0
SEDIMENT

This section provides:

1. A description of the methodologies used to assess sediment sources in the Ruby River watershed.
2. A summary of the results of the sediment source assessment for all sediment-listed streams.
3. TMDLs for all of the sediment-listed streams in the Ruby River watershed.
4. TMDL allocations and margin of safety for all of the sediment-listed streams in the Ruby River watershed.

The term sediment is used in this document to refer collectively to several closely-related pollutants, including siltation, suspended solids and sediment sources such as streambank erosion and riparian degradation that appear on Montana's 303(d) lists. The sediment TMDLs presented in this section are intended to address the sediment related 303(d) listings.

Streams within the Ruby River watershed in need of a sediment TMDL, and therefore discussed in Section 7.0, include:

- Alder Creek
- Basin Creek
- Burnt Creek
- California Creek
- Coal Creek
- Cottonwood Creek
- Currant Creek
- East Fork Ruby River
- Garden Creek
- Indian Creek
- Middle Fork Ruby River
- Mill Creek
- Mormon Creek
- Poison Creek
- Ramshorn Creek
- Ruby River below reservoir
- Ruby River above reservoir
- Shovel Creek
- Sweetwater Creek
- West Fork Ruby River
- Warm Springs Creek
- Wisconsin Creek

Several water bodies were included on the 1996 303(d) List for habitat alterations or sediment-related causes but were removed for the 2002/2004 303(d) List after further monitoring and assessment. Delisted streams include Harris Creek, Hawkeye Creek, North Fork Greenhorn Creek, and Mill Gulch. After further data evaluation MDEQ determined no TMDL is needed for any of these streams, with the exception of Current Creek. A TMDL will be provided for Current Creek because newer and more robust data indicating impairment was used when compared to data used for the 2004 303(d) List.

7.1 Sediment Source Characterization Methods

Sediment source characterization builds on the impairment determination provided in Section 5.0 and involves review of sediment source categories (Table 7-1). A review of the assessments used to estimate sediment loads are described in Sections 7.1.1 through 7.1.5. Data collection and analysis methods for these assessments are described in Appendix E. These assessments include:

- Upland Sediment modeling using a Universal Soil Loss Equation (USLE) and Automated Geospatial Watershed Assessment (AGWA) based models.
- Estimated sediment yield from road-related sources.
- Estimated sediment yield from human-caused and natural near-stream sediment sources.
- Point source loading.

Table 7-1. Source Assessment Method Summary.

Potential Sediment Source	Source Assessment Methodology
Point Sources	POTW Load estimates based on effluent data. Storm water load estimates based on basic USLE modeling.
Natural Background	USLE-3D Model and near-stream sediment source inventory
Mass Wasting	The stochastic nature of landslides is difficult to fully assess. Cut toe slopes of landslides are assessed as eroding banks at in the Near-stream Sediment Source Inventory. Sediment production from bare ground produced by landslides is considered by the upland sediment modeling. Categorized as part of natural loading for this watershed because there was no linkage of landslides to human caused activities.
Road-Related Sources	Washington Road Sediment Assessment Method (modified) and Near-stream Sediment Source Inventory (private road crossings).
Channel Manipulation	Included in Near-stream Sediment Source Inventory.
Mining, Past Vegetation Clearing, Other Past Influences	Included in Near-stream Sediment Source Inventory. These categories are separated further when necessary using BPJ.
Grazing	Riparian grazing sources are included in Near-stream Sediment Source Inventory. Upland grazing sources were assessed using USLE-3D model.

7.1.1 Modeled Upland Erosion

The USLE sediment modeling provided estimated annual loads from upland erosion for existing conditions and an improved management scenario. The USLE results are useful for source assessment as well as determining allocations for human-caused upland erosion. Field assessment data organized by reach with related photographs provide additional detail for determining upland sediment sources directly adjacent to riparian areas. The AGWA modeling estimated sediment erosion potential during storm events and provided a preliminary source assessment used to support some of the allocation approaches. Each of the source assessments is described in slightly more detail below.

A version of the USLE model was used within a GIS framework. The model used components of the Universal Soil Loss Equation with the landscape analysis capabilities of GIS to estimate upland erosion. Detailed methods and results for this modeling effort are included in Appendix H. Model output includes maps illustrating relative runoff potential, annual sediment yield by listed watershed, annual sediment yields for each land type, and annual sediment yields for a grazing management scenario.

USLE-3D modeling included consideration of grazing effects on uplands by estimating upland erosion under a scenario of a 10% increase in vegetation cover in grass and shrublands where grazing occurs. Field observations of ground cover in poor verses well managed pastures along with literature values of land cover values used in USLE assessments were used as justification of the 10% increase in cover for the scenario. This scenario is used to assess allocations to upland grazing practices. There have been very few areas were silviculture has occurred in the past decade, therefore silvicultural activities were not addressed in upland modeling scenarios (Appendix H).

Source characterization analysis also included modeling upland erosion potential using Automated Geospatial Watershed Assessment (AGWA) model software. Modeling predicted event-based sediment yields for current conditions, as well as predicted yields based on hypothetical scenarios related to resource management. The modeling results were used in conjunction with field assessments to help allocations related to Best Management Practice performance. Various land and water management scenarios were modeled to help determine if specific BMPs are likely to reduce sediment delivery or transport in the Ruby Watershed. Modeling scenarios focus on potential sediment source and transport reductions due to BMPs that may be implemented on roads, riparian areas and a reduction in beaver trapping activity.

Model output includes maps illustrating existing relative runoff potential, event based sediment yields for the Ruby watershed and relative sediment yields of smaller drainages within listed sub-watersheds. These results are also provided for each of the three management scenarios. AGWA modeling methods, maps and results are detailed in the summary report for AGWA modeling, included in Appendix H. The results of this analysis were not used in the source assessment because results are not reported in a comparable time scale compared to road and stream bank erosion assessments.

7.1.2 Road-Related Sediment Source Inventory

A rapid road sediment source inventory was conducted on public access roads to measure sediment sources at sites where road sediment is routed to streams. Quantitative measurement of sediment delivery from roads is extremely time consuming (MacDonald et al., 1991) and beyond the scope and budget of this assessment. Because of these constraints, a relative contribution approach was used, whereby potential sediment delivery is surveyed in the field and estimated using a number of field measurements based on a model that is calibrated from previous measurements.

Field measurements were used to provide information needed for a road erosion model (modified Washington Timber Fish and Wildlife methodology). Road-related sediment sources were documented on road segments within 100 feet of listed water bodies. Road characteristics collected in road inventories are summarized in Table 7-2.

Table 7-2. Variables Used for Estimated Sediment Yields in the Revised Road-Related Sediment Source Inventory.

Variable	Description
Road tread contributing length	Length of road draining to sediment routing site
Road tread width	Average width of contributing stretch of road
Road Gradient	Slope of the contributing road tread
Cutslope area	Area of cutslope (uphill of road) contributing to sediment source, calculated from height and length of contributing cutslope
Fillslope area	Area of fillslope (downhill of road) contributing to sediment source, calculated from height and length of contributing fillslope
Vegetation cover	Ocular estimate of vegetation cover on each surface contributing to sediment source
Road surface multiplier	Multiplier to take into consideration the relative erosion rate of different tread surfaces. Categories used in calculations are: • Dirt/Sand 100% • Gravel 60% • Paved 20%
Use level	A multiplier based on level of use on road segment. Categories include: • Heavy: Major traffic route with regular use every day • Moderate: Light use every day, but not a major traffic route • Light: Only occasional use
Background vertical erosion rate	Expected rate of vertical erosion of road tread. Based on literature values

Contributing length and width from road tread, cutslope and fillslope were measured and vegetative cover was estimated for each surface. Vegetative cover was considered in estimating overall erosion severity and a multiplier for surface treatment was used for the road tread to reflect the impact of road tread surface on erosion rate (Appendix E). Calculations also included a multiplier for use level (Table 7-2). Deriving potential volume of erosion involves estimating total area of tread, cutslope and fillslope, as well as vertical erosion rate, which can only be crudely estimated. A background erosion rate of 30 tons/acre of road surface was used to convert square footage of road surface to a relative rate. This rate was chosen based on comparison with other published rates for comparable landscapes (WFPB, 1997).

Estimates of sediment routing from road-related sediment sources are based on guidelines outlined in the Washington State Watershed Analysis Manual (WFPB, 1997). The road-related sediment source inventory included assessment of actual routing sites, rather than general conditions in near-stream segments of roads. The Washington manual recommends a sediment routing rate of 10% for sediment eroded from segments that contribute sediment to a hillslope within 200 feet of the stream (WFPB, 1997). In contrast, sediment delivery from actual routing sites, which were measured in this assessment, where roads contribute directly to streams or tributaries, can be as high as 100% (WFPB, 1997). Because the field assessments and extrapolation were completed in areas where roads were usually directly contributing sediment, a moderate to high average rate of delivery (70%) is assumed in the modeling for loads at each site. Additional details about estimation of routing from roads are included in Appendix E.

7.1.3 Streambank Sediment Source Inventory

Sources of sediment delivery associated with streambanks and the immediate floodplain were documented in reaches identified from an aerial assessment. The sediment source inventory included analysis of several source types. Table 7-3 lists and provides a brief description of assessment variables. A more detailed description of methods for the near-stream sediment source inventory, along with codes for types and causes of sediment sources, are included in Appendix E.

Table7-3. Factors Assessed in Near-Stream Sediment Source Inventory.

Factor	Description/Unit
Type of sediment source	Examples: Eroding bank, Road crossing, Hoof shear, Landslide, Recreation, etc.
Cause of sediment source	Examples: Natural, Grazing, Vegetation Clearing, Mining, Historic Management Effects, Road-Related, etc.
Location of discrete source	Latitude and Longitude in decimal degrees, NAD 83.
Percent of reach affected	Percentage.
Eroding Bank Height	Average height along an eroding bank in feet.
Eroding Bank Length	Measured in feet.
Contributing length of gully or road	Measured in feet.
Width of gully or road	Measured in feet.
Vegetation cover on bank	Ocular estimate based on Daubenmire vegetation cover guidelines.
Bank material particle size	Soil texture test, ocular determination for larger size classes.
Severity of erosion and deposition	Based on guidelines included in Washington Watershed Analysis procedures, including soil deposition, soil texture, vegetation cover, etc.

Yields were calculated for entire water bodies based on the assumption that field reaches provided a representative sample of conditions within the larger reach determined by aerial photo interpretation. Aerial photo interpretation reaches were broken out for the entire water body lengths based on significant differences in channel morphology or stream condition, as described in Appendix E. Sediment source inventory results were extrapolated to similar unassessed stream segments. All yields for all causes were then summed by water body for allocation purposes. Details of near-stream sediment source data analysis are provided in Appendix E. This source assessment did not consider unlisted tributaries and thus near stream sources may be underestimated in the overall watershed source assessment comparisons. The monitoring strategy (Section 11.0) identifies an approach to estimate watershed wide bank erosion rates for future efforts.

Streambank stability was also assessed using Rosgen's Bank Erosion Hazard Index (BEHI) methodology. The BEHI methodology evaluates a streambank's inherent susceptibility to erosion. Details of the BEHI methodology are in Appendix E. BEHI provided a general indication of streambank erosion potential at a representative site within assessment reaches. It was not completed for each specific sediment source, but averaged for a stream reach scale.

7.1.4 Point Source Assessments

Suspended sediment loading from the Sheridan wastewater treatment plant was determined using monthly flow and TSS sampling results. Sediment production of storm water runoff from a permitted facility was estimated using a USLE based assessment. Two permitted industrial facilities located in the Ruby Watershed discharge to ground water or dry detention basins and do not discharge to state waters.

7.1.5 Urban Runoff Assessment

Urban runoff from the Town of Sheridan was assessed using the STEPL model. This is a basic spreadsheet loading calculator based on TSS export coefficients and land cover types. The model estimates average annual TSS loads. Aerial photos were used to assess the area of different urban land cover types found in Sheridan, which were then assessed using the STEPL model. The STEPL model provides an estimate of average annual sediment yield. Because loading from urban areas is based on storm events, acute loading may be of concern from urban sources. Pictures of runoff entering Mill Creek are also used to assess the potential short-term affects of urban runoff (Appendix F – Mill #21-24). The results of the STEPL assessment are provided in Appendix I.

7.1.6 Uncertainty and Seasonality Considerations

A degree of uncertainty is inherent in any study of watershed processes related to sediment. The approach used in this study to characterize sediment sources involves several techniques, each associated with a degree of uncertainty. It should be noted that some sediment source inventories may under- or over-estimate natural inputs due to selection of sediment source inventory reaches and the extrapolation methods used to derive water body wide sediment loading. For water bodies where this is the case, professional judgment is used to adjust the values based on modeled landscape erosion potential using the upland modeling results, landslide areas digitized in GIS from aerial photos, and streambank stability and canopy cover documented in stream assessments. For these few cases, percentages are adjusted based on similar conditions within the same landscape. Uncertainty associated with estimation of sediment loading in near-stream source inventories is assumed to be about 10-20%. Near-stream source loading includes cutslopes at the base of landslides, and therefore represents a greater proportion than is contributed only from streambank scour.

In addition to each assessment’s uncertainty are a few other considerations. The near-stream sediment source assessment is composed of estimated loads derived along the stream in need of a TMDL and is compared to an estimated, watershed-wide upland sediment load. Small tributaries were not assessed for bank erosion because of budget constraints and the relative contribution from the stream network is likely underestimated as a result. The USLE assessment predicts total sediment loads that arrive at the watershed outlet, while the streambank erosion assessment estimates the sediment yield entering the stream along its continuum. Therefore, the source assessment should not be taken as an absolutely accurate account of sediment production within each watershed but should be considered as a tool to estimate and make general comparisons of sediment loads from various sources. Sediment limitations in many streams in the Ruby

Watershed relate to a fine sediment fraction found on the stream bottom. The source assessment relates to all sized sediment but is used as an indicator of fine sediment production in many cases. Roads and uplands produce mostly fine sediment loads, while stream bank erosion can produce all sizes of sediment. This TMDL document will include a monitoring and adaptive management plan to account for uncertainties in the source assessment.

Sediment loading varies considerably with season. For example, delivery increases during spring months when snowmelt delivers sediment from upland sources and resulting higher flows scour streambanks. However, these higher flows also scour fines from streambeds and sort sediment sizes, resulting in a temporary decrease in the proportions of deposited fines in critical areas for fish spawning and insect growth. Because both fall and spring spawning salmonids reside in the Ruby River TMDL planning area, streambed conditions need to support spawning through all seasons. Therefore, sediment targets are not set for a particular season and source characterization is geared toward identifying average annual loads.

In all but one instance, the sediment conditions of concern in the Ruby Watershed are: 1) sedimentation and 2) stream channel instability that affects sediment transport. Sediment delivery to the stream network is periodic and highly dependant upon weather conditions. Increased sediment loading during runoff events from uncontrolled nonpoint sources have a slow, cumulative influence on sedimentation in fish spawning areas. Likewise, sediments will flush out of spawning areas gradually after implementation of restoration practices. The stream channel's stability is also a slowly changing, long term condition, which can affect sediment transport and instream sediment sorting. Overall sedimentation and stream channel stability conditions do not fluctuate a great extent over a year's timeframe in the Ruby Watershed unless catastrophic flooding occurs. Sediments (sand) that impact beneficial uses move through the stream network slowly and therefore an average annual timeframe for TMDLs is appropriate for in the Ruby Watershed.

Determining sediment production for a daily timeframe can be very difficult, would introduce increased uncertainty to the source assessment, and is unnecessary to reduce sediment production within a range that would support beneficial uses in the Ruby Watershed. The sediment TMDLs in this document are presented as percent reductions to average annual sediment yields. Using average annual sediment yield reductions will promote water quality target attainment and attain instream conditions that support all beneficial uses. Also, the same restoration approaches would be used in the Ruby Watershed to reduce sediment loads for any timeframe (hourly, daily, or annually).

Unlike all other assessed sources, one sediment source that may contribute to acute suspended sediment conditions that may affect aquatic life over a short timeframe was found in the Ruby Watershed. This source was urban runoff from the City of Sheridan. A daily TMDL in this case is likely too long of a time period to consider for controlling this source. The effects of this source occur at hourly timeframes during intense summer storms. Initially, city runoff was assessed using a model that estimates average annual load rates. At this assessment timescale the sources is not a significant sediment producer when compared to others, but pictures of upstream and downstream turbidity indicate that this source severely impacts water clarity. A percent reduction allocation is provided for this source even though on an annual sediment budget assessment it appears to be a minor source. A percent reduction allocation is appropriate for this source because the restoration practices that will reduce sediment loading at an acute timescale will also reduce average annual sediment production by about the same percentage. The allocation for this source considers its short timeframes for intense fine sediment production.

7.2 Sediment Source Characterization Results

This section provides a summary of all potentially significant point, nonpoint and natural sources of sediment. Water body-specific discussions including source characterization, TMDL, and allocations for each necessary TMDL are included in Section 7.3.3.

All streams have a natural sediment load that is associated with natural sources such as landslides, wildlife grazing, channel migration, flooding and natural upland erosion. Sediment production can easily be increased where humans have influence over activities that reduce vegetation or increase runoff such as grazing, roads, urban, crop production or other activities. The source assessment attempts to identify natural and human caused sediment production.

Sediment loads in the Ruby River watershed originate both from natural and human-caused sources. The near-stream, road, urban, point source and USLE-3D upland erosion sediment source assessment results are combined to estimate the proportion of natural and human-caused sediment sources (Figure 7-1). The proportion of natural vs. human-caused sediment loading does not indicate the magnitude of total sediment loading for the water body.

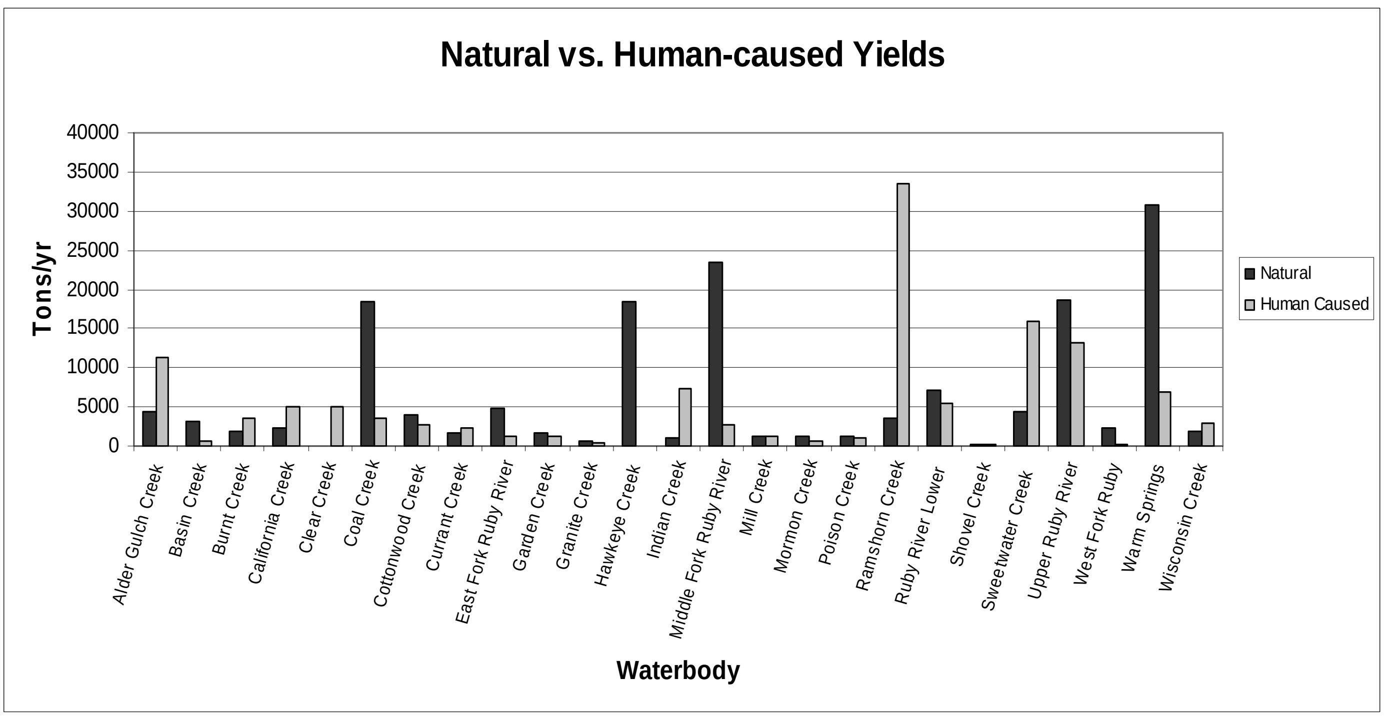

Figure 7-1. Relative Sediment Yield from Natural and Human Causes.

7.2.1. Natural Sources

7.2.1.1 Previous Sediment Studies

A number of considerations are necessary when assessing natural sediment yields in the Ruby Watershed. The lower Ruby River is prone to erosion and sedimentation from natural channel migration and is sensitive to human caused disturbance because it flows through erodible soils derived from Quaternary and Tertiary sediments (Appendix A – Map 4).

Several studies refer to the “unstable” nature of the geology and landforms that comprise the Ruby River above the Ruby reservoir and the headwaters of the Ruby River Basin (Page, 1978; Best, 1979; USDA Forest Service, 1992). Most studies identify natural, active landslides and stream erosion through landslide deposits as being a major source of sediment to the Ruby River. These studies reinforce the results shown in Figure 7-1 as it applies to most of the water bodies in the upper watershed, in which background sediment loading from natural sources accounts for a much greater proportion of the sediment yield than anthropogenic sources. In these studies natural sources are the dominant contributors of sediment in the upper watershed. Anthropogenic sources were estimated higher than background sources on two water bodies, Burnt Creek and Sweetwater Creek, in the recent TMDL assessment. These results may differ from previous studies and are due to sections on both of these streams where agricultural influences over many decades have contributed to significant changes in channel morphology and floodplain dynamics.

Most of these studies identify natural, active landslides and stream erosion through landslide deposits as being a major source of sediment to the Ruby River. The landslide deposits are most prominent on the east side of the Ruby River above the reservoir where Cretaceous black shale forms a dip-slope towards the Ruby River. When climatic conditions promote infiltration of water into the shale, shear strength is reduced and landslides occur. These deposits are frequently re-activated by stream erosion and consequently deliver large amounts of sediment to the Ruby River and its tributaries.

In addition, much of the valley is comprised of Cretaceous shale, which is highly erodible and easily compacted. Much of the correspondence contained in the Best (1979) report makes mention of the abundant sheet erosion occurring on the compacted shale during the 1940’s and 1950’s.

A few studies have attempted to calculate the amount of sediment being produced in the watershed (Page, 1978; Best, 1979; Van Mullem, 2000), although none of these studies tries to quantify the proportion of the sediment attributable to natural or human caused sources. Literature indicates that bank erosion and avulsion of the Ruby River itself is the main source of sediment in the watershed (Best, 1979). The sediment source assessment for the TMDL supports this conclusion.

Page (1978) collected and analyzed suspended sediment samples for two years (1975 and 1976) at 14 stations within the upper Ruby watershed. Page concludes that 25% of the upper basin sediment yield originates from channel erosion of the mainstem river, mainly between Vigilante Bridge and Ruby Canyon, while the upper Cottonwood Creek is the main sediment contributor of the upper Ruby tributaries (23%), followed by Warm Springs Creek (12%) and the East and West Forks of the Ruby River (11% and 12% respectively).

Page (1978) postulates that "large areas have been affected by rapid flowage and landslide type mass wasting in the past. Overgrazed headwaters at the turn of the century caused rills, gullies and a well integrated drainage net, such as in upper Cottonwood Creek." There is no mention of the potential impact of soil compaction on increases in the amount and intensity of run-off and erosion, or on the potential impacts to stream stability from increases in runoff intensity due to soil compaction.

7.2.1.2 TMDL Sediment Assessment Results

Results of AGWA and USLE-3D upland erosion modeling reveal trends in sediment yields similar to those found in Page (1978). AGWA results indicate that the listed tributary watersheds with the highest baseline sediment yield, based primarily on slope, aspect, soil erodibility, vegetation cover, and climatic conditions, are in the Gravelly range and Greenhorn range landscapes of the upper Ruby watershed. Warm Springs Creek is in the highest yield category for the watershed. Landslides are common in the Warm Springs Creek watershed and in many of the drainages in the Gravelly landscape south of Warm Springs Creek.

The USLE-3D model predicted average annual sediment yield from upland erosion. Sediment yield in individual subwatersheds varies considerably and ranges from 16 to 74 tons per square mile (Appendix H). The five highest sediment producers in the Ruby River Watershed (per unit area) as predicted by the model are: Basin Creek, East Ruby River, Robb Creek, Ruby River-06, and Peterson Creek (Appendix H - Figure 4). These are all steeply sloped rangeland watersheds located upstream of the reservoir. Sweetwater Creek is one of the largest contributing tributaries, but has a lower rate per unit area.

The upland sediment loading from natural sources was approximated in the USLE-3D model by creating a scenario of improved vegetation management (Appendix H). The modeled upland sediment load from natural sources using the USLE-3D model was added to estimated loads from natural sources identified in the near-stream inventory to determine the total natural sediment background loading. Natural sources documented in the near-stream sediment source inventory include wildlife grazing and trampling as well as beaver activity, natural stream scour, landslides, slumping, and slope failures.

Table 7-4 provides a comparison of natural loading from upland and near-stream sources for listed water bodies. Estimated USLE based upland erosion sediment yields range from 30-50 percent of the overall load depending upon the watershed. These modeling results suggest that 50-70 percent or more of the annual sediment load in the Ruby River Watershed originates from sources other than upland soils, such as landslides, bank erosion, or road sediment. The comparison of USLE-3D results with near-stream sources in Table 7-4 reveals that the contribution of near-stream sources (including road inputs) averages 80%. Natural loading is compared to human-caused sources of sediment for each necessary sediment TMDL in Section 7.3.3, Allocations.

Table 7-4. Comparison of Estimated Sediment Loading from Near-Stream and Upland Natural Sources on Listed Water Bodies.
Note: This Table has No Human Caused Sources Identified Within It.

Stream Name	Total Yield (Tons/Yr)	Yield from Natural Sources (Tons/Yr)	Near-Stream Natural Load (Tons/Yr)	Natural Load from Near-Stream Sources (%)	Modeled Natural Upland Load (Tons/Yr)	Natural Load from Upland Sources (%)
Alder Gulch Creek	15,562	4368	3397	78	971	22
California Creek	7303	2309	1946	84	362	16
Clear Creek	8470	3357	3357	100	NA	NA
Currant Creek	3954	1647	1499	91	148	9
Indian Creek	8351	971	542	56	429	44
Mill Creek	2499	1285	668	52	617	48
Ramshorn Creek*	41,103	5273	4724	90	549	10
Wisconsin Creek	4637	1809	1122	62	687	38
Lower Ruby River*	**100,522**	**24,890**	**19,541**	**79**	**5,349**	**21**
Basin Creek	3850	3228	2937	91	291	9
Burnt Creek	5485	1921	1719	89	202	11
Coal Creek	21,870	18,380	17,913	97	468	3
Cottonwood Creek	6619	3968	3578	90	389	10
East Fork Ruby River	6145	4876	4251	87	625	13
Garden Creek	2919	1761	1325	75	436	25
Middle Fork Ruby River*	54,478	46,488	45,105	97	1384	3
Mormon Creek	1939	1314	1055	80	259	20
Poison Creek	2405	1344	1176	87	168	13
Sweetwater Creek	20,253	4387	2591	59	1,796	41
Warm Springs Creek	37,627	30,816	29,735	96	1,081	4
Upper Ruby River*	**135,465**	**95,531**	**89,359**	**94**	**6172**	**6**

* Yields for Upper Ruby River, Lower Ruby River, Middle Fork Ruby River, and Ramshorn Creek include loads from mainstem segments as well as tributaries with TMDLs.

Inputs from landslides are considered a significant natural source of sediment. Landslide sources have been mapped and are estimated, but full quantification of landslide contributions is not possible in the current study and would not be practical. Landslides and landslide-prone areas visible on aerial photos were digitized into GIS (Appendix A – Map 3) to map unstable hillslopes influencing sediment loading to listed water bodies. Sediment contribution from landslide areas bordering listed water bodies was estimated during the near-stream sediment source inventory by measuring the eroding toe slopes that the streams intersect and applying estimated erosion rates. The influence of landslides on assessed stream reaches were extrapolated to overall water body segments using the aerial photo analysis of landslide prone areas. Surface erosion from large (>30 m^2) unvegetated areas caused by landslides was addressed by USLE-3D modeling, but more minor landslide-related inputs may not be considered except for estimated loading at their interface with the stream as part of the near-stream sediment source inventory. The portion of stochastic landslides that contribute sediment contribution by damming a stream and are subsequently eroded by the stream (i.e. a Quake Lake event) was not assessed by TMDL source assessment methods.

7.2.2 Montana Pollutant Discharge Elimination System Point Sources

7.2.2.1 Town of Sheridan Wastewater Treatment Plant

The town of Sheridan has a continuous discharging wastewater treatment lagoon system. Sheridan's average annual TSS load contribution was calculated using monthly TSS and discharge measurements from 1996-2005. The average TSS contribution at this source was 5.7 tons/year. The effluent drains to a small tributary of Indian Creek but is partially or totally consumed by irrigation prior to entering Indian Creek during most of the irrigation season. This waste load represents much less than one percent of the overall sediment yield assessed in the Indian Creek Watershed.

7.2.2.2 Industrial Sources

There are two industrial sites covered by MPDES permits in the Alder Creek Watershed. One discharges to ground water and the other discharges to settling ponds. These two NPDES sources are currently not discharging or contributing sediment to an impaired water body.

7.2.2.3 Storm Water Sources

Currently one active facility is permitted under the MPDES *General Permit for Storm Water Discharges Associated with Mining and with Oil and Gas Activities* in Alder Creek Watershed. This facility may discharge storm water to a tributary of Alder Creek and/or ground water. Sediment production from this facility, M & W Milling and Refining, was calculated using the Universal Soil Loss Equation (USLE). For the purposes of this calculation, the storm water produced at this site was assumed to be derived from eight acres of unpaved roads and disturbed ground due to mining or milling practices, and was assumed to discharge to surface waters.

The LS, K, and R factors from the USLE-3D watershed wide upland modeling (Appendix H) were used along with a C factor for transitional land types from the National Land Cover Data Set (NLCD) (Equation 7-1). Transitional lands are areas of sparse vegetative cover (less than 25 percent of cover) that are dynamically changing from one land cover to another, often because of land use activities. The C factor used in this assessment assumes that the site has about 20% ground cover. The USLE-based load calculation does not consider BMPs that are currently in place on this site and is used only to compare a relatively worst-case sediment load from this site to the watershed scale. Consequently, actual sediment production at this site would be lower than calculated. Because this area is very close to a tributary of Alder Creek, it is assumed that all of the sediment is delivered to the stream network, which conservatively assumes a relatively worst-case scenario for sediment production. The modeling calculation indicates that the permitted area contributes about 27 tons of sediment per year. This is approximately 2/10^{ths} of one percent of Alder Creek's total annual estimated sediment yield.

Equation 7-1. R*K*LS*C = soil loss in tons/ac/yr

Where:
R = Rainfall Erosivity Index
K = Soil Erodibility Factor
LS = Overland Flow Slope and Length
C = Land Cover Management Factor

Results: 12*0.16*11*0.22 = 3.38
3.38 tons/ac/yr * 8 acres = 27 tons/yr

Based on the fact that erosion BMPs have been either partially or wholly implemented, the actual load from this facility would be less than the 27 tons/yr, perhaps significantly less. Under full BMP implementation, this worst-case scenario load could be reduced as much as 90% (about 3 tons/yr) based on MDEQ Permit Program personnel estimates. Given the relatively low contribution of this source in relation to other sources, and the fact that there is a storm water permit for this facility, from a loading perspective it is sufficient to identify the load as being <27 tons/yr from this facility at this time.

7.2.3 Nonpoint Sources

This section includes a general discussion of sediment sources for the Ruby River watershed. This general discussion includes a summary of estimated sediment yield and percent contributions due to nonpoint sources.

7.2.3.1 Summary of Nonpoint Sediment Sources

A cursory review of land use was conducted initially to derive the categories of nonpoint source related human impact within the Ruby River. Agriculture, transportation and very limited urban development were identified. A number of individual source assessments were constructed for the identified source categories or source areas. This section assembles the results from the different assessments back into general source categories since some categories are covered by a number of the source assessments. Summaries of the major nonpoint, sediment sources are described in the sub-sections that follow.

Sediment sources related to human activities in the Ruby Watershed are related to many factors, including sediment routing from roads, direct grazing impacts such as bank trampling, indirect influences of overgrazing by livestock and wildlife such as reduction in riparian vegetation, other (mostly past) clearing of riparian vegetation for agricultural fields or landscaping, channel manipulation, flow manipulation, reduction in sediment trapping by beaver due to reductions in beaver population and habitat from natural levels, hillside erosion exacerbated by compaction and vegetation removal due to overgrazing, and channel instability due to placer mining.

Table 7-5 lists the percent of estimated sediment loading due to human causes for each listed water body. The proportion of human-caused sediment loading is further broken into proportion of the human caused yield due to separate sediment source categories. The sources of sediment are delineated into source categories that reflect past and present land management. Categorizing sediment sources in this manner facilitates allocation for water quality restoration. Channel Manipulation includes channel straightening or ditching. Sediment sources categorized as Other Human Causes include channel armoring, ditch returns, active vegetation clearing, recent mining, and crop cultivation. Past Uses includes widespread vegetation removal for agriculture or heavy overgrazing in past decades and past mining activities (primarily placer mining). Past vegetation removal related to agriculture is considered separately from recent clearing or vegetation removal from current or recent grazing. These source categories will be broken down further in each water body's individual source assessment.

Table7-5. Percent Total Yield Due to Human-Caused Nonpoint Sources and Percent of Human-Caused Yield Due to Nonpoint Sources By Category.

Stream Name	Total Yield	Total Human Caused Yield	Human Caused Yield (%)	Yield from Grazing (%)	Yield from Roads (%)	Yield from Channel Manipulation (%)	Yield from Other Human Causes (%)	Yield from Past Mining (%)	Yield from Past Veg. Clearing
Alder Gulch Creek	15562	11194	72	47	14	0	<1	34	5
California Creek	7303	4892	68	6	8	0	0	85	<1
Clear Creek	8470	5113	60	2	0	32	0	33	32
Currant Creek	3954	2307	58	66	34	0	0	0	0
Indian Creek	8351	7380	88	55	5	20	<1	20	0
Mill Creek	2499	1214	49	42	34	0	24	0	0
Ramshorn Creek*	41,103	36,840	90	48	25	2	4	21	0
Wisconsin Creek	4637	2828	61	96	2	0	2	0	0
Lower Ruby River*	**100,522**	**74,995**	**75**	**45**	**16**	**4**	**9**	**27**	**5**
Basin Creek	3850	622	16	100	0	0	0	0	0
Burnt Creek	5485	3564	65	100	0	0	0	0	0
Coal Creek	21,870	3490	16	100	0	0	0	0	0
Cottonwood Creek	6619	2651	40	69	28	3	0	0	0
East Fork Ruby R.	6145	1269	21	100	0	0	0	0	0
Garden Creek	2919	1157	40	73	27	0	0	0	0
Middle Fk Ruby R. *	54,478	7989	15	99	1	0	0	0	0
Mormon Creek	1939	624	32	100	0	0	0	0	0
Poison Creek	2405	1060	44	100	0	0	0	0	0
Sweetwater Creek	20253	15865	78	80	20	<1	<1	0	0
Warm Springs Creek	37627	6811	18	83	5	0	11	<1	0
Upper Ruby River *	**135,465**	**53,083**	**39**	**89**	**9**	**<1**	**2**	**0**	**0**

* Yields for Upper Ruby River, Lower Ruby River, Middle Fork Ruby River, and Ramshorn Creek include loads from mainstem segments as well as listed tributaries.

Sediment loads for the mainstem Ruby River include loads from assessed tributaries. This assumes that all of the estimated eroded sediment is eventually delivered from the subwatersheds. The actual time scale in which all sediment is delivered varies greatly, and may be influenced by land management, climatic conditions, beaver activity, or natural evolution of the stream channel and floodplain.

The sediment load estimate for the lower Ruby does not include any sediment loads from above the reservoir. Water bodies in the upper watershed are not considered a source for the lower Ruby because a prior study (Van Mullem, 2000) estimated that Ruby Reservoir is capturing all but about 5% of the sediment load from the upper watershed. The allocations for the water bodies above the Reservoir will address sources of sediment that pass through to the lower Ruby; therefore the estimated 5% passing through to the lower Ruby is not included in the allocation for that water body. Also, it is likely that reducing sediment loads from the upper watershed may not reduce the small amount of suspended sediment that exits the reservoir. Sediment production at the reservoir outlet may be more closely tied to shoreline, wave interaction and biological processes that occur in the reservoir near the outlet.

Load estimates do not include predicted increases in sediment loading. There may be minor increases associated with future activities, assuming 90% compliance with applicable BMP standards. Future impacts are likely to include urban growth, especially in the Mill and Indian Creek watersheds. BMPs, including maintaining appropriate riparian vegetation and appropriate road design and maintenance, should be followed to avoid excessive sediment loading associated with growth. The TMDL review process includes an adaptive approach, and can address any unforeseen new sources during the TMDL review timeframe.

7.2.3.1.1 Road-Related Sediment Delivery

Sediment delivery from roads was estimated by measuring specific features of road segments and applying a model, then extrapolating the sediment delivery rates from inventoried segments to additional segments of roads not included in the original inventory. Figure 7-2 illustrates the relative sediment yield from roads in watersheds needing TMDLs. Road-related sediment yield for the mainstem Ruby does not include contributions from tributaries in Figure 7-2 but tributaries are included in the allocation process for the main stem of the Ruby.

Inputs from private road crossings documented in the streambank sediment source inventory were added to yields derived from the inventory of road-related inputs. Loads were estimated at private road crossings by collecting the same measurements taken in the public road inventory. Methods for estimating yield from roads are included in Appendix H. Yields presented in Table 7-5 and Figure 7-2 are the sum of the public roads inventory and also inputs documented from private road crossings.

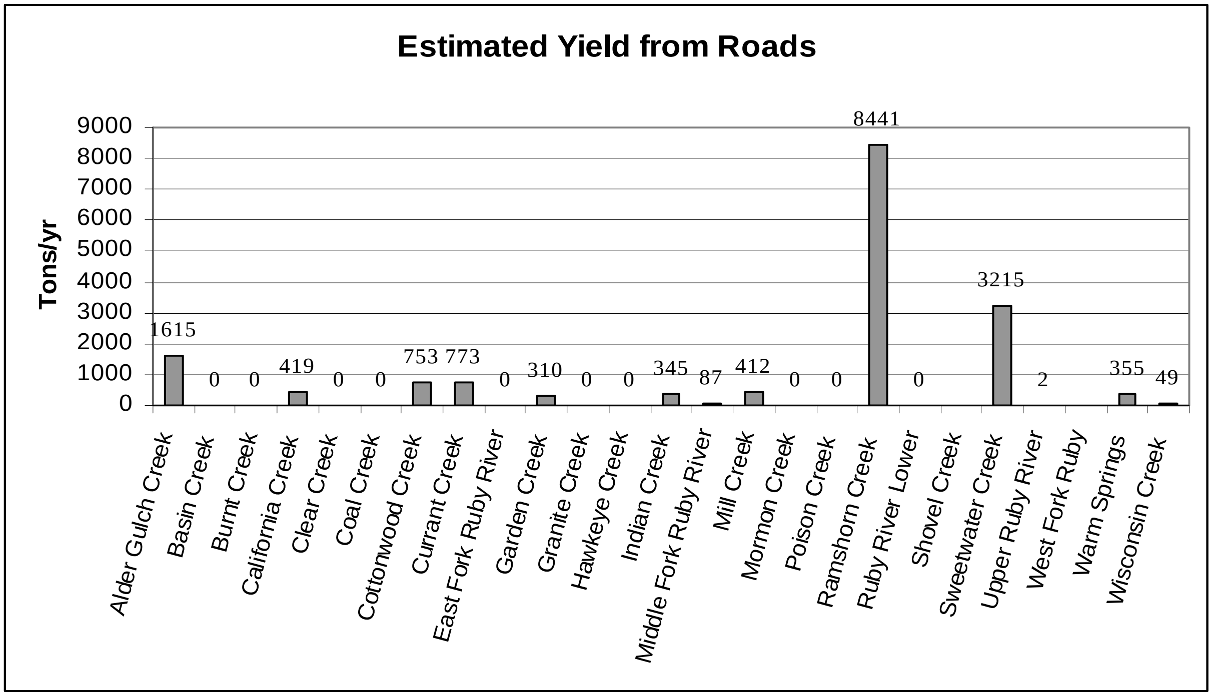

Figure 7-2. Relative Sediment Yield (Tons/Yr) Related to Roads on Listed Water Bodies.

The estimated yield from Ramshorn Creek is probably artificially high because the assessed road miles include areas directly adjacent to the stream that are graded regularly, and which contribute very high loads to the stream. The rate from this area is likely higher than that actually present on more minor roads that were not assessed, which have less traffic and less regular grading. This effect may be influencing estimated sediment yields from roads in other watersheds to a lesser extent, as roads on secondary tributaries often receive less traffic than the primary roads. However, the high sediment yield due to grading is appropriate considering grading regularly causes a large sediment input directly adjacent to Ramshorn Creek.

7.2.3.1.2 Grazing Influences

Livestock grazing contributes to sediment loading through direct inputs from bank shearing from hoof action as well as indirect inputs from vegetation removal and bank fracturing that lead to accelerated lateral erosion (Skovlin, 1984; Belsky et al., 1999). Although grazing restoration approaches for the Ruby River do not need to follow an exclusion strategy, studies have documented that grazed pastures have several times the bank erosion of ungrazed riparian pastures. For example, Kauffman et al. (1983) noted that streambank loss in grazed areas was three times that of the bank loss in areas where cattle were excluded. Magilligan and McDowell (1997) noted a decrease in bankfull width of 10 to 20% in ungrazed areas. Channel alteration resulting from overgrazing may also cause stream incisement, which decreases the ability of a stream to overflow its banks at high flow, directing scouring energy instead to streambanks. Alternately, excess sediment resulting from bank trampling may cause aggradation and may result in excessive flooding or channel braiding.

Stream incisement lowers the water table, often removing the stream from its original floodplain hydrologically. Overgrazing and lowering of the water table have reduced riparian vegetation in many areas. Removal of native floodplain vegetation over time has reduced beaver habitat, which in turn has decreased the potential for beaver pond complexes to trap sediment, mitigate scouring high flows, and elevate water tables to encourage native riparian vegetation and reconnect streams to their floodplains. Beavers can also create a natural groundwater reservoir in stream banks water storage that helps sustain late summer stream flows. Micheli and Kirchner (2002) noted increased bank instability and erosion in areas with drier floodplain vegetation compared to areas with native riparian vegetation.

Although most of the studies cited above usually compare a drastic range of conditions, grazing is not necessarily incompatible with a functioning riparian area and good stream condition. The effectiveness of implementing grazing BMPs to protect water quality and stream condition is well-documented in the scientific literature. Restoration recommendations related to grazing management are described in Section 10.0.

Many of the impacts attributed to "grazing" in the inventory are related to the indirect effects of past grazing on streambanks as a product of vegetation removal. Long-term heavy grazing can severely reduce or fully suppress riparian shrub regeneration and growth. Riparian vegetation removal is associated with stream bank erosion because a lack of vegetative root mass allows streambank erosion to increase dramatically in large flood events.

Grazing influences are often recorded as a large contribution because they include both present and past influences, and are not meant to represent only current management practices. Restoration activities designed to reduce sediment loading from current grazing practices would also address past influences from livestock and wildlife. For example, management improvements designed to allow riparian area recovery will mitigate vegetation removal from past management by allowing adequate rest for shrub regeneration.

Grazing is a major land use throughout the Ruby watershed. Grazing heavily impacts some tributaries, while others exhibit little influence from grazing. Riparian areas on much of the lower Ruby River are not currently grazed, but grazing has a large influence on riparian areas of much of the upper Ruby River. Near-stream grazing sources from Ramshorn Creek, Sweetwater Creek, and the upper Ruby River contribute over 50% of the grazing-related load (Figure 7-3). Relative loads illustrated in Figure 7-3 are not weighted by watershed size but represent the total estimated grazing-related sediment loading from near-stream sources for each listed or recently de-listed water body. The proportion of sediment loading attributed to each water body does not include loads from its listed tributaries.

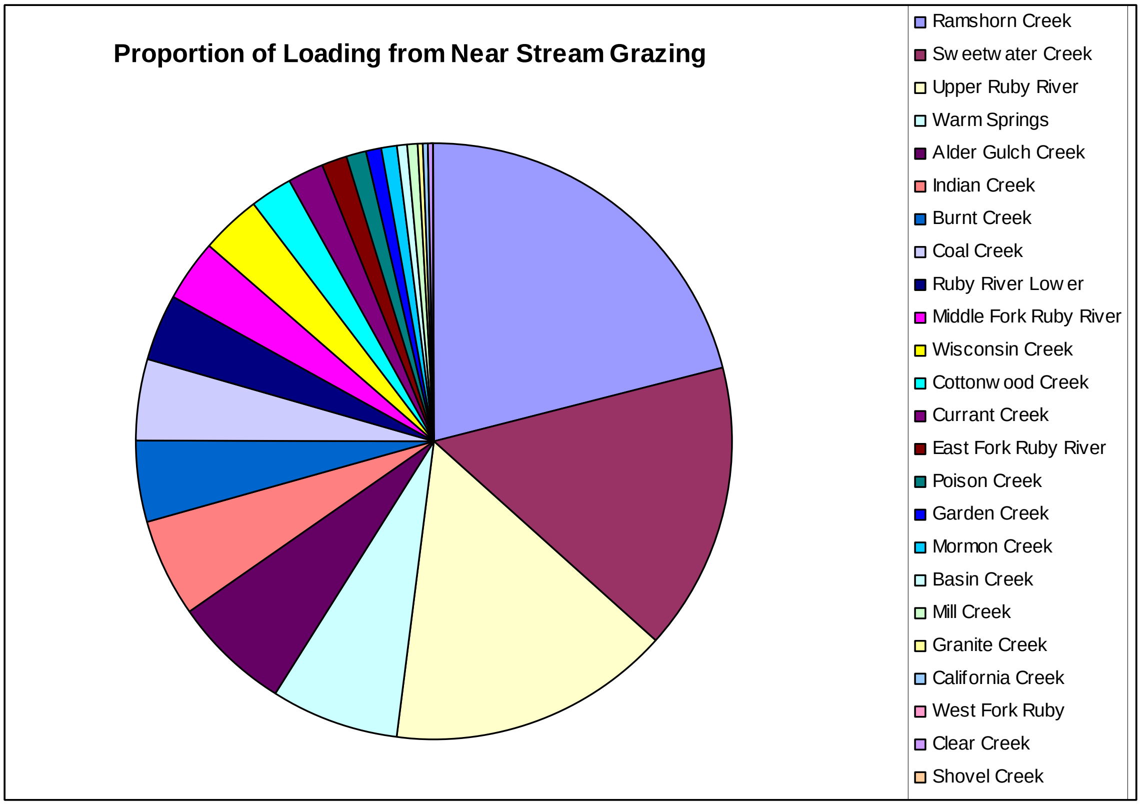

Figure 7-3. Relative Load From Near-Stream Sources Related to Grazing for Assessed Water Bodies in the Ruby River Watershed, Arranged in Decreasing Order From Top to Bottom of Legend and Clockwise On Chart.

The large sediment load estimated for Ramshorn Creek is due primarily to one reach, which has a combination of grazing-related sources, from livestock concentration along the road, bank trampling, vegetation removal, and hillslope erosion resulting from vegetation removal and trailing.

The upper and lower Ruby River were not modeled separately from tributaries in the USLE-3D modeling of upland sediment contributions assumed to be related to grazing. The upper Ruby River, Sweetwater Creek, Alder gulch, Warm Springs Creek, and Robb Creek, an unlisted tributary to the upper Ruby, were the primary contributors of sediment from upland grazing sources.

Upland erosion sediment loading from human causes is related primarily to livestock grazing as it affects vegetation cover and soil compaction. Rauzi and Hanson (1966) show in a carefully controlled study in South Dakota that water-uptake rates of soil are influenced by grazing, with a heavily grazed watershed having the lowest intake, a moderately grazed watershed intermediate uptake and a lightly grazed watershed high uptakes. Further, run-off producing precipitation events occurred most often in the heavily grazed watershed. Range conditions in the Ruby watershed during the last decade have also been influenced by persistent drought conditions. Upland erosion related to human causes was modeled using the USLE-3D. The modeled human-caused upland erosion load was added to the near-stream source yield related to grazing to derive the total estimated yield from grazing as presented in Table 7-5. Methods and assumptions for the USLE-3D model are detailed in Appendix H.

7.2.3.1.3 Channel Manipulation and Other Riparian Impacts

Channel manipulation was assessed through the near-stream sediment source assessment. The loads were assessed by estimating bank erosion due to channel manipulation.

Current and recent channel manipulation **–**Sediment sources related to channel manipulation include channel straightening and dredging, construction at diversions, and armoring in the past that has confined the stream or deflected stream energy onto another downstream bank.

Past channel straightening and rerouting **–** Channel manipulation from past activities constitutes a much greater part of this sediment source category than current activities. Lower reaches of several tributaries to the lower Ruby River have been channelized in the past. Channels have been straightened to increase hay pasture area, as an effect of road construction, at bridges, at irrigation diversions, and in placer-mined areas. Channeling causes increased sheer stress on banks and thus causes bank erosion.

Placer mining **-** Placer mining has had a dramatic effect on bank height, bank stability, and floodplain condition on many tributaries to the Ruby River, especially in the southern Tobacco Roots, but also in the Snowcrest and Gravelly ranges. Placer mining has completely destroyed the floodplain in some areas. In some areas most of the fine sediment was washed out of placer tailings a long time ago. The primary sediment source associated with placer mining is stream incisement and re-routing, causing a shift in erosional energy. The effect is mitigated to a large degree where floodplains are becoming re-established.

Urban riparian clearing - Riparian clearing and landscaping are the primary urban sources of sediment to Ruby River tributaries. Mill Creek, which flows through the town of Sheridan, is most affected by these urban influences. Most of the watershed is composed of agricultural land. Road crossings on Mill and Indian Creeks at the edge of Sheridan are potential pollutant sources. Sediment contributions from these crossings have been documented as part of the road-related sediment loading.

7.2.3.1.4 Urban Runoff

Mill Creek flows through the town of Sheridan. Both qualitative and quantitative assessments were used to determine the effects of urban runoff from the town of Sheridan. Initially pictures showed an indication that storm water runoff from the urban setting is contributing significant sediment load to Mill Creek. It is likely that this source causes exceedence of Montana's turbidity standards although no turbidity measurements are available. Because of the qualitative results, a more quantitative approach was used to estimate an average annual sediment yield from the town of Sheridan.

The STEPL 3.0 model was used to estimate sediment yield from the town of Sheridan. This is a simple model that incorporates land use measurements and export coefficients together to produce an estimated sediment yield. Aerial photos were used to estimate the extent of paved roads, unpaved roads, single family residential, multi family residential, commercial, open space and institutional areas found in Sheridan.

7.2.3.1.5 Habitat Alterations and Other Sources

These sources are generally not used for sediment load allocations but are worthy of recognition when considering water quality restoration. The following sources will be addressed in a restoration approach but usually are not considered in the sediment allocation sections unless they are very prominent component of sediment production. These sources will be addressed in the restoration section.

Beaver population – Heavy trapping of beaver in the past has probably had a dramatic effect on sediment yields in the watershed. Prior to removal of beaver, many streams in the watershed used to have series of catchments moderating flow, with smaller, un-incised, multiple channels and frequent flooding. Now many streams have an increased channel capacity, with incised, wider channels, and are no longer connected to the floodplain. This results in more bank erosion because high flows scour streambanks to a greater extent instead of flowing onto the floodplain. Parker (1986, as cited in Olson and Hubert, 1994) reported water below beaver complexes had 50 to 77 percent lower TSS than water above complexes.

The AGWA model was used to predict reductions in sediment yield due to placement of beaver complexes. One beaver pond with corresponding woody riparian and wetland communities on adjacent floodplains were simulated on Warm Springs Creek and Alder Creek. Sediment production was reduced by 3% in Warm Springs Creek from the placement of one small pond complex. Predicted sediment yield was reduced by less than 1% on Alder Creek from placement of the one instream pond. Large scale placement of multiple small ponds throughout the watershed (as generally occurs with natural beaver pond complexes) was not modeled, due to budget constraints. However, it is likely that such a scenario would reduce peak sediment discharge by a larger amount than was predicted for only one pond complex. The reduction in sediment from just one in-channel pond complex suggests that the sediment reduction due to pond complexes could be substantial over an entire watershed. Detailed methods and results for the AGWA modeling are included in Appendix H.

Field observations in 2003 also provided evidence of sediment trapping by beaver complexes. Water is noticeably less turbid flowing out of a beaver pond complex on the Middle Fork Ruby River. Beaver ponds are dynamic and can trap sediment effectively but also may release sediment if dams fail (Appendix F – MFR #2 and #3).

Channel cross-sectional area is reduced when sediment is trapped in beaver dam complexes, but channel capacity increases again when beaver dams fail and are not maintained. Maintaining enough habitat to allow beaver complexes to persist and to allow colonization of adjacent areas is important for maintaining the sediment-trapping effects of beaver dams.

Trapping of beaver and removal of riparian vegetation continue to suppress beaver populations. Most streams no longer have beaver complexes functioning to trap sediment and moderate high flows, resulting in greater sediment delivery to the Ruby River. This effect, when combined over the whole upper watershed, and to a less extent on the lower tributaries as well, would be a significant source of sediment to the Ruby River and a cause of excess fines in the lower reaches of tributaries.

Grazing by livestock, as well as by moose and elk, keep shrub cover low on floodplains in most areas on the tributaries of the upper Ruby River. Fire suppression is allowing encroachment of conifers into floodplains and is detrimental to aspen regeneration, further reducing the potential of these areas to support adequate forage for beaver.

Beaver are still trapped in the Ruby watershed. Trapping is often in response to complaints about detrimental beaver activity along the Ruby River or in lower reaches of tributaries or irrigation ditches, where they plug culverts or ditches and cut down trees that are valued for shade. Trappers still remove beaver from headwaters streams as well, for recreation and acquiring pelts. Beaver are becoming re-established in areas with adequate habitat, but much of the area that potentially could support beaver populations currently does not have adequate riparian vegetation to support beaver.

Restoration recommendations will be provided for areas of beaver reintroduction in headwaters where interaction between beavers and human activities do not severely conflict. Sediment allocations will not consider beaver activities.

Ruby Dam - Ruby dam has changed the dynamics of flow and sediment transportation on the Ruby, and therefore has had a large influence on channel morphology of the lower Ruby River. The upper Ruby often flows turbid, but the lower Ruby River generally has less turbid water because sediment settles out in the reservoir. Flow control on the lower Ruby River has changed flooding, scouring and deposition cycles beneficial for cottonwood recruitment. The lower Ruby is incised, and high flows are now less likely to escape the banks and spread over the floodplain, but rather scour the high banks common on the lower Ruby. Determining bank erosion to natural scour is problematic, because Ruby Dam was built prior to 1972 and is now being operated reasonably, and is therefore considered a naturally occurring condition by State Law. Based on this definition, changes in bank erosion due to channel incisement and alteration of the hydrograph and sediment transportation resulting from the dam are considered natural according to state law. To account for this uncertainty, determinations of natural erosion on the lower Ruby considered the condition of riparian vegetation and the presence or absence of local influences on channel morphology.

***Flow manipulation* -** Dewatering reduces the power of streams to move sediment through the system, and can result in higher sedimentation rates. Dewatering may reduce water levels during hot weather and seasonal low flow periods and thus impact riparian vegetation growth at bankfull. Impacting vegetation growth at bankfull reduces the streams natural ability to withstand sheer stress during floods. Similarly, flow manipulation may increase flows or alter natural flow patterns, increasing the eroding power and the rate of streambank erosion. Montana Fish Wildlife and Parks identify portions of the Lower Ruby River, Indian, Mill, Sweetwater, and Wisconsin Creeks as being chronically dewatered (MFWP, 1997). Current understanding of the effects of stream flow changes are not understood well enough to allocate for the effect of dewatering on sediment loads, but flow manipulation will be considered in management recommendations.

Irrigation return flows – Few irrigation surface flows return to the lower Ruby River. Other than qualitative field observations of turbid irrigation returns to the lower Ruby at the mouth of Ramshorn Creek and above Tuke Lane near Wisconsin Creek, and to Wisconsin and Indian Creeks above and below Sheridan, there is no information about suspended solids in irrigation return flows. Due to the lack of water quality information and the seemingly small sediment contribution, the current TMDL does not include numeric allocation for irrigation returns. The monitoring plan for the Ruby River TPA (Section 11.0) will include monitoring irrigation return flows and water quality.

Historic agricultural clearing **–** Most agricultural clearing was conducted on a large scale during past decades. Currently there is a trend toward increasing riparian buffers in many places, especially on the lower Ruby River. Recent clearing for agriculture, distinct from livestock grazing, is a minor sediment source in the Ruby River TPA.

7.3 Total Maximum Daily Loads

This section provides a general summary of sediment TMDLs and allocations, followed by water body-specific discussions outlining source assessment results, TMDLs and allocations. Water body-specific discussions include uncertainty and limitations of analysis for water bodies in which sediment sources.

A TMDL is the sum of waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources (Equation 7-2). In addition, the TMDL includes a margin of safety (MOS) that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving stream.

Equation 7-2. $$TMDL = \Sigma WLA + \Sigma LA + MOS$$

This definition of a TMDL reflects the initial emphasis on controlling point source pollution in the history of water quality planning under the Clean Water Act of 1972. It is relatively simple to identify point sources and allocate a waste load allocation among these discrete contributors. In contrast, identifying and allocating pollution among diffuse nonpoint sources across the landscape is problematic, making strict application of this equation difficult given spatial extent of contributing sources and budgetary constraints.

The sediment TMDL process for the Ruby River Watershed will adhere to this TMDL loading function but uses a percent reduction in loading allocated among sources and an inherent margin of safety. A percent reduction approach is used because there is uncertainty associated with the loads derived from the source assessment and using the estimated sediment loads creates a rigid perception that the loads are absolutely conclusive. A percent reduction allocation also considers the whole watershed as a source area and fits into a watershed wide water quality restoration planning approach. The percent reduction TMDL approach constructs a plan that can be more easily understood for restoration planning. The total maximum daily loads for sediment are stated as an overall percentage of the sediment load that can be achieved by sum of each individual allocation to a source. The sediment TMDLs use a percent reduction allocation strategy based on estimates of BMP performances in the watershed. Narrative performance based allocations may be used for smaller sources.

7.3.1 Margin of Safety

An implicit margin of safety (MOS) is provided by conservative assumptions for sediment loading, which are designed to ensure restoration goals will be sufficient to protect beneficial uses. An additional margin of safety is provided through an adaptive management approach that includes adjusting future targets and water quality goals based on monitoring outlined in the Monitoring Plan for the Ruby River TPA (Section 11.0). No explicit MOS is included in sediment TMDLs specified for each water body.

The margin of safety is to ensure that target reductions and allocations are sufficient to sustain conditions that will support of beneficial uses. The adaptive management process allows for continual feedback on the progress of restoration activities and status of beneficial uses. Any component can be changed to improve ways of achieving and measuring success. Furthermore, the use of multiple lines of evidence (biological and physical) allow for a more robust measure of stream conditions.

Because of the wide range of conditions present on listed water bodies and uncertainty in application of values from Forest Service reference areas to other landscapes, monitoring of instream targets should be part of the adaptive management plan to meet water quality goals. Effectiveness monitoring will include restoration progress tracking and also measuring sediment parameters to determine the effectiveness of restoration activities.

7.3.2 Sediment Load Allocations Based on Performance of BMPs

The sediment allocation strategy for the Ruby TMDL planning area depends upon estimating the performance of reasonable restoration practices to reduce sediment loads entering streams. Sediment yield from roads and grazing are the broadest based and significant sources in the Ruby Watershed that are easily addressed through changes in current management. Past uses such as mining impacts are not as easily mitigated through changes in current management, can be very costly to restore and are sometimes irreversible. Therefore, these sources will be addressed at an individual watershed scale established by a best professional judgment based cost/benefit consideration to determine if restoration is reasonable according to state law. Performance based allocations will focus on the efficiency of BMPs to prevent sediment loading from specific source categories. BMPs for roads, grazing, and other management practices are included in Section 10.0, Restoration Strategy. Allocations specific to listed water bodies are included in Section 7.3.3.

7.3.2.1 Summary of General Ruby TPA Allocations

General conservation practice performance-based load reduction allocations are summarized in Table 7-6. Allocations are based on the definition of “naturally occurring” according to Montana’s water quality standards summarized in Section 3.0, and therefore allow some loading over background levels. This approach assumes that 100% reduction in human caused sediment production is generally not feasible on a regional economic scale.

Table 7-6. Summary of Allocations by Sediment Source.

Large Sources	
Sediment yield from grazing sources	Reduce sediment delivery from grazing by 51%.
Sediment yield from road sources	Reduce sediment delivery from roads by 60%.
Sediment yield from other near-stream sediment sources	Allocations to other sources of sediment such as historic mining impacts, irrigation, vegetation clearing, and stream channelization will be addressed in water body-specific discussions. The allocation for these types of sources cannot be constant at a scale for the whole Ruby TPA.
Small Sources	
Nonpoint source urban storm water runoff	Based on development and implementation of urban storm water BMPs for the City of Sheridan.
Individual storm water point source	Based on following requirements of the MPDES storm water permit.
Future Development	90% compliance rate with applicable BMPs identified in Section 10.0.
Sheridan waste water point source	Based on following requirements of the MPDES permit.

7.3.2.1.1 Allocation to Roads

The reduction that can be achieved from mitigating road-related sources varies with landscape setting, management and road design. Generally an expected reduction comes down to a judgment call based on conditions present in a given area. Other Montana TMDL plans, including the Bitterroot headwaters, upper Blackfoot, Flathead headwaters, upper Lolo Creek, and Swan River TPAs have specified an expected reduction in sediment loading from roads ranging from 30-75%. Approaches include assigning a specific percent reduction across the whole road network or determining an average percent reduction by addressing the most critical areas. The latter approach will be taken in the Ruby River TMDL.

Of the 190 sites and reaches included in the road sediment source assessment, the 10 most severe road-related sediment sources account for 85% of the total estimated sediment load and the top 20 sites account for 91% of the total estimated load. Even after restoration these sites and reaches are likely to contribute some sediment. Mitigating problems at the worst sites is likely to result in a greater reduction in sediment loading than addressing lesser sources; therefore, it is realistic to expect a larger percent reduction at the worst sites. Reducing the sediment delivery by 75% from the worst 20 sites would result in a decrease of 68% in road-related sediment loading overall. Reducing sediment delivery by 50% from the next 20 worst sites as well, would only allow 4% additional reduction in the overall load. It is likely the sediment loading from the worst sites are overestimated to some extent. An overall reduction of 60% is set as the allocation to roads in watersheds with identified significant road sources. This value falls within the range of reductions expected from other areas of the state. The restoration strategy prioritizes specific sites for achieving an overall reduction in road-related sediment for the watershed. A margin of safety is provided by adaptive management approach that includes adjusting the reduction goal as necessary based on monitoring recommendations for the Ruby River TPA (Section 11.0). This approach to sediment allocation to roads also allows for a cost effective restoration strategy where key loading sites are addressed by BMPs.

7.3.2.1.2 Allocations to Grazing

Lowering impacts from livestock shall be achieved through implementation of grazing BMPs, and will not focus on total exclusion, except as preferred by the landowner. However, studies investigating sediment production in grazed and ungrazed pastures provide some insight toward reasonable reductions that can be expected by removing most influence of livestock on the stream.

According to a Forest Service study on South Fork of Blacktail Creek in southwest Montana (BDNF, n.d.), the presence of livestock increases the amount of sediment moved by the stream by at least an order of magnitude during years when streamflows have reached bankfull levels. During low flow years, sediment production more than doubles when livestock are present.

In other Montana TMDL plans, including those for Blackfoot/Nevada Creek, Dearborn River, and the Flathead headwaters TPA, load reduction from grazing-related near-stream sources range from approximately 25% to 100%. It is unrealistic to assume all grazing-related impacts will be mitigated in the Ruby watershed; therefore the allocation will include a percent reduction based on reducing impacts from the largest grazing-related sources.

Near-Stream Grazing

Near-stream sources comprise the majority of loading attributed to grazing. The total load attributed to grazing also includes increased erosion from uplands estimated by the USLE-3D model. Because grazing is very wide spread and pretty evenly distributed practice in the watershed a generalized allocation approach for the whole Ruby Watershed is provided.

Of the 131 inventoried sediment sources related to grazing, the 10 largest near-stream sediment sources contribute 66% of the total estimated load while the 20 worst sites contribute 83% of the total grazing-related near-stream sediment source loading. Reducing loading from the 20 next important sources by 75% would only reduce the overall near-stream sediment load by an additional 2% of the total load attributed to grazing. Assuming the monitored stream reaches represent the watershed well, restoration at the most severe sediment sources in a watershed is likely to result in a larger percent reduction in sediment than that done at smaller, more diffuse sources. For this reason the allocation is based on an expected reduction of 75% of sediment loading at the highest grazing related sediment-contributing sites. Reducing sediment loads from the largest sources by 75% would result in an overall reduction of 52% of the near-stream grazing source load or 47% of the total grazing loads that also consider upland sources. Resources should be focused on the 40 largest inventoried near-stream grazing sources, and areas comparable to these sites that were not assessed due to budget constraints, to provide the most benefit for reducing sediment inputs. The allocation to near-stream grazing related sources will be a 47% reduction in sediment loading, but addressing some smaller sources along with the large grazing sources could achieve a slightly higher reduction than the allocation provided. This allocation assumes efforts to address the largest near stream grazing sediment sources will not create higher sediment inputs from other sites. Allocations are based on the overall grazing load analysis for the Ruby watershed and is applied to all tributaries where grazing sources are significant; this makes the assumption that the analysis at a large scale represents smaller scales (tributary watersheds) within the Ruby TPA.

Upland Grazing

Upland sediment sources were estimated at 8% of the total load related to grazing, based on the scenario used in the USLE-3D model (see report in Appendix H). Reducing the upland sediment load by 50% would reduce the total estimated load attributed to grazing by another 4%.

Overall Grazing Allocation

Addressing upland sediment sources as well as the highest sediment loading near-stream sources would provide a reduction of 51% of the total load attributed to grazing. This estimate assumes management changes will allow grazing in listed watersheds with reasonable land, soil and water conservation practices in place. The overall allocation for all grazing sources (upland plus near-stream) is a 51% reduction in loads.

7.3.2.1.3 Allocation to Other Nonpoint Sources

Allocations to other sources of sediment such as historic mining impacts, irrigation, riparian vegetation clearing, landscaping, urban runoff, corrals and stream channelization will be addressed in water body-specific discussions. The allocation for these types of sources cannot be estimated at a scale for the whole Ruby TPA. Allocations to these sources will be addressed on an individual basis because the sediment reduction to restoration cost ratio can vary greatly with these sources. In some cases spending a large sum of money to reduce a small yield would be inappropriate and in other cases a simple fix may be available to reduce a large load. Sediment related to past influences, such as placer mining, the Ruby Dam, or widespread riparian clearing or channel armoring cannot always be reduced cost effectively, and will be addressed on a water body-specific basis. Other nonpoint sources such as urban runoff, corrals, landscaping, or cultivation along streambanks can be addressed with reasonable conservation practices to reduce most of the sediment load. Sources other than roads and grazing will be addressed as appropriate for each water body.

7.3.3 Water Body-Specific Discussions

The following sections provide stream-by-stream results of the sediment source assessment, as well as sediment TMDLs, allocations, and a discussion of uncertainty where applicable for each of the sediment-listed streams. The load allocations are presented as a percent reduction in sediment loads. In some circumstances a descriptive allocation approach is provided for small sediment sources.

7.3.3.1 Alder Creek

7.3.3.1.1 Sediment Source Assessment for Alder Creek

Alder Creek is currently primarily a C type stream (Rosgen 1996) with very low sinuosity and high width/depth ratio. Estimated natural background sediment yield is 4368 tons/year, or 28% of the total estimated load. Human causes account for 72% of the total estimated load, primarily from grazing, roads, and past placer mining (Table 7-5). Most of Alder Creek has been modified from an E type stream through placer mining activities. The Stream has been straightened and widened over much of its length. In some areas the channel is still unstable due to channel alterations from past mining. These areas provide the primary sediment inputs due to placer mining in the form of streambank erosion. Sediment delivered to Alder Creek from roads is concentrated mainly in the upper portions of the watershed and is caused by cut and fillslope erosion adjacent to stream crossings in this area. Overall, grazing contributes the largest estimated sediment load, due to bank trampling, crossings, and indirectly due to unstable banks or lack of riparian buffer resulting from vegetation removal by livestock.

7.3.3.1.2 Alder Creek Allocations and TMDL

The total maximum daily sediment load (TMDL) for Alder Creek is expressed as an overall 41% reduction in loads, plus the narrative waste load allocation. Sediment from natural background sources is beyond human control and is assumed to continue at rates estimated during the source assessment. The estimated existing loads and the percentage based load reduction allocations for Alder Creek are shown in Table 7-7.

Table 7-7. Sediment Allocations for Alder Creek.

Sources		Current Estimated Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Roads**	1,615	60% reduction in loading
	Grazing	5,246	51% reduction in loading
	Past Placer Mining	3,766	25% reduction in loading
	Past Vegetation Clearing for Agriculture	557	50% reduction in loading
Point Sources (WLA)	**Storm Water**	< 27	Loads will be managed by following MPDES permit requirements. No numeric % reduction allocation is assigned to this small source.
Natural Background		4,368	Not applicable
Total Load		15,580	At least a 31% reduction in loading

The grazing and road allocations follow the reductions presented in Sections 7.3.1.2 and 7.3.1.3. Sediment loads derived from eroding streambanks due to historic placer mining are allocated a 25% reduction. This allocation should be revisited after a feasibility study to determine the costs and full benefits of restoring the stream channel connectivity, reducing current sediment loads, and restoring stream channel complexity in placer mined areas. The middle and lower sections of Alder Creek are historic mining areas that show how past land use can impact natural ecosystems for generations. The only way to restore sediment loads in this area in a non-geologic timeframe will be the use of heavy machinery that can reconstruct stream connectivity, stream channel complexity and more natural floodplain characteristics. Full restoration of this source is not expected. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.2 Basin Creek

7.3.3.2.1 Sediment Source Assessment for Basin Creek

Basin Creek is primarily a steep, straight stream with low width/depth ratio and low entrenchment (Ea type). It can also be thought of as an A stream which has not downcut due to relatively young geologic age. Fine sediment production in the watershed is mainly due to high natural hillslope erosion and abundant landslide activity. Natural background erosion accounts for the majority (84%) of sediment loading, estimated at 3228 tons/year. Hillslope erosion is slightly exacerbated by grazing, through reduction in infiltration and increased surface runoff. Most of the load due to grazing is from near-stream sources, including destabilized banks. Sediment loading from erosion due to grazing is estimated at 16% of the total load, or 622 tons/year. Sediment contribution from roads is negligible.

7.3.3.2.2 Basin Creek Allocations and TMDL

The total maximum daily sediment load (TMDL) for Basin Creek is expressed as an overall 8% reduction in total sediment load. Sediment from natural background sources is beyond human control and is assumed to continue at rates estimated during the source assessment. The estimated existing loads and the percentage based load reduction allocations for Basin Creek are shown in Table 7-8. The only human influenced source identified for allocation in Basin Creek is livestock grazing (Table 7-8). There are no point sources in the Basin Creek Watershed; therefore no waste load allocation for sediment is necessary.

Table 7-8. Sediment Allocations and TMDL for Basin Creek.

Sources		Current Estimated Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	622	51% reduction in loading
Natural Background		3228	Not applicable
Total Load		3850	8% reduction in loading

Restoration should focus on continuing to improve grazing management and protecting habitat to encourage beaver repopulation to allow for recovery on this naturally high-sediment system. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.3 Burnt Creek

7.3.3.3.1 Sediment Source Assessment for Burnt Creek

Burnt Creek is primarily a steep, straight stream with low width/depth ratio and low entrenchment (Ea type). It can also be thought of as an A stream which has not downcut due to relatively young geologic age. Bank erosion is high resulting from large amounts of bank trampling and vegetation removal from overgrazing. Sediment production from overgrazed banks and upland sources is estimated at 3,564 tons/year, or 65% of the total load. Natural hillslope erosion and abundant landslide activity provide a large natural background sediment load, 1921 tons/yr (35% of the total load). Sediment production from roads is negligible.

7.3.3.3.2 Burnt Creek Allocations and TMDL

The total maximum daily load (TMDL) for Burnt Creek is expressed as an overall 33% reduction in total sediment load. Sediment from natural background sources is beyond human control and is assumed to continue at rates estimated during the source assessment. The estimated existing loads and the percentage based load reduction allocations for Burnt Creek are shown in Table 7-9. The only human influenced source identified for allocation in Basin Creek is livestock grazing (Table 7-9). There are no point sources in the Basin Creek Watershed; therefore no waste load allocation for sediment is necessary.

Table 7-9. Sediment Allocations and TMDL for Burnt Creek.

Sources		Current Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	3564	51% reduction in loading
Natural Background		1921	Not applicable
Total Load		5485	33% reduction in loading

Allocations can be achieved through implementing grazing BMPs and protecting riparian habitat. Current grazing management has helped improve conditions but further improvements are needed. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.4 California Creek

7.3.3.4.1 Sediment Source Assessment for California Creek

California Creek begins as a steep A type stream in the headwaters of the Tobacco Root Range. It changes gradually to a lower gradient B type stream with lower width/depth ratio as it flows through the pediment and finally to a C and E type stream with low sinuosity for these stream types as it flows onto the alluvial valley of the Ruby River.

Some areas of the headwaters and pediment reaches have been placer-mined in the past. Agriculture, including grazing, corrals, and irrigation, is the primary influence on lower reaches. The low sinuosity in the alluvial valley indicates channel straightening, which often leads to incisesment and in the case of California Creek has contributed to bank instability and erosion.

Natural sources of sediment contribute approximately 40% of the sediment load to California Creek. The natural background erosion rate of 2309 tons/year (Table 7-10) may reflect some channel adjustment resulting from historic channel manipulation related to placer mining. Some of the past placer impacts may be underestimated due to the difficulty in recognizing all of the effects on erosion from historic placer activity in a recovering system; however, placer mining contributes the largest sediment load for California Creek, estimated at 4151 tons/yr, or 57% of the total load. Loads from past placer mining are related to bank erosion from channel incision and adjustment. The next largest human-caused source of sediment delivery is from adjacent road cut and fillslope erosion, estimated at 419 tons/year, or 8% of the total anthropogenic load. Grazing is also a large source of sediment, contributing an estimated 6% of the total anthropogenic load. Other smaller sources of sediment are also present in the watershed and identified in Table 7-10.

Irrigation returns, partly as leakage from a canal crossing, are an obvious source of sediment to California Creek but quantifying TSS loading to streams from irrigation returns is beyond the scope of this study. Suspended sediment in irrigation returns is likely due to erosion of canal banks, assessing this source will be included in recommendations for further monitoring (Section

11.0). Further monitoring is identified to quantify contributions from irrigation returns, which may provide the information necessary to revise the sediment allocation.

7.3.3.4.2 California Creek Allocations and TMDL

The human influenced sources identified for sediment allocations in California Creek are livestock grazing, roads, past placer mining, irrigation and riparian clearing from agriculture (Table 7-10). The estimated existing loads and the percentage based load reduction allocations for California Creek are shown in Table 7-10. The sediment total maximum daily load (TMDL) for California Creek is expressed as an overall 21% reduction in total sediment load. Sediment from natural background sources is beyond human control and is assumed to continue at rates estimated during the source assessment. There are no point sources in the California Creek Watershed; therefore no waste load allocation for sediment is necessary.

Table 7-10. Sediment Allocations and TMDL for California Creek.

Sources		Current Estimated Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	318	51% reduction in loading
	Roads	419	60% reduction in loading
	Past Placer Mining	4151	25% reduction in loading
	Past Vegetation Clearing (Agriculture)	4	50% reduction in loading
Natural Background		2309	Not applicable
Total Load		7201	20% reduction in loading

Allocations to roads and grazing follow the Ruby Watershed wide approach for determining the estimated load reduction potential. The 50% load allocation reduction for riparian clearing assumes at least half the streambanks can be made stable through proper management that allows recovery of riparian vegetation. Sediment loads derived from eroding streambanks due to historic placer mining are allocated a 25% reduction. This allocation should be revisited after a feasibility study to determine the costs and full benefits of restoring eroding banks and floodplain dynamics in placer mined areas. The potential reduction from irrigation return sediment loading is dependent on the irrigation management options deemed reasonable and their influence on suspended solids. A reduction of 50% is used to remain consistent with reductions to other sources; however, the resulting allocation may be revised to reflect the maximum feasible reduction, based on future monitoring and irrigation management decisions.

Restoration should first focus on addressing road-related sources and to improve grazing management. If these two main sources cannot be reduced to a level that provides full instream use support, the other allocations will need to be called upon. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0.

7.3.3.5 Coal Creek

7.3.3.5.1 Sediment Source Assessment for Coal Creek

Coal Creek is a steep B4a type stream in the headwaters grading to a Cb to F type in lower reaches near the confluence with the Ruby River. Natural sources produce the large majority of the sediment load due to erodible soils, high cutslopes, wildlife use, and landslide activity. Grazing impacts to streambanks are noticeable in many areas but provide a low percentage of the total sediment yield (16%). Sediment contribution from roads is negligible. This system used to be highly influenced by beaver, but had no current or recent beaver activity during the assessment period in 2003. Removal of riparian habitat and indirect or direct removal of beaver is a likely source of higher sediment yield. For example, grazing on fragile depositional soil in grown-in beaver ponds can produce relatively large sediment loads attributed both to grazing and natural causes. The influence of changes in beaver populations and location of beaver colonies over time cannot be quantified and beaver influences are not included in allocations.

7.3.3.5.2 Coal Creek Allocations and TMDL

The only human influenced source identified for allocation in Coal Creek is livestock grazing (Table 7-11). There are no point sources in the Coal Creek Watershed; therefore no waste load allocation for sediment is necessary.

Table 7-11. Sediment Allocations and TMDL for Coal Creek.

Sources	Current Load (Tons/Yr)		Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	3490	51% reduction in loading
Natural Background		18,380	Not applicable
Total Load		21,870	8% reduction in loading

Allocations to grazing follow the Ruby Watershed wide approach for determining the estimated load reduction potential. The sediment TMDL is an 8% reduction in sediment loading.

Restoration should focus on continuing to improve grazing management to protect riparian habitat. One management strategy to reduce sediment yield could be to allow recovery of riparian habitat to support beaver populations in the future. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.6 Cottonwood Creek

7.3.3.6.1 Sediment Source Assessment for Cottonwood Creek

Cottonwood Creek is a steep, straight stream with low width/depth ratio and low entrenchment (Ea type). It can also be thought of as an A stream which has not downcut due to relatively young geologic age. Estimated natural erosion rate is 3968 tons/year, primarily from cutting toe slopes and natural scour of erodible soils. Estimated road related sediment delivery is 753 tons/yr, or 11% of the total load. This is the result of long contributing lengths of cut, fill and tread erosion. Grazing related impacts are estimated at 1823 tons/year (27%) and channel manipulation is minor, estimated to contribute 75 tons/year (1%). This is another system with signs of large beaver complexes that are no longer maintained. Grazing on fragile depositional soil in grown-in beaver ponds is a relatively large sediment source, attributed both to grazing and natural causes.

7.3.3.6.2 Cottonwood Creek Allocations and TMDL

Human influenced sources identified for allocation in Cottonwood Creek are livestock grazing, roads and channel manipulation (Table 7-12). There are no point sources in the Cottonwood Creek Watershed; therefore no waste load allocation for sediment is necessary.

Table 7-12. Sediment Allocations and TMDL for Cottonwood Creek.

Sources		**Current Estimated Load (Tons/Yr)**	**Sediment Load Allocations**
Anthropogenic Nonpoint Sources	**Grazing**	1823	51% reduction in loading
	Roads	753	60% reduction in loading
	Channel Manipulation	75	25% reduction in loading
Natural Background		3968	Not applicable
Total Load		6619	21% reduction in loading

Allocations to roads and grazing follow the Ruby Watershed wide approach for determining the estimated load reduction potential. Sediment loads derived from eroding streambanks due to historic channel straightening are allocated a 25% reduction. This allocation should be revisited after a feasibility study to determine the costs and full benefits of restoring the stream channel, reducing current sediment loads, and restoring the floodplain in this area. The sediment TMDL is a 21% reduction in sediment loading.

The greatest sediment load reductions will be achieved through addressing grazing and road related sources through adherence to BMPs. Re-establishing woody riparian vegetation in areas with fragile banks should be a priority. Road maintenance and runoff BMPs are likely to achieve the allocation for roads. The area where the channel was straightened would be considered the lowest priority for restoration since the sediment loads are quite small and the cost for restoration would be high. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.7 Currant Creek

7.3.3.7.1 Sediment Source Assessment for Currant Creek

Currant Creek is a steep, fairly stable, A type stream. Some areas have been destabilized by past mining and subsequent overgrazing in riparian areas. Mining impacts do not appear to contribute significant loads of sediment and are not easily addressed; therefore, sediment loads in these unstable areas are attributed to grazing. Riparian vegetation is dominated by herbaceous species in some of the sensitive meadow areas, with few decadent willows present. Steep hillslopes adjacent to the stream contribute sediment due to a combination of naturally erodible soils and vegetation removal and trampling from grazing. Natural background erosion levels (1647 tons/year) comprise 42% of the total estimated sediment load. Grazing-related sources are estimated at 1534 tons/year, or 39% of the total load. Road contribution (773 tons/year) is predominantly from stream crossings and long contributing lengths. Erodible soils and steep grade make sediment management from roads in this system a challenge.

7.3.3.7.2 Currant Creek Allocations and TMDL

Human influenced sources identified for allocation in Current Creek are livestock grazing and roads (Table 7-13). There are no point sources in the Current Creek Watershed; therefore no waste load allocation for sediment is necessary.

Table 7-13. Sediment Allocations and TMDL for Currant Creek.

Sources		Current Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	1534	51% reduction in loading
	Roads	773	60% reduction in loading
Natural Background		1647	Not applicable
Total Load		3954	32% reduction in loading

Allocations to roads and grazing follow the Ruby Watershed wide approach for determining the estimated load reduction potential. The sediment TMDL for Current Creek is a 32% reduction in sediment loading. Restoration should focus on continuing to improve grazing management and protecting riparian habitat. Addressing road-related sources is also high priority. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.8 East Fork Ruby River

7.3.3.8.1 Source Assessment for East Fork Ruby River

East Fork Ruby River is primarily a Ba and Ea type high gradient stream. There are two placer mine sites on the East Fork Ruby River (Appendix A – Map 7), but there is no information about their impact on riparian or aquatic habitat. Placer mining is not identified as a source of habitat degradation on the 303(d) list. Natural sources contribute the majority (79%) of the estimated sediment load, 87% of the natural sources were attributed to near-stream areas. Natural near-stream sources include landslides, cutting toe slopes on valley margins, and channel adjustment in meadows formed by past beaver activity. Grazing contributes the remainder of the estimated load, primarily near the confluence and in meadows with sensitive soils (Table 7-14). Loading from roads is negligible.

7.3.3.8.2 East Fork Ruby River Allocations and TMDL

The only human influenced source identified for allocation in East Fork Ruby River is livestock grazing (Table 7-14). There are no point sources in the East Fork Ruby River Watershed; therefore no waste load allocation for sediment is necessary.

Table 7-14. Sediment Allocations and TMDL for East Fork Ruby River.

Sources		**Current Estimated Load (Tons/Yr)**	**Sediment Load Allocations**
Anthropogenic Nonpoint Sources	**Grazing**	1269	51% reduction in loading
Natural Background		4876	Not applicable
Total Load		6145	11% reduction in loading

The allocation to grazing follows the Ruby Watershed wide approach for determining the estimated load reduction potential. The sediment TMDL for the East Fork Ruby River is an 11% reduction in sediment loading. Restoration should focus on continuing to improve grazing management and protecting riparian habitat. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.9 Garden Creek

7.3.3.9.1 Sediment Source Assessment for Garden Creek

Garden Creek is a steep stream with low sinuosity and variable entrenchment (Ea, A and B types). Natural sources contribute 60% of the estimated total sediment load, 75% of which is attributed to near-stream sources. Natural near-stream sources include unstable toe slopes on valley margins, wildlife use, and stream adjustment from changes in beaver activity. Road related sediment contribution is 310 tons/year, or approximately 11% of the total estimated load. Road proximity to stream and tread erosion are major factors in the sediment contributed from roads. Streambank erosion is accelerated by vegetation removal and trampling due to grazing and is estimated at 29% of the total load.

7.3.3.9.2 Garden Creek Allocations and TMDL

Human influenced sources identified for allocation in Garden Creek are livestock grazing and Roads (Table 7-15). There are no point sources in the Garden Creek Watershed; therefore no waste load allocation for sediment is necessary.

Table 7-15. Sediment Allocations and TMDL for Garden Creek.

Sources		Current Estimated Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	847	51% reduction in loading
	Roads	310	60% reduction in loading
Natural Background		1762	Not applicable
Total Load		2919	21% reduction in loading

The allocations to grazing and unpaved roads follow the Ruby Watershed wide approach for determining the estimated load reduction potential. The sediment TMDL for Garden Creek is a 21% reduction in loading. Grazing related sources are high priority for restoration activities. Restoration should focus on continuing to improve grazing management and protecting riparian habitat. Addressing road-related sources is also high priority. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.10 Indian Creek

7.3.3.10.1 Sediment Source Assessment for Indian Creek

Indian Creek begins in the headwaters of the Tobacco Root Range as a steep, straight, confined stream (A type). It changes to a B to C type stream as it flows across the pediment and fan surface until joining the Ruby River alluvial valley. Much of the flow of Indian Creek has been diverted into other channels and ditches, and there is some question as to the historic natural channel location in the pediment landscape. The downstream end of Indian Creek has been rechannelized and joins Leonard Slough at the base of Wisconsin Creek.

Natural erosion on Indian Creek only contributes about 12% of the total estimated load. Grazing related sediment contribution is nearly half of the total estimated load, at 48%. Bank erosion is accelerated due to vegetation removal related to grazing in many areas. Channel manipulation and clearing, mainly from past activities, constitute 35% of the estimated current sediment load. The continued influence of these past activities will depend on current and future efforts to protect riparian area and stream condition. Sediment contribution from roads accounts for approximately 4% of the total estimated yield, mainly from tread erosion and fillslope erosion at stream crossings. Indian Creek is completely dewatered for part of the year in some areas of lower reaches. Stream flow impacts to sediment transport and sediment contributions from irrigation returns have not been quantified, but are included in the monitoring recommendations Section (11.0). Dewatering reduces riparian vegetation cover, and therefore has an indirect influence on bank stability and erosion.

7.3.3.10.2 Indian Creek Allocations and TMDL

Human influenced sources identified for allocation in the Indian Creek Watershed are current livestock grazing, roads, past riparian vegetation removal, ditch crossings, past stream channel manipulation and the Sheridan WWTP (Table 7-16). Stream dewatering also likely has effect on sediment transport and stream energy but dewatering impacts to sediment production and delivery are not directly quantified.

Table 7-16. Sediment Allocations and TMDL for Indian Creek.

Sources		Current Estimated Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	4044	51% reduction in loading
	Roads	345	60% reduction in loading
	Channel Manipulation	1482	25% reduction in loading
	Historic Vegetation Removal	1482	25% reduction in loading
	Irrigation (Ditch Crossings)	28	50% reduction in loading
Point Sources (WLA)	**Sheridan WWTP**	6	Loads will be managed by following MPDES permit requirements. A TSS reduction feasibility study and/or pollutant trading program will be initiated if Sheridan WWTP doubles average annual TSS loads from current conditions.
Natural Background		971	Not applicable
Total Load		8358	36% reduction in loading

The sediment TMDL for Indian Creek is a 45% reduction in sediment loading. Together roads and current grazing practices contribute the highest loads, which can be reduced effectively through implementation of BMPs. The allocations to grazing and roads follow the Ruby Watershed wide approach for determining the estimated load reduction potential. Channel manipulation includes mostly past channel straightening and rerouting. Historic vegetation removal appears to be due to clearing, past overgrazing, and flow manipulation. The effects of these past sources can be mitigated in part by re-establishing riparian shrub cover through grazing and irrigation management and active planting or bioengineering treatments in select critical areas. Restoring sediment loads in this area in a non-geologic timeframe may include the use of heavy machinery to restore streambank stability, stream channel complexity and more natural floodplain characteristics. Full restoration of this source is not expected. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.11 Middle Fork Ruby River

7.3.3.11.1 Sediment Source Assessment for Middle Fork Ruby River

The middle fork of the Ruby River is a low gradient, sinuous E type stream. Contribution from natural sources constitutes 89% of the total estimated sediment load. Natural sources include landslides and slumping, upland erosion on highly erodible soils, and high cut toe slopes. Contribution from grazing related bank and upland erosion contributes the majority (97%) of the anthropogenic sediment load. Estimated sediment contribution from roads is 87 tons/year, or 3% of the anthropogenic sediment load. Road sediment delivery is mainly related to stream crossings.

7.3.3.11.2 Middle Fork Ruby River Allocations and TMDL

Human influenced sources identified for allocation in the Middle Fork Ruby River Watershed are livestock grazing and roads (Table 7-17). There are no point sources in the Middle Fork Ruby River Watershed; therefore, no waste load allocation for sediment is necessary.

Table 7-17. Sediment Allocations and TMDL for Middle Fork Ruby River.

Sources		Current Estimated Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	2730	51% reduction in loading
	Roads	87	60% reduction in loading
Natural Background		23,536	Not applicable
Total Load		26,353	5% reduction in loading

Three listed water bodies, namely Coal, Basin, and Poison Creek, flow into the Middle Fork Ruby River. Allocations for these water bodies are addressed separately in their respective water body-specific discussions.

Allocations to roads and grazing follow the Ruby Watershed wide approach for determining the estimated load reduction potential. The sediment TMDL for the Middle Fork of the Ruby River is a 5% reduction in sediment loading. Because the impairment is marginal, it is likely that the small overall load reduction can achieve support of instream beneficial uses. Restoration should focus on continuing to improve grazing management and protecting riparian habitat. Addressing road-related sources is also high priority.

Field assessments from 2003 documented a high level of beaver activity on the Middle Fork Ruby River and the ability of beaver pond complexes to reduce the turbidity of storm runoff water flowing into the ponds. Maintaining or expanding beaver populations in the upper Ruby tributaries including the Middle Fork may prove effective at drastically reducing sediment delivery to the Ruby River. Improving riparian habitat will be critical for allowing expansion of beaver in this system. More detail about management recommendations and restoration priorities for listed water bodies is included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.12 Mill Creek

7.3.3.12.1 Sediment Source Assessment for Mill Creek

Mill Creek is a stable, B type stream as it emerges from the Tobacco Root Range and flows through the pediment and fan. It becomes an E type stream as it flows onto the Ruby Valley. The lower section in the Ruby Valley has been straightened and is entrenched. Loading from natural sources constitutes just over half (51%) of the total estimated load. Natural hillslope erosion is moderate in this part of the Tobacco Root range. Loading from grazing-related sources is estimated at 21% of the total load. Grazing-related sources are present for most of the watershed, but are primarily a concern in the lower reaches. Sediment delivery from roads is estimated at 16% of the total load and is contributed primarily in reaches in the Tobacco Root Landscape. Road related sediment comes from tread and cutslope erosion at numerous stream crossings and from poor runoff management on road segments paralleling the stream.

Bank erosion related to riparian vegetation removal was documented from the Brandon area through the town of Sheridan and to the upper alluvial valley reaches. Vegetation removal contributes an estimated 11% of the total load, and is due to riparian clearing associated with riparian grazing and to landscaping in urban areas. Urban runoff at Sheridan is another urban source of sediment. Minor sources from recreation impacts are present in higher reaches on Forest Service land, but these sources contribute less than 1% of the total sediment load.

The stream is partially dewatered for irrigation use from the base of the Tobacco Root area to the Alluvial Valley. Diversions originating at Mill Creek are mapped in (Appendix A – Map 7). Dewatering of some lower reaches and loss of riparian vegetation in urbanized areas affect trout populations (MDEQ, 2003 SCD_BUD). Mill Creek is on the MFWP list of Chronically Dewatered Streams. Mill Creek has a complex network of irrigation diversions and canals. In many years Mill Creek is completely dewatered below the town of Sheridan, and the only water in the channel is added to the stream from irrigation ditches and canals below Sheridan (Hamler, pers. comm.). Quantifying the effects of dewatering and flow manipulation on sediment deposition and transport in Mill Creek is beyond the scope of this study, but is recommended for further study in the Monitoring Recommendations (Section 10.0). The complicated network of diversions and canals complicates assessment of sediment transport, but they likely affect stream energy and sediment transport.

7.3.3.12.2 Mill Creek Allocations and TMDL

Human influenced sources identified for allocation in the Mill Creek Watershed are livestock grazing, roads, urban areas and recreation (Table 7-18). There are no point sources in the Mill Creek Watershed; therefore, no waste load allocation for sediment is necessary.

Table 7-18. Sediment Allocations and TMDL for Mill Creek.

Sources		Current Estimated Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	Grazing	531	51% reduction in loading
	Roads	412	60% reduction in loading
	Riparian Vegetation Clearing (Urban and Agricultural)	265	50% reduction in loading
	Recreation	6	50% reduction in loading
	Urban Runoff	6	85% reduction in loading
Natural Background		1285	Not applicable
Total Load		2505	26% reduction in loading

Allocations to roads and grazing follow the Ruby Watershed wide approach for determining the estimated load reduction potential. The sediment TMDL for Mill Creek is a 26% reduction in sediment loading. The largest reductions in sediment production will be achieved through implementation of BMPs for roads and grazing.

An overall sediment load reduction of 11% can be achieved by addressing bank erosion due to landscaping and riparian clearing through education, riparian fencing and native revegetation efforts. A minimal reduction (<1%) can be achieved through improving stream access points at recreation sites. Urban runoff has not been quantified, but should be addressed through implementing storm water BMPs and monitoring the effectiveness of those measures.

Restoration should focus on protecting riparian habitat through grazing management and urban education programs. Addressing road-related sources is also high priority. The sediment load derived from storm water in the town of Sheridan may not be a large source on an annual basis but it is likely a significant source of suspended sediment on an acute basis and may cause turbidity standards exceedences during storms (Appendix F – Mill #21-24). Because of this situation, urban runoff is included in the allocation and should be addressed with storm water BMPs. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0, Restoration and Implementation Strategy.

There is a known potential sediment source at the Buckeye mine site near Brandon. This source was not specifically quantified in the sediment source inventory but is in the process of being restored in 2004-2005. This source is already being addressed through restoration efforts. The restoration efforts are designed to reduce contribution of metals-laden sediment from the site.

7.3.3.13 Mormon Creek

7.3.3.13.1 Sediment Source Assessment for Mormon Creek

Mormon Creek is a steep stream with low sinuosity yet low entrenchment (Ea and Eb type). Sediment loading related to grazing is estimated at 624 tons/year, or 32% of the total estimated load. The remainder of the sediment load is attributed to natural sources. Road-related sediment delivery is negligible, much less than 1%, but proper road BMPs should be followed to avoid contributions from roads.

7.3.3.13.2 Mormon Creek Allocations and TMDL

Human influenced sources identified for allocation in the Mormon Creek Watershed are livestock grazing and roads (Table 7-19). There are no point sources in the Mormon Creek Watershed; therefore, no waste load allocation for sediment is necessary.

Table 7-19. Sediment Allocations and TMDL for Mormon Creek.

Sources	Current Estimated Load (Tons/Yr)		Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	624	51% reduction in loading
Natural Background		1314	Not applicable
Total Load		1938	16% reduction in loading

The allocation to grazing follows the Ruby Watershed wide approach for determining the estimated load reduction potential. The sediment TMDL for Mormon Creek is a 16% reduction in sediment loading. Grazing related sources are high priority for restoration activities. Restoration should focus on continuing to improve grazing management and protecting riparian habitat. Addressing road-related sources is also high priority. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.14 Poison Creek

7.3.3.14.1 Sediment Source Assessment for Poison Creek

Poison Creek is a steep, straight, relatively entrenched stable stream that ranges from a Ba type down to a Cb stream. Natural sources contribute slight over half (56%) of the total estimated sediment load. The remainder is attributed to grazing effects including bank trampling and vegetation removal related to overgrazing. Some improvements due to recent management changes have been achieved, but sediment sources related to grazing are still widespread, especially in meadow areas.

7.3.3.14.2 Poison Creek Allocations and TMDL

The only human influenced source identified for allocation in the Poison Creek Watershed is livestock grazing (Table 7-20). There are no point sources in the Poison Creek Watershed; therefore, no waste load allocation for sediment is necessary.

Table 7-20. Sediment Allocations and TMDL for Poison Creek.

Sources	Current Estimated Load (Tons/Yr)		Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	1060	51% reduction in loading
Natural Background		1344	Not applicable
Total Load		2404	22% reduction in loading

The allocation to grazing follows the Ruby Watershed wide approach for determining the estimated load reduction potential. The sediment TMDL for Poison Creek is a 22% reduction in sediment loading. Restoration should focus on continuing to improve grazing management and protecting riparian habitat. More detail about management recommendations and restoration priorities for listed water bodies are included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.15 Ramshorn Creek

7.3.3.15.1 Sediment Source Assessment for Ramshorn Creek

Ramshorn Creek originates as a steep, straight, entrenched stream in the headwaters of the Tobacco Root Range. It changes to a B type stream as it flows through the pediment and fan surface. It is ditched (straightened and entrenched) in the alluvial valley of the Ruby River where it joins an irrigation ditch. Natural sediment sources contribute a relatively low percentage (10%) of the total estimated sediment load. This is due in part to the presence of a large sediment source related to road and grazing effects in the foothills.

Human-caused bank erosion is high, mainly caused by a combination of factors including bank trampling, historic placer mining, road fill, and potentially beaver removal. Grazing provides the highest anthropogenic input, estimated at 42% of the total sediment load. Road-related sources provide the next highest human-caused sediment load (22% of total load), due to close proximity of the road and stream, poor grading practices, and numerous stream crossings and long contributing lengths from cutslopes. The load caused by destabilizing of the stream due to historic placer mining is estimated at 21% of the total load. The influence of past mining is difficult to quantify and is closely tied to other sources, such as grazing and natural processes. Relatively small loads were attributed to channel manipulation (2%) and irrigation structures (4%). These sources are mostly in the lowest reach where an irrigation ditch intercepts Ramshorn Creek.

7.3.3.15.2 Ramshorn Creek Allocations and TMDL

Human influenced sources identified for allocation in the Ramshorn Creek Watershed are livestock grazing, roads, past placer mining, irrigation and past channel straightening (Table 7-21). There are no point sources in the Ramshorn Creek Watershed; therefore, no waste load allocation for sediment is necessary.

Currant Creek, also a listed water body, flows into Ramshorn Creek. Allocations for Currant Creek are addressed separately in the discussion specific to that water body. Those allocations will address Currant Creek as a source to Ramshorn Creek.

Table 7-21. Sediment Allocations and TMDL for Ramshorn Creek.

Sources		Current Estimated Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	Grazing	16,155	51% reduction in loading
	Roads	8441	60% reduction in loading
	Channel Manipulation	587	50% reduction in loading
	Past- Placer mining	8002	25% reduction in loading
	Energy Shift From Irrigation Diversions/Headgates	1348	50% reduction in loading
Natural Background		3626	Not applicable
Total Load		38,159	43% reduction in loading

The sediment TMDL for Ramshorn Creek is a 43% reduction in sediment loading. Greater reductions are expected if Ramshorn Creek Road is redesigned to separate the road and stream. The road along Ramshorn Creek just below and into public land is directly adjacent to the stream and is an area cattle tend to congregate, making the influence of both roads and grazing high in this area. Most of the expected sediment load reductions can be achieved by focusing resources on improving the road and grazing practices in two critical reaches (RAM2F and RAM5D), which include this area.

Estimated loading related to irrigation is due to bank erosion and channel adjustment caused by headgates and due to turbid water inputs to the downstream end of Ramshorn Creek. Quantifying the suspended sediment load from irrigation water was beyond the scope of this project, but is included in monitoring recommendations for Ramshorn Creek.

A relatively high load is allowed due to the large influence of past impacts, which reasonably can not all be mitigated. Some error in loading estimates is expected; therefore, the margin of safety includes adaptive management, which allows for revision of TMDLs if deemed necessary based on future monitoring. The reduction for Past and Other human causes is based on Best Professional Judgment, and considers the reduction in sediment that can be achieved through stabilizing currently unstable streambanks. The reduction from sources related to placer mining and channel manipulation should be achieved by focusing resources on stabilizing banks in critical areas. The only way to remove the majority of the anthropogenic sediment loads in this area in a non-geologic timeframe will be the use of heavy machinery that can reconstruct streambank structure, stream channel form and complexity and more natural floodplain characteristics. Full restoration of this source is not expected, as an overall channel reconstruction is neither practical nor desirable. Because of these considerations the allocation from this sediment source calls for a 25% reduction.

More detail about management recommendations and restoration priorities for listed water bodies is included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.16 Lower Ruby River

7.3.3.16.1 Source Assessment for Lower Ruby River

The Lower Ruby River is a low gradient, sinuous entrenched stream and was classified primarily as a C type channel. The potential type for this stream is considered an E in many places, due to the very high sinuosity and its history of widespread flooding prior to construction of the dam. Flow regulation and channel manipulation have changed the setting of the lower Ruby. By Montana law the dam, if operated with reasonable practices, is now considered “natural” (see Section 3.0 for further explanation) therefore the potential condition must also consider the current setting. Sediment field assessments and allocations consider the dam-controlled setting of the lower Ruby as natural, and therefore focus on issues that can be addressed with current management, even though altered conditions are noted.

Sediment contribution attributed to natural sources accounts for over half the estimated sediment load (57%). Grazing-related sources provide the majority of the anthropogenic sediment, and 27% of the total load. Channel manipulation, past vegetation removal, and channel adjustment from flow alteration and channel armoring are primarily due to past activities that have changed the character of the lower Ruby. Bank erosion due to these three sources constitutes most of the remaining anthropogenic sediment load to the lower Ruby, and 16% of the total estimated load. Other minor sources that are included in the allocations are cultivation on streambanks and recreation. Sediment contribution from roads and hillslope is low due to the position in the alluvial valley.

Parts of the lower Ruby are considered dewatered. Quantifying the influence of dewatering on sediment loads and transport is beyond the scope of this study, but is included in future monitoring recommendations.

7.3.3.16.2 Lower Ruby River Allocations and TMDL

Human influenced sources identified for allocation in the Lower Ruby River Watershed are livestock grazing, roads, past placer mining, irrigation and past channel straightening other than placer mining (Table 7-22). The sediment TMDL for the lower Ruby River is a 19% reduction in sediment loading. The town of Sheridan WWTP is located in the watershed and is addressed in Indian Creek’s TMDL and allocations.

Table 7-22. Sediment Allocations and TMDL for Lower Ruby River.

Sources	Current Estimated Load (Tons/Yr)		Sediment Load Allocations
Anthropogenic Nonpoint Sources	Grazing	3354	51% reduction in loading
	Channel Manipulation	1048	25% reduction in loading
	Past – Vegetation Removal/Clearing	662	50% reduction in loading
	Channel Adjustment From Bank Armoring, Flow Manipulation	356	25% reduction in loading
	Cultivation Along Banks	10	80% reduction in loading
	Recreation	2	50% reduction in loading
Natural Background		7165	Not applicable
Total Load		12,597	19% reduction in loading

These allocations do not include reductions for listed tributaries contributing sediment to the lower Ruby. Clear Creek is a side-channel of the lower Ruby River and is included in this section, below the allocations for the mainstem. Addressing the sediment sources on the listed tributaries and on Clear Creek will help achieve water quality goals for the lower Ruby River.

Percent reductions for sources related to past vegetation removal and channel adjustment due to armoring and flow manipulation are based on best professional judgment. An 80% reduction for cultivation along streambanks should be feasible simply by maintaining a riparian buffer along banks, but rest will not be completely effective to re-establish vegetation in some areas with high raw banks no longer connected to the floodplain. In some areas bank recontouring and planting may be necessary. Restoration efforts and agricultural BMPs should allow for a 50% reduction in streambank erosion in areas adjusting to vegetation removal. Riparian shrubs should be allowed to regenerate, or in some cases should be actively planted, on streambanks made unstable by channel armoring or channel straightening (manipulation) in other areas. Due to the complexity of the restoration needs, a 25% reduction in sediment loading is expected for these areas.

Determining the most cost-effective approach for stabilizing eroding banks will have to be conducted on a site-by-site basis, and through cooperation with the individual landowners. Access areas for recreation are likely to remain sediment sources, but can be stabilized to some extent through signing, active bank protection measures, and providing smaller, more distinct pathways. The allocation to grazing follows the Ruby Watershed wide approach for determining the estimated load reduction potential. The largest reduction in sediment will result from implementation of grazing BMPs.

More detail about management recommendations and restoration priorities for listed water bodies is included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.16.3 Clear Creek

Clear Creek is a side channel of the lower Ruby River. Although not listed separately, it is considered part of the lower Ruby River and is therefore addressed as a listed water body. Allocations for Clear Creek are listed separately because the two water bodies do not have all of the same primary sediment sources, but restoration of Clear Creek should be considered part of restoration of the lower Ruby River.

7.3.3.16.3.1 Sediment Source Assessment for Clear Creek

Clear Creek is an F type stream, an entrenched stream with high width/depth ratio. This is evidence of historic degradation and loss of floodplain function, and probably results primarily from flow and channel manipulation in the lower Ruby system. The stream has an E type potential, based on its setting and high sinuosity. Large amounts of sediment are produced through bank erosion as the reach acquires a new floodplain at a lower level. Bank erosion is accelerated by willow suppression from grazing and a lowered water table. Estimated yield due to bank erosion and incisement resulting from past effects comprises the majority of the sediment load, at 60%. Estimated sediment yield due to livestock grazing is 96 tons/year, representing only a minor proportion of the total sediment load (1%). Natural background sediment yield is estimated at approximately 40% of the total load.

7.3.3.16.3.2 Clear Creek Allocations and TMDL

Human influences identified for allocation for Clear Creek are grazing and channel adjustment from past channel and flow manipulation and riparian clearing (Table 7-23). The sediment TMDL for Clear Creek, a side channel of the Ruby River, is a 15% reduction in sediment loading. No point sources are present in this watershed; therefore, no waste load allocation for sediment is necessary.

Table 7-23. Sediment Allocations and TMDL for Clear Creek.

Sources		Current Estimated Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	Grazing	96	51% reduction in loading
	Past Channel Manipulation, Clearing, Flow Manipulation	5018	25% reduction in loading
Natural Background		3357	Not applicable
Total Load		8471	15% reduction in loading

Channel manipulation and flow alteration have affected bank erosion in Clear Creek. The expected reduction has been set at 25% as a first estimate of how much of this source can be reduced. Reductions would come from areas with altered banks where vegetation removal has accelerated erosion of high banks, often in areas with grazing influence as well. Allocation focuses on reductions that can be achieved through management of agricultural sources through implementation of BMPs. The allocation may be revised as more information is gained. More detail about management recommendations and restoration priorities for listed water bodies is included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.17 Ruby River above Ruby Reservoir

7.3.3.17.1 Sediment Source Assessment for Upper Ruby River

The Upper Ruby River is a low gradient stream, with high sinuosity and high width/depth ratio (C type). It has the potential to be an E type stream as evidenced by the very high sinuosity, the abundance of oxbows and tight old meander bends. Some reaches show high entrenchment (F type) indicating floodplain abandonment and changes in base level. This shift in channel elevation occurs mostly near the more restricted canyon area, and appears to be predominantly natural, resulting from geologic influences. Section 2.0 of this report includes a discussion of geologic influences in the upper Ruby watershed. The upper Ruby appears to be in adjustment due to geologic influences and potential influences from changes in beaver population and/or past overgrazing. Natural sediment sources contribute the majority (71%) of the total sediment load. Grazing related sources, primarily bank erosion due to vegetation removal, contribute an estimated 29% of the overall sediment load. Road related loading is minor, estimated at less than 1% of the total load. Roads have a greater influence on some listed tributaries of the upper Ruby River and over the watershed as a whole. Loads and allocations for the listed tributaries are presented in separate water body-specific discussions to focus management efforts to each tributary acting as a sediment source for the upper Ruby River.

7.3.3.17.2 Upper Ruby River Allocations and TMDL

Human influenced sources identified for allocation for the upper Ruby River are livestock grazing and roads (Table 7-24). Allocations to the identified human caused sources follow the Ruby Watershed wide allocation approach. The sediment TMDL for the upper Ruby River is a 15% reduction in sediment loading. The influences of other minor sources, such as irrigation and past channel straightening has not been quantified but are addressed in restoration approaches. There are no point sources in the upper Ruby River watershed; therefore, no waste load allocation for sediment is necessary.

Table 7-24. Sediment Allocations and TMDL for Upper Ruby River.

Sources		Current Estimated Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	13,151	51% reduction in loading
	Roads	2	60% reduction in loading
Natural Background		31,813	Not applicable
Total Load		44,966	15% reduction in loading

The sediment allocation can be achieved by implementing grazing and road BMPs. Grazing management should be designed to protect riparian and aquatic habitat. Protecting riparian vegetation is also important to reduce erosion in areas made less stable from past channel manipulation. The influence of irrigation needs to be assessed and is included in the Monitoring Plan (Section 11.0). More detail about management recommendations and restoration priorities for listed water bodies is included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.18 Shovel Creek

7.3.3.18.1 Sediment Source Assessment for Shovel Creek

Contribution from natural sources constitutes an estimated 68% of the total sediment load. Natural sources include landslides and slumping, upland erosion on highly erodible soils, and high cut toe slopes. Contribution from grazing related bank and upland erosion contributes the entire anthropogenic sediment load.

7.3.3.18.2 Shovel Creek Allocations and TMDL

Livestock grazing is the only human influenced source identified for allocation in Shovel Creek's Watershed (Table 7-25). The allocation may include sources that were derived from historic sheep grazing that have not fully healed. There are no point sources in the Shovel Creek's Watershed; therefore, no waste load allocation for sediment is necessary.

Table 7-25. Sediment Allocations and TMDL for Shovel Creek.

Sources		Current Estimated Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	141	51% reduction in loading
Natural Background		298	Not applicable
Total Load		439	16% reduction in loading

Allocations to grazing follows the Ruby Watershed wide approach for determining the estimated load reduction and may need refinement in the future according to specific study within Shovel Creek's watershed. The sediment TMDL for Shovel Creek is a 16% reduction in sediment loading. Because the impairment is marginal, it is likely that the small overall load reduction can achieve support of instream beneficial uses. Restoration should focus on continuing to improve grazing management and protecting riparian habitat.

7.3.3.19 Sweetwater Creek

7.3.3.19.1 Source Assessment for Sweetwater Creek

Sweetwater Creek is a moderately steep, straight stream in the headwaters, which changes to a low gradient stream in the lower part of the valley. The stream has an E character in many places but is entrenched and unstable in a few reaches (G type). Natural background loading in this watershed accounts for 22% of the total load.

Streambank erosion is mainly influenced by grazing related vegetation manipulation and bank trampling. Grazing-related near stream and upland sources contribute the largest proportion of the total sediment load (62%). Roads contribute another significant load (16%), mainly from adjacent tributary crossings. Other minor sources include channel manipulation and irrigation structures and returns (each less than 1%). Load estimates for Sweetwater Creek include the North Fork of Sweetwater Creek because it drains a significant portion of that watershed.

7.3.3.19.2 Sweetwater Creek Allocations and TMDL

Human influenced sources identified for allocation in the Sweetwater Creek Watershed are livestock grazing, roads, irrigation, and past channel straightening (Table 7-26). The sediment TMDL for Sweetwater Creek is a 41% reduction in sediment loading. There are no point sources in the Sweetwater Creek Watershed; therefore, no waste load allocation for sediment is necessary.

Table 7-26. Sediment Allocations and TMDL for Sweetwater Creek.

Sources	Current Estimated Load (Tons/Yr)		Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	12,628	51% reduction in loading
	Road	3215	60% reduction in loading
	Channel Manipulation	2	50% reduction in loading
	Irrigation Diversions	21	50% reduction in loading
Natural Background		4387	Not applicable
Total Load		20,253	41% reduction in loading

Addressing grazing and road-related sources by implementing BMPs will provide the largest reduction in sediment load to Sweetwater Creek. Bank erosion resulting from channel manipulation can be reduced by re-establishing riparian vegetation and following agricultural BMPs. Recovery would occur more rapidly with active restoration, but the expense to stabilize banks through bioengineering may be excessive given the expected reduction in sediment loading. The effects of flow manipulation and dewatering have not been quantified, but are likely influences on sediment production and transport. Restoring instream flow in dewatered reaches will be important to allow recovery of riparian vegetation for stabilizing streambanks. Quantifying and mitigating contributions from irrigation ditch returns should also be a focus of the restoration strategy. More detail about management recommendations and restoration priorities for listed water bodies is included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.20 Warm Springs Creek

7.3.3.20.1 Sediment Source Assessment for Warm Springs Creek

Warm Springs Creek is a stable B type stream in the headwaters and grades into an E and C type stream as it emerges onto the valley. Natural landslides and hillslope slumping are common in this watershed. Natural sediment sources contribute 82% of the estimated total load, due mainly to unstable slope surrounding the valley. Grazing related bank erosion is high (5,678 tons/year) but contributes only 16% of the overall estimated sediment yield in the watershed. Past influences, such as channel manipulation and vegetation removal from past placer mining and overgrazing, contribute 2% of the estimated total load. Roads are estimated to contribute less than 1% of the overall load. Loads for Warm Springs Creek include the North, Middle, and South forks of Warm Springs Creek, because all forks contribute significant flow.

7.3.3.20.2 Warm Springs Creek Allocations and TMDL

Human influenced sources identified for allocation in the Warm Springs Creek Watershed are livestock grazing, roads, past vegetation clearing and channel straightening (Table 7-27). The sediment TMDL for Warm Springs Creek is a 9% reduction in sediment loading. There are no point sources in Warm Springs Creek Watershed; therefore, no waste load allocation for sediment is necessary.

Table 7-27. Sediment Allocations and TMDL for Warm Springs Creek.

Sources	Current Estimated Load (Tons/Yr)		Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	5678	51% reduction in loading
	Roads	355	60% reduction in loading
	Past Vegetation Clearing and Channel Straightening	778	50% reduction in loading
Natural Background		30,816	Not applicable
Total Load		37,627	9% reduction in loading

The allocations to grazing and roads follow the Ruby Watershed wide approach for determining the estimated load reduction potential. The largest sediment reductions will be achieved through continuing to improve grazing management to protect riparian vegetation and channel condition. Implementing additional road BMPs and agricultural BMPs will be part of the restoration strategy to meet allocations. More detail about management recommendations and restoration priorities for listed water bodies is included in Section 10.0, Restoration and Implementation Strategy.

7.3.3.21 West Fork Ruby River

7.3.3.21.1 Sediment Source Assessment for West Fork Ruby River

Contribution from natural sources constitutes an estimated 88% of the total sediment load. Natural sources include landslides and slumping, upland erosion on highly erodible soils, and high cut toe slopes. Contribution from grazing related stream bank and upland erosion contributes the entire anthropogenic sediment load.

7.3.3.21.2 West Fork Ruby River Allocations and TMDL

Livestock grazing is the only human influenced source identified for allocation in West Fork Ruby River's Watershed (Table 7-28). The allocation may include sources that were derived from historic sheep grazing that have not fully healed. There are no point sources in the West Fork Ruby River Watershed; therefore, no waste load allocation for sediment is necessary.

Table 7-28. Sediment Allocations and TMDL for West Fork Ruby River.

Sources		Current Estimated Load (Tons/Yr)	Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	298	51% reduction in loading
Natural Background		2204	Not applicable
Total Load		2502	6% reduction in loading

Allocations to grazing follows the Ruby Watershed wide approach for determining the estimated load reduction and may need refinement in the future according to specific study within West Fork Ruby River's watershed. The sediment TMDL for West Fork Ruby River is a 6% reduction in sediment loading. Because the impairment is marginal, it is likely that the small overall load reduction can achieve support of instream beneficial uses. Restoration should focus on continuing to improve grazing management and protecting riparian habitat.

7.3.3.22 Wisconsin Creek

7.3.3.22.1 Sediment Source Assessment for Wisconsin Creek

Wisconsin Creek originates as a steep mountain stream in the headwaters of the Tobacco Root Range, and changes to a B type stream as it flows through the pediment. It is a straightened E type stream in a lower reach in the alluvial valley. The sediment load from natural erosion is 1809 tons/year, which is relatively low compared to most other subbasins in the Ruby watershed. Natural loading contributes 39% of the total load. Grazing related bank erosion accounts for the majority of the anthropogenic sediment source, predominantly from grazing related vegetation removal in the lower end. The grazing-related load contributes 59% of the total estimated load. Sediment delivery from roads is a relatively minor source to Wisconsin Creek, contributing only approximately 1% of the total load. Dewatering and irrigation return flows affect sediment deposition and transport. Quantifying the irrigation affects on sediment transport was beyond the scope of this study, but will be included in monitoring recommendations in Section 11.0.

7.3.3.22.2 Wisconsin Creek Allocations and TMDL

Human influenced sources identified for allocation in the Wisconsin Creek Watershed are livestock grazing, and roads (Table 7-29). The sediment TMDL for Wisconsin Creek is a 31% reduction in sediment loading. The influences of other minor sources, such as irrigation and past channel straightening has not been quantified but are addressed in restoration approaches. There are no point sources in Wisconsin Creek Watershed; therefore, no waste load allocation for sediment is necessary.

Table 7-29. Sediment Allocations and TMDL for Wisconsin Creek.

Sources	Current Estimated Load (Tons/Yr)		Sediment Load Allocations
Anthropogenic Nonpoint Sources	**Grazing**	2780	51% reduction in loading
	Roads	49	60% reduction in loading
Natural Background		1809	Not applicable
Total Load		4638	31% reduction in loading

Allocations can be met through implementation of grazing, agricultural, and road BMPs. Further study is needed to quantify the influence of irrigation on sediment loads, as recommended in Section 11.0. Agricultural BMPs should be implemented to address irrigation-related sources. BMPs are listed in Section 10.0, Restoration and Implementation Strategy.

7.3.4 Uncertainty and Adaptive Management

All sizeable sources are assessed by the sediment assessment, but a few small sources may have been overlooked because of budgetary and temporal limitations of the TMDL project. If the allocations are followed, sediment loads are expected to be reduced to a degree that the sediment targets are met. The allocation reductions vary by the watershed. In some cases a small overall reduction is called for, but sediment conditions and beneficial uses are already close to targets and the ability to address human caused sediment sources is small. On the other hand, some of the TMDLs call for a large reduction in sediment load, the uses are severely impaired, and there is room for a large sediment load reduction through reasonable land, soil and water conservation practices.

The waste load allocation for the town of Sheridan is based on monthly sampling. The storm water waste load source assessment for Alder Creek is based on worst case BMP scenario even though there are a number of BMPs in place. The point source assessments were completed in order to justify that these sources are minor, therefore a narrative waste load allocation is provided.

Sediment loading source assessments are based on load estimates derived from near-stream inventories, which were then extrapolated to un-assessed areas with the aid of GIS and field reconnaissance. Some error is inherent in this process (see Appendix E). Choosing the appropriate reaches to use as a basis for estimating loading involves best professional judgment, and necessarily involves assumptions about similarity in controlling influences among reaches. At least 80% of the stream miles on tributaries were viewed by assessment crews either walking or driving. Roughly 60% of the Ruby River was viewed. Of these areas, approximately 25% of the impaired stream miles were inventoried. Another potential source of error includes the upland sediment modeling, which is part of the overall sediment source assessment. Model results are only as good as the input data, and southwest Montana has coarse data for modeling compared to many other, more populated areas. Additionally the amount of upland loading due to human causes is based on modeling sediment yields given a potential increase in upland vegetation, which itself is based on literature values and Best Professional Judgment rather than empirical data. Urban runoff modeling for the town of Sheridan was completed because of observed turbidity entering Mill Creek. The urban runoff modeling is based on estimates of certain urban land cover types estimated from aerial photos. The model assumes a constant annual load from each land cover type and the export coefficients are based on nation wide monitoring results.

Modeled loading from upland sediment sources are a best approximation based on available data, but may not accurately reflect delivery to the stream as affected by riparian buffer condition. The USLE-3D model estimates loading on a watershed scale, and includes all sub-basins within each listed watershed. The near-stream sediment source inventory is only extrapolated to the listed water bodies, and not to minor tributaries. Therefore, the scale of the two assessments is not the same, but each is assumed to capture the majority of the sediment loading affecting each listed water body.

Another consideration for uncertainty is the ability to characterize sediment sources in a temporal timescale. The source assessments composed in this document address average sediment source conditions over decades. Sediment production from both natural and human caused sources is driven by storm events. Pulses of sediment are produced periodically, not uniformly through time. The source assessment characterizes average conditions over long timeframes.

Even with the uncertainties, the source assessment is nevertheless a good indicator of the magnitude of each source. The numbers used for the source assessment should not be thought of as absolute and should be considered in light of the limitations and error associated with the source assessments. Because of this uncertainty in the source assessment the allocations are not set as absolute load reductions, but percent load reductions. Sediment source assessment results are useful for determining the largest sources within each watershed and are useful, along with consideration of restoration costs, to determine an allocation strategy based on economic costs and environmental benefits.

Uncertainty in loading estimates is also addressed through an adaptive management approach, where the TMDL and allocations from this document can be revised as additional information is collected. The monitoring identifies further assessment priorities to address uncertainties in the recent source assessment. The monitoring plan also includes effectiveness monitoring before and after implementation of restoration practices, additional water quality monitoring and quantification of irrigation returns and withdrawal. Adaptive management is part of the margin of safety and requires long-term monitoring to track BMPs and track stream condition to determine if targets have been achieved. This approach allows management recommendations and practices to be revised if targets have not been met. Monitoring recommendations are detailed in Section 11.0.

Noticeable improvement in habitat and reduction in sediment loading will not occur until most types of restoration mechanisms or management based activities have been in place for several years or more. Habitat improvements due to grazing BMPs should be observable within 3 to 5 years after project implementation. Water quality improvement may not be noticeable within the first several years, as it may take up to 10 years for sediment to flush through the system, depending on flow management, climate, and the magnitude of excess deposition in different stream reaches. Therefore sediment reductions to meet the allocations will be a long-term goal.

SECTION 8.0
NUTRIENTS

This section provides:

1) A description of the methodologies used to characterize sources of nutrients.
2) A summary of the results of the nutrient source assessment for the water body listed for nutrients (Sweetwater Creek).
3) TMDL and allocations for Sweetwater Creek.

Sweetwater Creek is the only water body listed for nutrients, although high levels of some nutrient fractions indicate a need for further assessment of other water bodies in the Ruby Watershed. The other water bodies with indications of nutrient enrichment are identified in Impairment Status Section (5.0) and in the Monitoring Plan (Section 11.0).

8.1 Nutrients Source Characterization Methods

Nutrient source characterization builds on the impairment determination and involves review of chemical, physical, and biological data to identify sources of nutrients. The types of data used include:

- Aerial assessments, GIS assessments, and on-stream reconnaissance
- Water quality data
- Biomonitoring data
- Sediment source inventory

Because of limited data, the limiting nutrient during the summer timeframe is unknown so both total nitrogen and total phosphorus TMDLs will be provided. Nutrients, particularly phosphorus, are often transported into streams with sediment; therefore the source assessment for nutrients considers sediment sources. The sediment source inventory identified significant sediment loads from sources related to grazing and roads. Methods for the sediment inventories are described in Appendix E (SOPs).

8.2 Source Characterization Results

Sources of nutrient enrichment are relatively straightforward, as the land use in this watershed is almost entirely agricultural. Phosphorus levels are often closely tied to streambank erosion and subsequent sediment deposition (U.S. EPA, 1999), therefore sources of impairment due to nutrients may also be related to near stream sediment sources. Several road-related sediment sources were documented for this water body as well, but nutrients are usually associated with eroding soils and most of the sediment producing road segments had soil surfaces removed when they were built.

Ground water is a pathway for nutrients reaching Sweetwater Creek. Nutrients from both natural and agricultural sources are transported in groundwater. The lower most water quality sampling site on Sweetwater Creek is located approximately one mile below a 2 mile reach that has been dry in recent years. Water in the channel at this site is primarily ground water. All three samples collected from this site in 2003 had TKN and total nitrogen levels exceeding targets. There is not enough available information to determine if nutrients at this site are contributed primarily from ground water, or what proportion of ground water nutrient levels would be natural. One study documented that nutrients added to ground water can persist for at least 30 years; therefore, high nutrient concentrations in ground water could be due to past land management as well as any current influences. Further investigation of sources of nutrients in ground water, including management history, is included in monitoring recommendations for Sweetwater Creek.

8.2.1 Natural Sources

The Sweetwater drainage is composed mainly of mixed metamorphic and volcanic rocks, and has volcanic ash accumulation in alluvial valleys. There are no large phosphate deposits in the Sweetwater drainage, but ash may have some influence on nutrient levels as it breaks down and is incorporated into natural cycles in the system. Geologic information is based on personal communication with a retired State Geologist who has studied the Ruby River watershed extensively (Ed Ruppel, 2003 pers comm).

Although there are no large natural phosphate deposits on Sweetwater Creek, phosphorus levels are probably related in part to natural sediment inputs. Phosphorus is primarily transported in surface runoff with eroded sediments, due to its tendency to sorb to soil particles and organic matter (U.S. EPA, 1999). Phosphorus may become unavailable when it sorbs to sediments in the water column and on the substrate. In slow water systems, which include beaver ponds on this water body, phosphorus may be held in substrate sediments, but may become available during a sediment flush at high flow. Nitrogen is not as likely to become tied up in sediments and can be incorporated into the water column through atmospheric deposition and nutrient cycling. Nitrogen is also more easily transported via ground water than phosphorus.

Relatively high upland erosion may be contributing phosphorus from natural sources. Modeling has indicated Sweetwater Creek contributes moderately high loads of sediment from upland sources relative to other subbasins within the watershed. The Sweetwater drainage was given a “moderate” rating from AGWA modeling of hillslope erosion potential (Appendix H). Upland sheet erosion modeling by MDEQ indicated Sweetwater Creek is one of the highest contributors of sediment from upland sources, partly due to the large size of the watershed (Appendix H). Some influence from human activities may add to upland sheet erosion, but quantifying their influence on nutrient loading was not possible for this analysis. The sediment source assessment and allocations (Section 7.0) examine this issue more closely.

The middle stretch of Sweetwater Creek is characterized by extensive beaver activity, which affects nutrient cycling and sediment routing. Beaver ponds act as a nutrient sink, and often reduce nutrient levels, but they also act as a sink for organic deposits, and can lead to organic enrichment when deposited sediment is flushed through the stream system (Olson and Hubert, 1994). Sediment-dwelling organisms in beaver ponds may contribute nitrogen to a system through increased nitrogen fixing. Naiman et al. (1998) reported a three-fold increase in standing organic matter following damming of a stream by beaver, which resulted in an overall increase in the abundance of nutrients in the system. However, Parker (1986, as cited in Olson and Hubert, 1994) reported water below beaver complexes had 20 to 65 percent lower TP and TKN and 20 to 25 percent nitrate nitrogen than above the beaver activity. Affects of beaver activity on nutrient conditions are likely inconsistent and episodic.

Direct inputs from native ungulates are probably minimal for most of the length of Sweetwater Creek, due to widespread habitat degradation reducing desirable cover and forage. Identifiable impacts from livestock grazing were much more pronounced than those identified from wildlife.

Ground water may be a natural source of nutrients. One of the sampling sites on Sweetwater Creek is located below a reach of the stream that is completely dewatered; therefore all water present in the channel at the lower sampling site was due to local ground water recharge during sampling timeframes. The influences of agriculture on ground water nutrient levels is unknown, however, and water resurfaces far enough upstream of the sampling site that local streamside land use may influence water quality at this sampling site as well. Ground water nutrient inputs are often indicated by total nitrates+nitrites; however, there is not enough information to quantify the extent to which nutrient additions from ground water are natural or irrigation induced. Irrigation on sensitive soils and geology can increase ground water nutrient loading. Irrigation combined with fertilizers can also increase ground water nutrient loading.

8.2.2 Point Sources

There are no known point sources on Sweetwater Creek.

8.2.3 Nonpoint Sources

Sweetwater Creek watershed is primarily agricultural, with no urban influence. Nonpoint sources of nutrients include habitat alteration that may lead to increases in temperature and sunlight due to channel widening and reduced shade which can stimulate algal growth, changes in nutrient cycling due to stream and riparian area degradation, direct inputs from livestock, phosphorus loading associated with sediment inputs from streambank erosion, increased ground water flow due to irrigation through sensitive soils and geology and agricultural inputs such as fertilizer and manure. These sources are often found in agricultural watersheds (Porter, 1975; U.S. EPA, 1999).

Grazing-related sources – The primary land use in Sweetwater Creek is livestock grazing. In addition, part of the stream is completely diverted for irrigation, leaving a dry channel until ground water recharges the channel at a lower level. Some of the poorest streamside soil and vegetation conditions in the Ruby Watershed are found on Sweetwater Creek in heavily grazed areas above and below the beaver-dominated canyon reaches. Heavily grazed reaches scored poorly in assessments due to high bank alteration, severe vegetation removal, dewatering, and direct manure inputs to the stream. Complete removal of woody riparian vegetation along Sweetwater Creek has had a large impact on the condition of downstream reaches, and is a major source of nutrient impairment in the Watershed (Appendix F – SWC #18). Sweetwater Creek had the second highest estimated sediment inputs from grazing-related near-stream sources of all listed water bodies in the Ruby watershed. Particulate nitrogen and phosphorus are entering the water column due to excess streambank erosion and upland sediment production from grazing sources.

Fertilizer/irrigation inputs - Additions of fertilizer on irrigated fields are a likely source of nutrients. Flood irrigation likely delivering fertilizer-enriched water and sediment to the stream, but levels of fertilizer use and the amount of surface or subsurface return flow from flood irrigation is poorly understood. Lack of native riparian vegetation appears to be in part, due to dewatering, in part caused by irrigation, on lower reaches of Sweetwater Creek.

Corrals- Seasonal overland runoff from one corral area may reach the stream due to slope and low vegetation cover, even though the corral is at least 20 ft off the stream. This potential source flows into a dry section of Sweetwater Creek. Manure is common in the channel and on the floodplain in the headwaters and throughout the dewatered stretch of lower Sweetwater Creek, providing a source of nutrients.

Roads - Sweetwater Creek has the second highest road-related sediment input of all inventoried water bodies in the Ruby watershed (Section 7.0). The amount of nutrients associated with the sediment yield from these sources is not known, although many of the roads surfaces are gravel and sand that do not contain many available nutrients. Most nutrients are associated with smaller soil particles. Nutrient assessment from unpaved road runoff should be investigated further in Southwest Montana. No allocation will be made to this source at this time.

Agricultural and natural sources are the largest contributors of nutrients in the watershed. All of the human caused sources are related to agricultural practices except for the potentially low nutrient production from road runoff. Agricultural sources include near stream and upland grazing pastures, irrigated crops, and a corral.

8.3 TMDL and Allocations for Sweetwater Creek

8.3.1 TMDL

The nutrient TMDLs represent the maximum amount of total nitrogen or total phosphorus that Sweetwater Creek can assimilate without exceeding the narrative aquatic life standards that apply to nutrients (Section 3.0). The assimilative capacity is a function of the stream flow rate, which acts in a dilution capacity. Therefore, the TMDL must be designed to be protective of beneficial uses and meet water quality standards under the full range of stream flow and water chemistry conditions anticipated. To achieve this, the nutrient TMDLs are presented as an equation to be used to calculate the maximum allowable load of a specific nutrient at any time or under any conditions. The nutrients produced during storm events may be deposited, stored and subsequently released into usable forms of nitrogen and phosphorus. The TMDL equations are as follows:

Equations 8-1:

Total Maximum Daily Load for Total Nitrogen (lb/day) = (300 ug/L)(Y cfs)(0.0054)
where:

X = the applicable target in ug/L according to Section 4.0 of this document;
Y = streamflow in cubic feet per second;
(0.0054) = conversion factor

Total Maximum Daily Load for Total Phosphorus (lb/day) = (20 ug/L)(Y cfs)(0.0054)
where:

X = the applicable target in ug/L according to Section 4.0 of this document;
Y = streamflow in cubic feet per second;
(0.0054) = conversion factor

The TMDL and targets are set for the summer months (July 1-October 1) when algal growth can become a nuisance to recreation and may consume dissolved oxygen, which may affect fish and aquatic life at night when respiration exceeds photosynthesis. Figure 8-1 provides equations describing TMDLs at a range of flows. At any given flow during the summer season (June through September), nutrient loads should remain below the line representing the TMDL. Diamonds represent field measurements. Two locations will be used to monitor the TMDL, above the canyon area and near the confluence with the Ruby River.

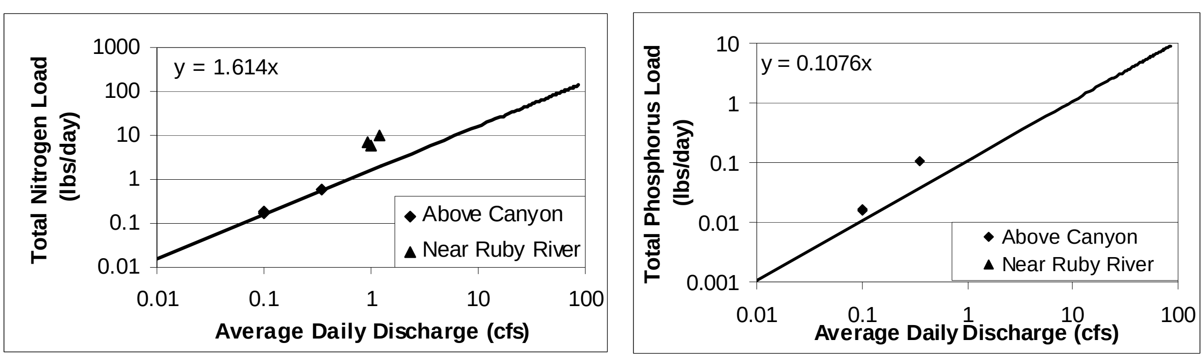

Figure 8-1. Existing Data Compared to Nutrient TMDLs for Sweetwater Creek.

The current data set is limited to low flow, non-runoff conditions which do apply to the most sensitive use timeframe. Further monitoring is recommended to strengthen the current understanding about how current loads compare to the TMDLs at a broader range of summer stream flows and to add more certainty to a currently small dataset.

Table 8-1. Total Nitrogen TMDL Application for Sweetwater Creek.

Site	Target (µg/L)	Flow (cfs)	TMDL (lb/day)	Sampled Load (lb/day)	Percent Load Reductions Required
Sweetwater near Ruby River	300	0.99	1.57	5.79	73
Sweetwater near Ruby River	300	1.2	1.91	10.28	81
Sweetwater near Ruby River	300	0.93	1.48	6.97	79
Sweetwater above Canyon	300	0.35	0.56	0.60	7
Sweetwater above Canyon	300	0.1*	0.16	0.17	6
Sweetwater above Canyon	300	0.1*	0.16	0.18	11

*Estimated flows

Table 8-2. Total Phosphorus TMDL Application for Sweetwater Creek.

Site	Target (µg/L)	Flow (cfs)	TMDL (lb/day)	Sampled Load (lb/day)	Percent Load Reductions Required
Sweetwater near Ruby River	20	0.35	0.04	0.10	64
Sweetwater above Canyon	20	0.1*	0.01	0.02	37
Sweetwater above Canyon	20	0.1*	0.01	0.02	31

*Estimated flows

8.3.2 Load Allocation Development Strategy

Two sources of nutrient loading have been identified for the nutrient TMDL allocation in Sweetwater Creek's watershed, including:

- Agriculture (Rangeland Grazing, Irrigated Crop Production)
- Natural background loading

Because limited information is available for these sources, a generalized approach has been adopted for nutrient load allocation in Sweetwater Creek watershed. Under this restoration plan the total allowable load (the TMDL) for Sweetwater Creek watershed has been assigned to the combination of agricultural and natural sources. This approach to load allocation will ultimately account for all potential sources of nutrients, while recognizing the current lack of detailed information on specific nutrients loading sources. The allocation strategy is based on certain premises, such as natural background conditions will not preclude attainment of water quality standards, and that restoration of agricultural sources can reduce nutrient loading to levels necessary for attainment of water quality standards. If future data collection shows this to not be the case, this TMDL and water quality restoration plan will be modified in accordance with the Adaptive Management Strategy outlined in Section 8.4.6.

8.3.3 Source Category Load Allocations for Nutrients in Sweetwater Creek

Nitrogen and phosphorus load allocations in the Sweetwater Creek watershed follow the source category approach, where the allowable load for a given nutrient, or TMDL for that nutrient in pounds per day, is distributed to agricultural and natural sources. The source category allocation approach is particularly useful for situations like Sweetwater Creek watershed where impairment conditions are defined, but quantitative information on the major human caused nutrient loading source is poorly understood. In this situation, a source category allocation scheme provides a "first cut" at load allocation. Human caused sources of nutrients are quite apparent and uniform in this watershed, and therefore a basic land use category allocation strategy may be all that is needed for nutrient source assessment in this watershed.

As previously described, suspected sources of nutrient loading to Sweetwater Creek and its main tributary, Sage Creek, can be grouped into the two categories of agricultural and natural sources. The allowable total nitrogen and phosphorus loads, or TMDLs, in Sweetwater Creek watershed are allocated to agricultural and natural source categories. Due to a lack of detailed water quality data, more detailed delineation of loads between these source categories is not currently possible, and the entire Sweetwater Creek TMDL is allocated to the combined agricultural/natural category. The Sweetwater Creek nutrients allocations are based on the assumption that natural condition loading alone will not result in exceedences of applicable water quality standards and associated TMDLs, and that restoration practices that address grazing, crop related and confined livestock sources can achieve the reductions necessary for compliance with the TMDLs. This allocation approach is used for both total nitrogen and total phosphorus. Because these sources can be addressed by standard agricultural best management practices (BMPs), this approach provides adequate restoration guidance to implement the TMDL. An adaptive management strategy will be used if further source assessment is needed for implementing agricultural BMPs.

The full TMDL will be allocated to agricultural and natural background loading. The highest measured TMDL exceedences at the site above the Canyon would need a 64% reduction in total phosphorus loading and an 11% reduction in total nitrogen loading to meet the TMDL. The highest measured TMDL exceedences at the site near the Ruby River would need a 78% reduction in total nitrogen loading to meet the TMDL. No comparable total phosphorous data is available at this site for load calculation. It should be noted that the TMDL and load allocations apply for the specific streamflow conditions and restoration targets used in the TMDL calculations, and apply at locations used in the TMDL calculations. Specific TMDLs, and thus load allocations for any given point in time, will vary based on specific streamflow conditions existing at that time. Although the TMDLs and allocations are set for the summer timeframe when uses are impacted by nutrients, the restoration approaches need to be implemented continuously because nutrient transport timeframes from agricultural sources are unknown.

An adaptive management plan may consider estimating agricultural and natural background nutrient loads in the watershed if necessary for restore uses. Although few if any new nutrient sources are anticipated in this watershed, they should follow standard BMPs and management recommendations designed to protect water resources. Best management guides are provided in Section 10.0- Restoration Strategy.

8.3.4 Seasonality and Margin of Safety

All TMDL/Water Quality Restoration Planning documents must consider the seasonal variability, or seasonality, on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and load allocations. TMDL development must also incorporate a margin 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 describes in detail considerations of seasonality and a margin of safety in the Ruby River watershed nutrients TMDL development process.

8.3.4.1 Seasonality

Seasonality addresses the need to ensure year round beneficial use support. Optimal growing conditions for benthic algae occur during the summer (July 1-Oct 1) timeframe, therefore the TMDL and targets are set for this timeframe. Because of the simple allocation approach taken in this TMDL and the uncertainties associated with nutrient transport and cycling, the allocations should not translate into seasonal controls of agricultural nutrient loading. Continual, year round, agricultural restoration activities should occur with the agricultural nutrient sources.

8.3.4.2 Margin of Safety

The margin of safety may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (U.S. EPA, 1999). The margin of safety is addressed in several ways as part of this document:

- Compliance with targets and refinement of load allocations are based on an adaptive management approach that relies on future monitoring and assessment for updating planning and implementation efforts.
- In addition to numeric water column criteria, additional beneficial use support targets include bioassessments that assess algal growth conditions.
- The TMDL is based on meeting water chemistry targets during expected algal growth periods, and the targets are set to protect the beneficial uses.

8.4 Restoration Approach

Restoration recommendations focus on addressing inputs from agricultural sources. Most of the grazing related impacts can be addressed by grazing management practices and passive restoration techniques that allow vegetation to recover. The near stream sediment source assessment can be used to identify grazing restoration priorities that will also reduce nutrient loading. Load reductions derived from reduced bank erosion due to grazing management may take a decade to fully respond, while grazing BMPs may immediately reduce a portion of nutrient loads attributable to animal defecation in the riparian corridor. Addressing the corral will likely result in immediate nutrient reductions. Irrigated crop management occurs in a small portion of the watershed but is a high priority for restoration activities such as nutrient management planning and creating riparian buffers. See Section 10.0 of this document for a more detailed restoration approach.

8.5 Monitoring Recommendations and Adaptive Management Plan

Additional monitoring may be needed to better to delineate specific nutrient loading sources, to support allocation of loads, or for restoration planning. In addition, environmental monitoring is needed to assess the effectiveness of future restoration actions and attainment of restoration targets. Additional nutrient monitoring could include collecting more water chemistry and chlorophyll a samples to reduce uncertainties about existing nutrient conditions in the watershed.

Effectiveness monitoring should have a long-term focus to track BMP implementation and to track water quality and stream condition over time. In this capacity effectiveness monitoring is an essential part of all adaptive management decisions, including refining restoration recommendations. Implementation monitoring to assess progress toward meeting restoration targets is required by the TMDL rules (75-5-703(7) & (9)), and is also an integral component of the implicit margin of safety incorporated in the nutrients TMDLs developed in this restoration plan.

SECTION 9.0
METALS

This section provides:

1) A brief review of the metals impairment for all metals 303(d) listings in the Ruby watershed.
2) A description of the methodologies used to assess sources of metals for water bodies in the Ruby River watershed that are impaired due to metals.
3) A summary of the results of the metals source assessment for necessary metals TMDLs.
4) TMDLs and allocations for all necessary metals TMDLs.

9.1 Metals TMDL Impairment Status Summary

Review of available metals water quality data was conducted and new data was collected for the Ruby Watershed TMDL project. Bioindicators, fish tissue, and benthic sediment samples for metals were used as additional indicators of impairment along with water chemistry data. The more in depth review has resulted in new guidance for future 303(d) metals listings in the watershed. A stream by stream summary of data and impairment review for metals is included in Section 5.2. An impairment Status Review summary is provided for Streams listed for metals as a cause of impairment on Montana's 1996 or 2004 303(d) Lists and other streams that metals were found to have likely standards exceedences during the TMDL project in Table 9-1.

Table 9-1 Summary of Metals Listings and TMDL Status.

Alder Creek	303(d) Listing	2004 – Lead, Mercury, Metals
	Product	No lead TMDL needed. Quality of data the listing is based upon is suspect. New data indicate low lead concentrations. A mercury TMDL is needed. Mercury TMDL will be completed after further monitoring.
Mill Creek	303(d) Listing	2004 – Lead, Zinc, Metals
	Product	No TMDL needed on main stem. Error in listing; data used for listing were from Middle Fork Mill Creek and mine adits. Middle Fork Mill Creek is identified for further monitoring in Section 11.0.
Ramshorn Creek	303(d) Listing	1996 – Metals 2004 – Lead, Metals
	Product	Lead TMDL provided for Ramshorn Creek.
Browns Gulch	303(d) Listing	Not identified on any 303(d) list.
	Product	Potential metals contamination. Identified for further monitoring in Section 11.0.
Poison Creek	303(d) Listing	Not identified on any 303(d) list
	Product	Potential metals contamination. Identified for further monitoring in Section 11.0.
Currant Creek	303(d) Listing	Not identified on any 303(d) list for a metal
	Product	Potential metals contamination. Identified for further monitoring in Section 11.0.
Upper Ruby River	303(d) Listing	1996 – Metals
	Product	No metals TMDLs needed. Quality of data the listing is based upon is suspect. New data indicate low metals concentrations.
Lower Ruby River	303(d) Listing	1996 – Metals
	Product	No metals TMDLs needed. Quality of data the listing is based upon is suspect. New data indicate low metals concentrations.
Wisconsin Creek	303(d) Listing	2004 – Lead, Arsenic, Metals
	Product	No WQ standards exceeded instream but sediment concentrations and potential toxic effects are near target thresholds. A water quality monitoring plan is provided to collect data for a more robust impairment update. No TMDL written at this time.

The outcome and justification of Impairment Status Reviews are provided in Section 5.2. Only two metals TMDLs to address either 1996 or 2004 303(d) metals listings are necessary according to the impairment status review in Section 5.2. Alder creek mercury conditions warrant a TMDL a lead TMDL is needed for Ramshorn Creek. No WQ standards were exceeded in Wisconsin Creek but sediment concentrations and potential toxic effects are near target thresholds. A water quality monitoring plan is provided for Wisconsin Creek to collect data for a more robust impairment update since metal conditions are near thresholds but not conclusive. This effort identified other streams, which were not identified by Montana's 303(d) lists for metal contamination, which may be impacted by metals. Monitoring plans for these other potentially impacted streams are provided for future program guidance.

9.2 General Source Assessment Methods

Initially, GIS layers, readily available metals chemistry data, and aerial photos were used to determine general sources. MDEQ abandoned mine data were examined to determine likely sources of mine-related metals inputs (Appendix A – Map 7). Sediment delivery can be a source of metals at mine sites and is also deposited in stream channels, therefore, available sediment metal concentrations are also used to assess sources. Point source discharge permit data were reviewed for metals exceedences if applicable. Geologic information was examined in GIS and through personal communication with a retired State geologist who has mapped the geology of the Ruby Valley (Ruppel 2003, pers. comm.). GIS maps of geology and abandoned mine sites are included in (Appendix A – Maps 4 and 7). Limited water quality results were assessed during TMDL development.

9.3 Alder Creek Mercury TMDL

At the time of this report, insufficient data are available to accurately quantify mercury exposure pathways to fish in Alder Creek. Future monitoring is recommended (see Section 11.0) to better assess complex mercury sources, at which time the mercury TMDL will be completed.

9.4 Ramshorn Creek Lead Source Assessment, TMDL and Margin of Safety

Existing conditions and impairment status are reviewed in Section 5.0.

9.4.1 Source Assessment

All of the samples that were above standards, from both Ramshorn Creek and Current Creek (a tributary to Ramshorn Creek), were collected during storm events or spring runoff. Therefore, a major source of lead is likely associated with sediment sources near the stream network. Likely sources for the elevated metals levels in Ramshorn Creek watershed are a Priority Abandoned Mine, other abandoned mines, other human caused erosion, and natural sources (MDEQ, 1997). Metals may be contributed to the stream network by mine adit water or metals-laden sediment inputs to the stream. Areas mined for metals also generally have naturally high levels of metals in the soils. Erosion caused by human activity in ore-rich areas is a likely source of lead. Human activities in these two watersheds that influence erosion are the road network, grazing, and past mining activities along the stream corridor.

The Goldsmidt/Steiner priority abandoned mine site is located on Currant Creek and is a likely source of metals (Appendix A – Map 7). Sediment lead levels increase by 8 times below the Goldsmidt/Steiner mine site. The only other identified abandoned mine on Current Creek is the Current Creek Mine but no data or investigation about this mine is available. Other underground abandoned mines in the Ramshorn Creek watershed are: Agitator Concentrator, Pedro, Walker, Silversmith, Betsy Baker and Bedford mines but their metals contributions are unknown. A placer-mined area is located in the headwaters. Sources of the lead loads from upper Ramshorn Creek can not be pinpointed at this time and a monitoring plan to further delineate sources in upper Ramshorn Creek will be needed prior to any mine reclamation work in the upper Ramshorn Creek watershed. No permitted point sources are located in the watershed. Both Current Creek and Ramshorn Creek above this confluence are contributing to lead loading and lead water quality standard exceedences.

Human caused sediment sources such as grazing and unpaved roads that may be enriched by natural or unnatural metals conditions are a large component of the sediment load in Ramshorn and Currant Creek. The sediment source assessment estimates that 58% of the sediment yield comes from human influences in Currant Creek's watershed and 90% in Ramshorn Creek's watershed (Section 7.0). Grazing, roads and historic placer mining are the largest human caused sources of sediment. These sediment sources are also likely lead sources and can be controlled by BMPs and restoration practices identified in the sediment TMDL (Section 7.0).

9.4.2 TMDL

The TMDL represents the maximum amount of lead that Ramshorn Creek can assimilate without exceeding Montana's numeric metals chronic aquatic life standards. This assimilative capacity is a function of the streamflow rate (dilution capacity) and the water hardness (which determines the numeric water quality standard). Therefore, the TMDL must be designed to be protective of beneficial uses and meet water quality standards under the full range of streamflow and water chemistry conditions anticipated. To achieve this, the metals TMDL is presented as an equation to be used to calculate the maximum allowable load of a specific metal at any time or under any conditions. The TMDL equation is as follows:

Equation 9-1:

Total Maximum Daily Load for Lead (lb/day) = (X ug/L)(Y cfs)(0.0054)
where:
X = the applicable water quality numeric standard (target) in ug/L with hardness adjustments according to Equation 3-1 and Table 3-6;
Y = streamflow in cubic feet per second;
(0.0054) = conversion factor

In the case of lead, the three variables (concentration, flow, and hardness) prohibit the use of a simple two-dimensional visual interpretation of the TMDL. Total maximum daily loads are calculated for all samples showing exceedence for examples, using hardness and flow conditions for each sample (Table 9-2). All of the samples that exceed targets and the TMDL were collected during runoff conditions. Seventy one percent of high flow samples collected exceeded the TMDL. None of the samples collected during base flow exceeded standards or the TMDL.

Table 9-2. TMDL Application for Ramshorn Creek and Tributary Samples Exceeding the TMDL.

Site	Target (µg/L)	Flow (cfs)	TMDL (lb/day)	Sampled Load (lb/day)	Percent Load Reductions Required Under Sampled Target Exceedence Conditions*
Ramshorn Creek M04RAMHC01	1.3	4	0.028	0.065	56
Ramshorn Creek M04RAMHC02	0.7	23	0.087	0.373	77
Currant Creek M04CURRC01	2.2	2	0.024	0.076	68
Currant Creek M04RAMHC02	2.1	2.85	0.032	0.062	48
Currant Creek M04RAMHC02	0.9	1.42	0.007	0.046	84

*All standard exceedences were during spring snowmelt or storm runoff conditions. Seventy one percent of high flow samples collected are above the chronic aquatic life standard. No exceedences occur during non-runoff timeframes.

9.4.3 Allocation

A TMDL is the sum of all of the load allocations (for nonpoint sources) plus all of the waste load allocations (for point sources) in a watershed, plus a margin of safety. Waste load allocations are only required for water bodies affected by point source discharge permits and Ramshorn Creek has no point source discharges. The margin of safety is addressed in Section 9.4.4.2. Since no explicit margins of safety or waste load allocations are required, the metals TMDLs consist solely of the nonpoint source load allocations for the watershed.

9.4.3.1 Load Allocation Development Strategy

Four potential sources of metals loading have been identified in Ramshorn Creek watershed, including:

- Surface or underground drainage from abandoned mines and tailings.
- Sediment production near abandoned mines.
- Sediment production from other human caused sources occurring over mineral rich areas.
- Natural background loading from mineralized geology.

Because limited information is available for these sources (especially abandoned mines and background), a generalized approach has been adopted for metals load allocation in Ramshorn Creek watershed. Specific parts of the total allowable load (the TMDL) for Ramshorn Creek watershed have been assigned to metals loading source categories. This approach to load allocation will ultimately account for all potential sources of metal loading, while recognizing the current lack of detailed information on specific metals loading sources. The allocation strategy is based on certain premises, such as natural background conditions will not preclude attainment of water quality standards, and that restoration of active and abandoned mines, grazing and road related sources can reduce metal loading to levels necessary for attainment of water quality standards. If future data collection shows this to not be the case, this TMDL and water quality restoration plan will be modified in accordance with the Adaptive Management Strategy outlined in Section 9.4.6.

9.4.3.2 Source Category Load Allocations for Lead in Ramshorn Creek

Load allocations in the Ramshorn Creek watershed follow the source category approach, where the allowable load for a given metal, or TMDL for that metal in pounds per day, is distributed among the known or suspected categories (or types) of metals loading sources. The source category allocation approach is particularly useful for situations like Ramshorn Creek watershed where impairment conditions are adequately defined, but quantitative information on specific metals loading sources is lacking. In these situations, a source category allocation scheme provides a "first cut" at load allocation and ultimate water quality restoration, while recognizing the potential need for additional water quality information and detailed source delineation before water quality restoration can be assured. Section 9.4.6 of this document presents a conceptual monitoring plan designed to provide this information. Section 9.4.6 also presents an Adaptive Management Strategy outlining an iterative process of further source assessment, implementation of restoration activities, and monitoring. The Adaptive Management Strategy provides a framework for refinement of the allocation and restoration process based on future data collection, to help ensure that water quality impairments are addressed and water quality standards are ultimately attained.

Since the Ramshorn Creek's lead TMDL is exceeded during runoff events that produce surface runoff and sediment production, watershed erosion plays a role in lead production. The Ramshorn Creek sediment TMDL allocations to roads and grazing (Section 7.0) call for a 60 % and 51% sediment reduction, respectively. A constant, proportional relationship between sediment and lead production is assumed for both of these sources. Therefore, the same allocations to these sources used for the sediment TMDL are also used for lead. The sediment allocations are based on implementing all reasonable land, soil and water conservation practices for these sources and the remainder of the load after effective conservation practices are in place is considered naturally occurring according to State law. The remainder of the load from these sources after conservation practices are in place is included in the naturally occurring conditions loading discussion below.

As previously described, suspected sources of metals loading to Ramshorn and its main tributary, Currant Creek, also include historic mines, and natural lead loading. The allowable lead loads, or TMDL, in Ramshorn Creek watershed are allocated to the historic mining and naturally occurring source categories, which includes the loads from roads and grazing after reasonable conservation practices are implemented. Due to a lack of detailed high flow water quality data, more detailed delineation of loads between these source categories is not currently possible, and the entire Ramshorn Creek TMDL is allocated to the combined historic mine/naturally occurring condition category. The Ramshorn Creek metals allocations are based on the assumption that natural condition loading alone will not result in exceedences of applicable water quality standards and associated TMDLs, and that reclamation of abandoned mines as well as sediment reductions from grazing and road restoration can achieve the reductions necessary for compliance with the TMDLs throughout the year.

The overall lead allocation begins with a 60% reduction in annual lead loading from roads and a 51% reduction from grazing related erosion. The full TMDL will be allocated to historic mining, the remainder of the road and grazing loading after reasonable land soil and water conservation practices, and natural background loading (Figure 9-1). To comply with state law, it is important that reasonable land soil and water conservation practices do all that they can to minimize metals loading (i.e., they must protect the use to the extent practicable). It should also be noted that the TMDL and load allocations apply for the specific streamflow conditions and restoration targets used in the TMDL calculations, and apply at locations used in the TMDL calculations. Specific TMDLs, and thus load allocations for any given point in time, will vary based on specific streamflow and water chemistry conditions existing at that time.

An adaptive management plan will consider identifying estimated loads from increased erosion due to grazing and roads, natural background metal conditions in the watershed, and identifying a specific reduction needed from the historic mining sources. It may be possible to satisfy the TMDL via load reductions from mining sources alone.

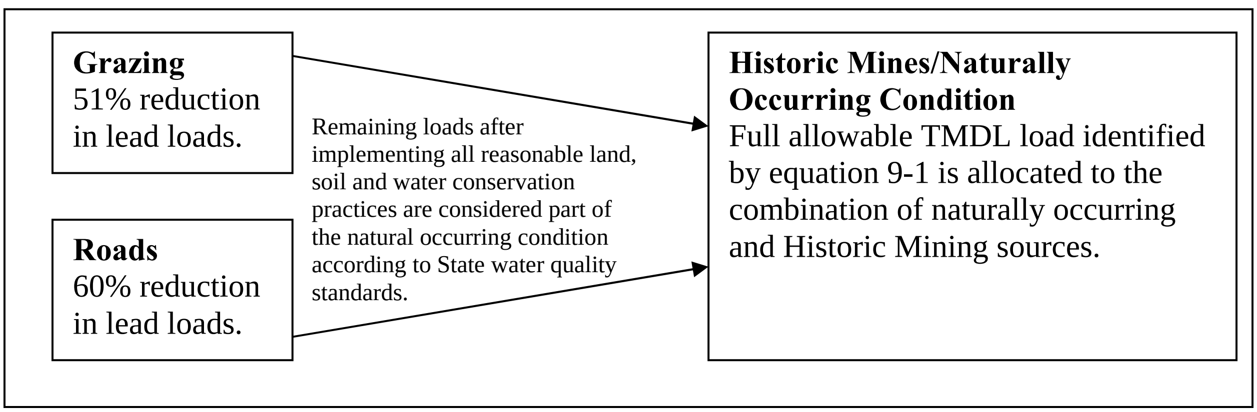

Figure 9-1. Ramshorn Creek Lead Allocation.

Any new mining, grazing or road building activity should follow standard BMPs and management recommendations designed to protect water resources. Sources for standard mining guidelines are listed in Section 10.0, Restoration Strategy.

9.4.4 Seasonality and Margin of Safety

All TMDL/Water Quality Restoration Planning documents must consider the seasonal variability, or seasonality, on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and load allocations. TMDL development must also incorporate a margin 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 describes in detail considerations of seasonality and a margin of safety in the Mill Creek watershed temperature TMDL development process.

9.4.4.1 Seasonality

Seasonality addresses the need to ensure year round beneficial use support. The TMDL should include a discussion of how seasonality was considered for assessing loading conditions and for developing restoration targets, TMDLs, and allocation schemes, and/or the pollutant controls. 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 TMDL document as follows:

- Metals impairment and loading conditions are evaluated for runoff and baseflow conditions. Lead TMDL and target exceedences were only found during runoff events in Ramshorn Creek.
- Metals TMDLs incorporate streamflow as part of the TMDL equation.
- Metals targets apply year round, with monitoring criteria for target compliance developed to address seasonal water quality extremes associated with loading and hardness variations.
- Example targets, TMDLs and load reduction needs are developed for conditions where the TMDL has been exceeded.
- Biological sampling will be conducted during low flow conditions within a given seasonal time period based on MDEQ sampling protocols.
- Sediment chemistry sampling will be conducted during low flow conditions after runoff and deposition of potentially excess metal pollutants.
- Further source assessment will be completed prior to abandoned mine restoration efforts.

9.4.4.2 Margin of Safety

The margin of safety may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (U.S. EPA, 1999). The margin of safety is addressed in several ways as part of this document:

- Compliance with targets, refinement of load 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.
- The numeric water quality criteria used as restoration targets in this TMDL include built in margins of safety to assure protection of beneficial uses.
- The most protective numeric standard (typically the chronic aquatic life support standard) is used to set target conditions where multiple numeric standards are applicable.

- In addition to numeric water column criteria, additional beneficial use support targets include bioassessments using periphyton and macroinvertebrates.
- Sediment chemistry targets are developed to help ensure that potential upstream areas of metals impairment and source loading are not overlooked, and to help ensure that episodic loading that normal sampling events may miss are factored in since the sediment chemistry can be an indicator of these types of loading occurrences. Biological response measurements are also considered by the targets.

9.4.5 Restoration Schedule

Restoration recommendations focus on addressing inputs from priority abandoned mines and following the sediment TMDL restoration approach. A schedule for restoration of these sites to achieve TMDL targets by a given time period can be recommended, but the schedule may be dependent on the cleanup priority assigned these sites by the MDEQ Mine Waste Cleanup Bureau. According to the Mine Waste Cleanup Bureau database, the Goldschmidt/Steiner Mine on Currant Creek is ranked 90^{th} in the state for clean-up priority. Details of restoration recommendations are presented in Section 10.0. Due to the relative scarcity of existing data, an important component of water quality restoration will be monitoring to acquire a more thorough dataset and determine the most effective restoration approach for the mining sources and to evaluate the effectiveness of restoration practices implemented to improve water quality.

9.4.6 Monitoring Recommendations and Adaptive Management Plan

Additional monitoring is required to better delineate specific metals loading sources, to support allocation of loads, and for restoration planning. Most of the lead loading in Currant Creek is derived at or near the Goldschmidt abandoned mine. The lead loading from upper Ramshorn Creek can not be pinpointed at this time and a monitoring plan to further delineate sources in upper Ramshorn Creek is needed. In addition, environmental monitoring will be required to assess the effectiveness of future restoration actions and attainment of restoration targets. Additional assessment monitoring needs also include collecting additional data for acquiring a dataset spanning several continuous years.

Effectiveness monitoring must have a long-term focus to track BMP implementation and to track water quality and stream condition over time. In this capacity effectiveness monitoring is an essential part of all adaptive management decisions, including refining restoration recommendations. Implementation monitoring to assess progress toward meeting restoration targets is required by the TMDL rules (75-5-703(7) & (9)), and is also an integral component of the implicit margin of safety incorporated in the metals TMDLs developed in this restoration plan.

To obtain the needed information, recommended monitoring includes collection of water quality data throughout the hydrograph, and concurrent monitoring of low-flow water quality sampling, biomonitoring for periphyton and macroinvertebrates, and collection of benthic sediment samples. More monitoring is needed above and below mine sites and should include sampling at sites already established during the TMDL assessment. As described previously, monitoring should entail a long-term approach to capture variation in defining trends in metals loading. Further monitoring recommendations are described in Section 10.0.

SECTION 10.0 RESTORATION STRATEGY

This section provides recommendations for restoration and management strategies for both Ruby watershed-wide water quality restoration planning and also to address restoration of water bodies in need of TMDLs. Recommendations are based on the source assessment completed for this report as well as existing literature and stakeholder feedback. The restoration strategy includes general recommendations followed by site-specific recommendations. Next, an implementation plan is provided to guide stakeholders on where restoration activities are more likely to be realized.

A time element for nonpoint source restoration activities is not explicit in the document because most restoration projects rely upon public funding programs, local and private funding match, local efforts to apply for funds, and landowner participation. A time frame for restoration projects on public land is also not specified because annual budget fluctuations for the agencies are unpredictable. An objective of the TMDL project is to provide tool to public land management agencies and private landowners to acquire funds for future restoration projects identified in the document.

The following are the primary basin-wide objectives of this water quality restoration project. These goals would be achieved through implementation efforts outlined in this restoration strategy.

1. Ensure full recovery of aquatic life beneficial uses to all impaired and threatened streams identified by the State of Montana within the Ruby River TPA;
2. Avoid conditions where additional water bodies within the Ruby River TPA become impaired;
3. Work with landowners and other stakeholders in a cooperative manner to ensure implementation of water quality protection activities; and
4. Continue to monitor conditions in the watershed to identify any additional impairment conditions, track progress toward protecting water bodies in the watershed, and provide early warning if water quality starts to deteriorate.

Specific water quality targets and justification for targets are detailed in Section 4.0. These targets were used to verify impairment status of listed water bodies and will be used as a basis for long-term effectiveness monitoring for the water quality goals listed above. These targets are intended to reflect conditions that need to be satisfied to ensure protection and/or recovery of beneficial uses. Goal 3 is designed to ensure cooperation exists among all parties involved. Section 11.0, Monitoring Strategy, details monitoring recommendations designed to meet water quality goal 4.

Management improvements have already been implemented in recent years in many parts of the watershed. These restoration efforts are mostly related to improvements in irrigation management, livestock management, mine site restoration, and fisheries projects, but may include other restoration efforts as well. A discussion of existing restoration efforts is included in the following sections.

10.1 General Management Recommendations

Roads, grazing, and irrigation are currently the primary human caused sources of impairment to water quality in the Ruby watershed. Natural sources are also significant and past management influences such as beaver trapping, large-scale riparian clearing, channel and flow alteration, and mining have had a large influence on the character of the listed water bodies, but these influences are not as easily mitigated through reasonable soil, land and water conservation practices. Where feasible, these past impacts are also addressed in restoration priorities.

General management recommendations are outlined for major sources of pollutants in the Ruby watershed. Best Management Practices form the foundation of the management recommendations but are only part of the restoration strategy. Recommendations may also address evaluating current use and management practices. In some cases a larger effort than implementing new BMPs may be required to address sources of impairment. In these cases BMPs are usually identified as a first effort and an adaptive management approach will be used to determine if further restoration approaches are necessary to achieve all beneficial uses. Monitoring will also be an important part of the restoration process. Monitoring recommendations are outlined in Section 11.0

10.1.1 Grazing Management Recommendations and BMPs

Improving riparian habitat, streambank erosion and channel condition through grazing BMPs is well-documented in the literature (Mosley et al., 1997). A restoration strategy for reducing impacts of grazing on water quality and riparian and channel condition should include implementation of multiple BMPs prescribed on a site-specific basis. BMPs are most effective as part of a management strategy that focuses on critical areas within the watershed, which are those areas contributing the largest pollutant loads or are especially susceptible to impacts from grazing. Grazing BMP focus areas are mapped and described in following sections.

Some general grazing management recommendations and BMPs to address grazing sources of pollutants and pollution are listed below (Table 10-1). Further information on grazing BMPs can be obtained from the sources listed in Table 10-1. Recommendations specific to critical areas and water bodies are described in Section 10.2.

Table 10-1. Example Grazing Best Management Practices.

BMP and Management Techniques	Sources
Design a grazing management plan and determine the intensity, frequency, duration, and season of grazing to promote desirable plant communities and productivity of key forage species.	MDNRC, 1999
Provide off-site high quality water sources.	MDNRC, 1999
Create hardened stream crossings for livestock to reduce the number of crossing areas and reduce erosion at crossings.	MDNRC, 1999
Monitor livestock forage use and adjust grazing strategy accordingly.	MDNRC, 1999
Maintain adequate vegetative cover to prevent accelerated soil erosion, protect streambanks and filter sediments. Set target grazing use levels to maintain both herbaceous and woody plants. No grazing unit should be grazed for more than half the growing season of key species.	MDNRC, 1999 NRCS, 2002

Table 10-1. Example Grazing Best Management Practices.

BMP and Management Techniques	Sources
Ensure adequate residual vegetative cover and regrowth and rest periods. Periodically rest or defer riparian pastures during the critical growth period of plant species.	MDNRC, 1999 Mosley et al., 1997
Distribute livestock to promote dispersion and decomposition of manure and to prevent the delivery of manure to water sources.	MDNRC, 1999
Alternate season of use from year to year in a given allotment or pasture.	MDNRC, 1999 NRCS, 2002
Time grazing to reduce impacts based on limiting factors for system recovery. For example, early spring use can cause trampling and compaction damage when soils and streambanks are wet. Fall and early winter grazing can encourage excessive browse on willows.	MDNRC, 1999 NRCS, 2002
Encourage the growth of woody species (willow, alder, etc.) along the streambank to limit animal access to the stream and provide root support to the bank.	MDNRC, 1999
Place salt and minerals in uplands, away from water sources (ideally ¼ mile from water to encourage upland grazing). Periodically rotate feed and mineral sites. Keep salt in troughs and locate salt and minerals in areas where soils are less susceptible to wind or water erosion.	MDNRC, 1999 Mosley et al., 1997
Create riparian buffer exclosures through fencing or develop riparian pastures to be managed as a separate unit through fencing. Fencing should be incorporated only where necessary. Water gaps can be included in riparian fencing.	MDNRC, 1999
Critical area planting with short-term fencing	ID DEQ, 2003

The applicability and effectiveness of each of the recommendations provided in Table 11-1 will differ among grazing allotments and pastures, and should be addressed on a site by site basis. The Natural Resource Conservation Service offers technical staff to work with landowners to develop grazing management plans appropriate for their operations on private lands and can develop appropriate site plans.

Several areas on public land were identified as sources of water quality degradation in the 2003 TMDL assessment monitoring. The last two decades has seen improvement in grazing management and stream condition on public lands in many areas of the Ruby watershed, but several sites still appear to be on a downward trend or held at an impaired state. Forest Service and BLM have recently revised grazing plans to improve stream condition. The sites identified by this effort should be incorporated into future water quality and land use planning for public lands.

10.1.2 Road Management Recommendations and BMPs

Most (79%) of the assessed road-related sediment loading is contributed from the Ramshorn Creek, Sweetwater Creek, and Alder Creek watersheds. These watersheds contain the most severe sites for sediment routing. Ramshorn Creek road provides the largest road-related sediment input. The critical site, located in reach RAM5D (Appendix A – Map 2) was assessed through the near-stream sediment source inventory rather than the road inventory due to the length of the site and its proximity to the stream. The next largest sources of sediment from roads are contributed from the Cottonwood Creek, Currant Creek, California Creek, and Mill Creek watersheds. These seven top priority watersheds contribute 93% of the estimated sediment loading from road-related sources. The Cottonwood Creek watershed contains a moderately severe site, but the large loads contributed from the Mill Creek, California Creek, and Currant Creek watersheds are due to a large number of minor sites resulting from poor road drainage. This is also an issue on roads in Indian Creek and Warm Springs watersheds, which contribute the next highest loading.

The road sediment source inventory conducted for the Ruby River watershed identified many specific instances where sediments are transported from roads to waterways. The inventory identified 188 sediment routing sites on public roads. In addition, the near-stream sediment source inventory included 11 assessment reaches with private road crossings acting as sediment sources. Most commonly, the road is simply too close to the stream. The situation is often exacerbated with other factors such as steep, unstable fillslopes, lack of vegetation, and maintenance activities. The primary road-related concerns and restoration recommendations are summarized and described in this section. Road erosion issues and general recommendations are provided below. Additional road BMPs can be found on the Montana DEQ or Montana DNRC websites. The recommendations below provide general guidelines, and are not meant to replace site specific review prior to restoration.

Ditch Relief Combined with Stream Crossings

Inboard ditch systems often flow directly into culvert stream crossings. This is an extremely damaging technique, which contributes large quantities of sediment wherever it is employed. This technique is particularly common on Mill Creek.

Restoration Recommendations

Stream culvert crossings should never be used for ditch-relief. The following road BMPs should be followed to avoid this problem:

- Provide adequate ditch relief up-grade of every stream crossing.
- Construct waterbars, where appropriate, up-grade of every stream crossing.
- Use rolling dips frequently throughout segments of concern.
- Consider eliminating the inboard ditch and out-sloping the road prism in appropriate locations. Out-sloped roads work well where the fillslope is stable and drainage will not flow directly into stream.
- For insloped roads, the inside ditch generally should be on a grade greater than 2% to ensure flow, but less that 8% to prevent down-cutting and erosion. Provide erosion control measures on inside ditch to prevent erosion. Specific engineering requirements must be determined for each road segment.

Ditch Relief Culverts

Ditch relief culverts often transport large quantities of sediment from the inside road ditch to areas outside of the road corridor, typically just beyond the outer edge of the road fill. If the road is near a stream, sediment delivery is highly probable.

Restoration Recommendations

The character of the cutslope and ditch maintenance activities strongly influence how much sediment is available to the stream.

- Inside road ditches should be on a grade greater than 2% to ensure flow, but less than 8% prevent down-cutting and erosion.
- Do not over-maintain ditches; grading often results in an unstable cutslope and associated erosion and sediment delivery.
- Vegetate cutslopes, either by creating conditions that promote natural plant establishment, or seed with an appropriate endemic seed mix.

For the ditch-relief culverts:

- Construct stable catch basins.
- Install culverts sloped to the original topography. If this is not possible, construct a stable drain across unstable fill material to stable and vegetated areas.
- Armor culvert outlets.
- Install culverts on a 20 to 30 degree angle to the ditch to lessen the chance for inlet erosion and plugging.
- Install culverts 2 to 4 percent more than ditch grade to ensure sufficient water velocities to carry sediments through the pipe.

Where water and associated sediments leave the road corridor, ensure adequate sediment filtration between the road and the stream. This can be accomplished many ways:

- Encourage dense plant growth between the road and the stream.
- Construct slash filters.
- Construct “spreader” structures to dissipate water flow energy and associated sediment carrying capacity.
- Use topography to filter sediments; flat, vegetated areas are more effective sediment filters.
- Increase the distance from the road to the stream.

Stream Crossings

Wherever a stream crosses under a road, the waterway is vulnerable to sediment delivery. Culvert stream crossings are a sediment source nearly everywhere they are found. Specific sediment sources include un-armored inlets and outlets, road gradings, and road surface materials.

Restoration Recommendations

Avoid problems associated with stream crossings:

- Place culverts at the base of fill material and at the grade of the original streambed.

- Ensure proper culvert size.
- Armor inlets and outlets.
- Vegetate inlets and outlets.
- Avoid side-casting during maintenance activities.

Road Maintenance

Sediment is often made available to the stream by the way the road is maintained. Current grading practices contribute significantly to the sediment load in many listed tributaries.

Specific problems include:

- Loose soil is side-cast onto fillslopes near streams.
- Berms of loose soil piled on the outside road edge, creating drainage problems by concentrating overland flow down the road.
- Inside ditch maintenance and associated damage to the cutslope also contribute to sediment loading. Once the toe of the cutslope is removed, soils from above the cut will move to fill the void, greatly increasing erosion. Moving or eroding soil rarely allows natural plant establishment.

On Ramshorn Creek large sediment inputs from grading are due in part to the close proximity of the stream and road, in addition to the issues listed above.

Restoration Recommendations

Road maintenance crews must consider sediment delivery to waterways every time they work. Maintenance considerations include:

- Grade materials to the center of the road and compact.
- Avoid removing the toe of the cutslope.
- If necessary, remove/transport loose soils and put them where they will not end up in the stream.

Related construction recommendations:

- Install rolling dips where appropriate. Dips are easy to construct, simply by reversing the road grade for short distances, directing surface runoff to the outside of the road. When installing rolling dips, ensure proper fillslope stability and sediment filtration between the road and nearby streams.
- Eliminate the need for inboard ditch maintenance by out-sloping the road.
- Ensure the cut and fillslopes are not too steep to allow plant growth.

Over-Steepened Slopes

Cut and fillslopes are often constructed beyond the soils' natural angle of repose. Slope stability is strongly influenced by grade. Soil on these slopes are extremely vulnerable to mass wasting and erosion. In addition, establishing vegetation on a moving soil is nearly impossible.

Restoration Recommendations

- Prevent disturbance to vulnerable slopes; for example, inappropriate maintenance and livestock grazing.
- Establish vegetation. A legume/grass mix tailored to the specific ecosystems is generally preferable. Emphasize vegetation near the toe of the slope.
- Place slash on adjacent bare slopes to provide habitat for natural plant establishment.
- In problem areas, employ bioengineering techniques. Bioengineering is an approach to land stabilization that uses plants as engineering materials, such as live-fascines, hedge-layering.
- In some areas, full-bench road construction with no fillslope may be appropriate.

Descriptions of additional BMPs and related information are available at Montana DNRC or the MSU Extension publication, Water Quality BMPs for Montana Forests (MSU Extension, 2001).

Livestock Grazing and Roads

Grazing and road systems have a synergistically negative influence on stream integrity. Cut and fillslopes are extremely vulnerable to disturbance and associated erosion. Adding grazing disturbances to these features significantly accelerates an existing problem. Grazing best management practices (Table 10-1) are recommended to reduce the impact of roads on riparian areas in grazed sites. Specifically, management should emphasize distribution of cattle away from riparian corridors, with attention to the potential of roads to concentrate livestock along streams.

10.1.3 Irrigation Management

Irrigation management issues are primarily related to flow manipulation for irrigation and ditch return water quality. Most listed streams in the lower Ruby watershed are affected by irrigation influences, but irrigation is an important management consideration for the upper watershed as well. The sections below outline the most important critical issues for water quality related to irrigation and recommendations for addressing impacts from irrigation. State law indicates that legally obtained water rights cannot be divested, impaired or diminished by Montana's water quality law (MCA 75-5-705); therefore, local coordination and planning are a necessary component of any irrigation management strategy.

Dewatering

The priority streams for obtaining more instream flow are Indian, Wisconsin, Mill, and Sweetwater Creeks. These streams are on the MFWP list of dewatered streams and are completely dewatered in places at certain times of year. The lower Ruby River is also on the MFWP list of dewatered streams. Local stakeholder coordination has lead to improvements in stream flow in the lower Ruby River during recent years. Mill Creek and the lower Ruby River are listed for temperature, adding to the importance of addressing dewatering on these water bodies. Section 6.0 identifies the relationship between dewatering to stream temperature for Mill Creek and the lower Ruby River.

Indian Creek, Wisconsin Creek, and Mill Creek are all in the same landscape and are severely dewatered for part of the year. All three streams are completely dewatered for part of their length in the area between the lower pediment and the upstream end of the alluvial valley area. Although some dewatering is due to natural loss to ground water in the pediment area, local sources have indicated that recent changes in management on Wisconsin and Indian Creeks have resulted in a drastic reduction in flow. Recent changes in flow have apparently had negative impacts on the fisheries on both of these streams. According to some landowners along these streams, certain areas that used to support trout populations approximately ten years ago are now dry, even at critical times of the year for migration and spawning. Due to dynamics of water use on these streams, water management on these streams must include careful planning and established agreements with landowners regarding water use and instream flows. The costs and benefits of obtaining water for instream uses should be considered on a case-by-case basis.

The costs and benefits of increasing instream flows must also consider westslope cutthroat trout (WCT) populations. Currently parts of Indian Creek and two tributaries to Wisconsin Creek support pure WCT populations. Securing enough instream flow in areas used by WCT should be a priority for water management on Indian Creek and Wisconsin Creek. Fish passage is another consideration for these streams. Lower Indian Creek has been largely diverted into other channels, and is now the main source of water to Leonard Slough, which is a spawning area for brown trout. Any restoration efforts related to reestablishing a natural channel for Indian Creek down to the Ruby River and re-establishing continuity on Wisconsin Creek must consider how to avoid genetic mixing of rainbow trout with WCT and how to maintain trout spawning habitat.

Sweetwater Creek is the only water body in the upper Ruby watershed on the MFWP list of Chronically Dewatered streams. The channel is completely dry for much of the year just below the canyon area. Irrigation is one cause of dewatering, but the influence of natural ground water-surface water interactions on stream flow in Sweetwater Creek has not been quantified. Further study should include an analysis of natural flow dynamics, the influence of current irrigation management, and feasibility of maintaining instream flow.

Ruby River below the dam is on the MFWP list of Chronically Dewatered Streams. Because flows are so heavily controlled by the dam, this segment may have the greatest potential for increasing instream flow because Ruby Dam can be used as a management tool to release saved water during critical timeframes. Other improvements in irrigation may benefit the lower Ruby. Any improvements should be implemented after a feasibility study is completed and should include consideration of fisheries requirements. Ruby River above the reservoir is not considered chronically dewatered, but irrigation improvements on the upper Ruby should be considered as well to benefit instream flows and water supply for the entire mainstem.

Management recommendations include examining the feasibility of leasing instream flow, working with landowners to determine when irrigation withdrawals can be reduced without major economic impacts, and examining opportunities for development more efficient water sources. Any improvements in irrigation efficiency should be coupled with increasing instream flow rather than increasing irrigated area.

Irrigation Return Flows

Surface water irrigation returns have been documented on Sweetwater, Wisconsin, Mill, Indian, Ramshorn, Alder, and California Creeks and lower Ruby River. Irrigation returns account for a large portion of the flow present in dewatered sections of Indian, Wisconsin, Mill, and Ramshorn Creeks. In effect, natural stream flow is taken out for irrigation and replaced with water from irrigation canals and ditches originating from the Ruby Reservoir. Field observations on some of the tributaries indicate ditch return water is higher in temperature and sediment, and possibly nutrients, than the natural stream water in tributaries. Two of the largest inputs of warmer, more turbid water noted in the 2003 TMDL field assessments are the Schoolhouse Ditch at lower Ramshorn Creek and the Vigilante Canal at Wisconsin Creek. The influence of ditch returns on stream flow, water temperature, suspended solids and other water quality constituents is poorly understood. A survey of irrigation return flows and water quality is needed to fully understand sediment and temperature dynamics on water bodies with significant inputs from irrigation returns.

Restoration Recommendations for Irrigation

Several techniques are available for increasing irrigation efficiency over traditional flood irrigation. These include but are not limited to:

- Improved water application systems, including efficient sprinkler or drip systems.
- Flood irrigation using land-leveling and gated pipe.
- Ditch lining or piping.

Further study of the ground water-surface water interactions are recommended before implementing new irrigation techniques because much of the lower Ruby is sub-irrigated from flood irrigation and leakage from irrigation ditches and canals.

Restoration should focus on modifying the current irrigation design to increase instream flows by reducing withdrawals. Revised irrigation management should include reducing ditch return water originating from the Ruby Reservoir, using this water instead to irrigate areas currently irrigated by other stream water where possible.

A water balance and irrigation efficiency study was recently conducted for the lower Ruby valley (Payne, 2004). The TMDL temperature source assessment built upon the Payne 2004 study and estimated the water savings that could be realized by increasing irrigation efficiency in the largest irrigation diversions on the lower Ruby River that divert Ruby Reservoir water. Larger canal systems are likely provide the most cost effective irrigation water management restoration opportunities. Down gradient water availability impacts from individual irrigation water management restoration sites should be considered using ground water models. Impacts due to reduced ground water influence in down gradient fish spawning sites should be avoided.

Existing water rights can be leased for use as instream flow. Several organizations, most notably Montana Water Trust, Trout Unlimited, and MFWP have programs for leasing instream water rights. This option may be a solution where landowners are hesitant to leave more water in the stream due to fear of losing a water right or reducing the economic value or feasibility of an operation. Securing more instream flow will be critical to remove dewatered streams from the impaired waters list.

10.1.4 Other Land Uses

Mining

Placer mining has drastically altered the channel of several listed water bodies, most notably Alder Gulch and Ramshorn Creek, but also smaller portions of California and Currant Creels. In placer mined areas it is important to maintain beaver populations and protect riparian vegetation in placer-mined reaches to allow natural floodplain building and recovery to continue. Active restoration may be desired in some areas, as specified in water body-specific recommendations (Section 10.2). All new mining must adhere to BMPs to protect water quality and channel condition.

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

Montana's AML Program maintains an inventory of all potential cleanup sites, and also has a list of priority sites from which to work from. This includes sites such as the Republic Mine and Smelter Site discussed within this report. The Montana Department of Environmental Quality conducts cleanups under the Abandoned Mine Funds as public works contracts utilizing professional engineers for design purposes and private construction contractors to perform the actual work.

Mitigating impacts associated with discharging adits can be included within the cleanup, although ongoing water treatment is not pursued as a reclamation option to avoid long-term operational commitments, which are outside the scope of the program and funding source. Therefore, even after cleanup, an abandoned mine site could still represent a source of contaminant loading to a stream, especially if there is a discharging adit associated with the site. Where discharging adits are not of concern, cleanup may generally represent efforts to achieve all reasonable land, water, and soil conservation practices for that site.

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

Other Streambank/Floodplain Disturbances

Channel straightening
Stream channels have been straightened in many areas of the Ruby watershed for several purposes related primarily to mining, agriculture, and roads. Channel straightening should be avoided in future management. Restoration approaches that remediate straightened channels, which are sediment sources, are considered on a stream-by-stream basis but associated costs and benefits should be weighed. Any future projects that require stream channel construction or channel realignment should consider natural channel designs.

Floodplain vegetation removal and increased width/depth ratio
As possible, encourage vegetative reinforcement of banks to prevent stream overwidening and increases in width:depth ratio. This entails protection of riparian vegetation and replanting where practical. In some cases bioengineering can be used to reduce channel widths and improve aquatic habitat.

Bank hardening/riprap/revetment/floodplain Development
Limit bank armoring to areas with a demonstrated infrastructure threat. Where deemed necessary, apply bioengineered bank treatments to induce vegetative reinforcement of upper bank, reduce stream scouring energy, and provide shading and cover habitat. Limit infrastructure threats by reducing floodplain development through land use planning initiatives. Development is a growing concern in the Ruby valley. A floodplain management plan should be completed to prevent impacts to floodplain and stream integrity.

10.1.5 Other Watershed Management Issues

This section includes a discussion of issues that are not currently primary limiting factors to water quality, but are a consideration for long-term watershed management and restoration. All of the previous and following management issues are interrelated; therefore a long-term holistic approach to watershed management will provide the most effective results.

Timber Harvest
Current timber harvest currently is not a land use activity significantly affecting water quality in the Ruby TPA. Forest roads are generally known to be the largest sources of sediment from timber harvest, and are addressed under the road recommendations listed above. Future harvest

activities must follow published Forestry BMPs (MT Dept of State Lands, 1994; MSU Extension Service, 2001).

Invasive Weeds
Invasive weeds are a growing concern in the Ruby watershed and most areas of Montana. Developing an integrated weed management plan is recommended to address noxious weeds across land ownership boundaries. This can be accomplished through the establishment of a Weed Management Area (distinguishable areas based on similar geography, weed problems, climate, and human use patterns), which can provide a channel of communication among landowners and a conduit for funding sources (Duncan, 2001). NRCS and County Weed Management Specialists can provide information about weed management BMPs. Weed growth can decrease streambank stability when weeds out compete native species that provide larger root mass.

Beaver Populations
Management of headwaters areas should include improving beaver habitat. Long-term management could include maintenance of headwaters protection areas and managing beaver populations re-established in areas currently lacking the beaver complexes to trap sediment, reduce peak flows and increase summer low flows.

10.2 Site-Specific Restoration Recommendations

Restoration recommendations are presented for areas in which stream assessments and sediment source inventories were completed. Water quality goals can be achieved by addressing these areas or by implementing these strategies in equivalent areas not included in the assessed reaches.

10.2.1 Sediment, Nutrients, and Temperature

Influences on sediment, nutrients, and temperature are largely related in the Ruby watershed. For example, an increase in suspended sediment increases fluxes of particulate nitrogen and phosphorus (McClain et al., nd). In turn, stream temperature can increase when streams become shallower due to excess sediment.

Most of the impaired water bodies in the Ruby valley are listed for sources of impairment related to sediment but only Sweetwater Creek is listed for nutrients and only Mill Creek and the lower reach of Ruby River are listed for temperature. Impairments for sediment, nutrients, or temperature are related primarily to riparian degradation and resulting streambank erosion, road and urban inputs (for sediment and nutrients) and dewatering. Sediment, nutrients, and temperature will be addressed largely with the same management recommendations. Impairment due to metals also relates to sediment production in Ramshorn Creek Watershed, but will be addressed in a separate section for site-specific recommendations.

Focus areas for restoration are prioritized based on sediment load contributions. Prioritization of these sites may also be dependent on land ownership, private landowner participation and priorities, stream condition, T&E species, and human health concerns. Several priority sites based on sediment loading are also in areas supporting pure or nearly-pure populations of

Westslope Cutthroat trout or Fluvial Arctic Grayling. These areas include headwaters in the Tobacco Root landscape and in the upper Ruby River drainage. Distribution of these species is mapped in Map 6 of Appendix A.

Priority Grazing-Related Sediment Sources

Near-stream sources from Ramshorn Creek, Sweetwater Creek, and the upper Ruby River contribute over 50% of the assessed grazing-related sediment load. Warm Springs Creek, Alder Creek, Indian Creek, Burnt Creek, and Coal Creek watersheds are also major sources of sediment to the Ruby River. These subbasins together contribute over 75% of the near-stream grazing-related sediment load. The restoration strategy prioritizes sites on these water bodies to call attention to critical sediment sources. Sites in other watersheds that contribute less sediment may be prioritized in the implementation strategy because of landowner interest or because restoration projects for those sites meld well with other restoration efforts being pursued. This approach prioritizes the most severe sediment sources but encourages restoration in other areas as well to reduce sediment loading throughout the watershed. The implementation strategy is described in Section 10.4.

Reducing sediment loading from grazing on uplands is an important component of the restoration approach. Upland grazing management has recently been modified in USFS and BLM grazing allotments. Restoration should include cooperation with public land management agencies to ensure continued monitoring and adaptive management to reduce erosion from uplands are incorporated with stream corridor restoration.

Table 10-2 lists critical areas from field assessed reaches for grazing-related sediment sources in order from highest to lowest sediment contribution. These are the 40 most severe sites that were assessed during field work, which contribute 69% of the estimated load from near-stream sources related to grazing. Reaches are mapped by sediment load contribution in Appendix A – Map 3. It was not practical to assess all stream reaches within the Ruby Watershed for the TMDL monitoring effort, therefore, reaches with comparable sediment production characteristics as reaches identified in Table 10-2, discovered by future monitoring should also be considered as restoration priorities.

Table 10-2. Priority Grazing-Related Sediment Sources Sites Assessed by TMDL Field Monitoring.

Rank	Stream Name	Reach ID	Estimated Sediment Yield (Tons/Yr)	Percent of Near-Stream Grazing Yield for the Ruby Watershed
1	Ramshorn Creek	RAM5D	14840.9	19.6*
2	Upper Ruby River	RRU7E	3848.4	5.1
3	Sweetwater Creek	SWC2C	3547.2	4.7
4	Sweetwater Creek	SWC1A	2967.4	3.9
5	Warm Springs	WS6C	2068.3	2.7
6	Coal Creek	COA2B	1933.7	2.6
7	Wisconsin Creek	WIS2J	1885.9	2.5
8	Upper Ruby River	RRU9C	1775.7	2.3
9	Ruby River Lower	RRL1L	1634.4	2.2
10	Sweetwater Creek	SWC7H	1488.6	2.0

Table 10-2. Priority Grazing-Related Sediment Sources Sites Assessed by TMDL Field Monitoring.

Rank	Stream Name	Reach ID	Estimated Sediment Yield (Tons/Yr)	Percent of Near-Stream Grazing Yield for the Ruby Watershed
11	Middle Fork of Ruby River	MFR2C	1436.2	1.9
12	Sweetwater Creek	SWC5F	1264.9	1.7
13	Burnt Creek	BUR3B	1045.5	1.4
14	Warm Springs	WS5D	999.9	1.3
15	Burnt Creek	BUR4A	961.2	1.3
16	Indian Creek	IND2H	959.9	1.3
17	Currant Creek	CUR1B	893.8	1.2
18	Middle Fork of Ruby River	MFR3A	708.9	0.9
19	Burnt Creek	BUR2C	705.1	0.9
20	Coal Creek	COA2B	628.8	0.8
21	Indian Creek	IND4E	541.7	0.7
22	Coal Creek	COA1C	494.8	0.7
23	Indian Creek	IND6C	460.7	0.6
24	Cottonwood Creek	COT3A	459.0	0.6
25	Poison Creek	POI1C	421.5	0.6
26	Poison Creek	POI2B	395.2	0.5
27	Wisconsin Creek	WIS2I	382.0	0.5
28	Currant Creek	CUR2A	367.4	0.5
29	Middle Fork of Ruby River	MFR2B	363.5	0.5
30	Basin Creek	BAS1C	317.6	0.4
31	Ramshorn Creek	RAM_NF	289.0	0.4
32	Garden Creek	GAR1A	269.7	0.4
33	Middle Fork of Warm Spring	MFWS-A	261.7	0.3
34	Ruby River Lower	RRL4H	250.4	0.3
35	Granite Creek	GRA-A	232.9	0.3
36	Ruby River Lower	RRL11F	228.7	0.3
37	Coal Creek	COA1C	212.1	0.3
38	Indian Creek	IND4E	193.9	0.3
39	East Fork of Ruby River	EFR4A	192.3	0.3
40	Currant Creek	CUR1B	171.3	0.2

* Sediment loading from this site may be overestimated but is still considered the most critical site.

Road sediment source priority areas

The 20 most severe road-related sediment sources are listed below in Table 10-3. These 20 sites account for approximately 91% of the assessed sediment load from road-related sources in inventoried reaches. Road related sources are color-coded by severity in Appendix A – Map 3. A large portion (67.5%) of the road-related sediment load was attributed to one reach on Ramshorn Creek (Table 10-3). The next 19 sites account for 23.5% of the estimated load due to roads. The load from the highest priority site on Ramshorn Creek may be overestimated, but is considered the most critical site. It was not practical to assess all roads within the Ruby Watershed for the TMDL monitoring effort, therefore, road segments with comparable sediment production characteristics discovered by future monitoring should also be considered as future restoration priorities.

Table 10-3. Priority Road-Related Sediment Sources Sites Assessed by TMDL Field Monitoring.

Water Body	Site ID	Est. Yield Tons/Yr	%Rd Load
Ramshorn Creek	RAM5D	7468.7	67.5*
Cottonwood Creek	136A	830.4	7.5
Ramshorn Creek	RAM_NF	289.0	2.6
Alder	113	225.6	2.0
Alder	115	171.9	1.6
Ramshorn Creek	RAM6B	103.4	0.9
Brown's Gulch	100	95.5	0.9
Sweetwater Creek	151	93.3	0.8
Alder	114	85.3	0.8
Cottonwood Creek	135	80.9	0.7
Ramshorn	78	79.7	0.7
Middle Fork Ruby	168	72.8	0.7
Sweetwater Creek	148	70.9	0.6
Middle Fork Ruby	164 B	69.0	0.6
Warm Springs	189	67.8	0.6
Brown's Gulch	106	62.0	0.6
Middle Fork of Ruby River	MFR2C	60.3	0.5
Brown's Gulch	107	59.7	0.5
Timber Cr.[a]	196 C	52.3	0.5
California Creek	90	44.8	0.4

* Loading from this site may be overestimated but is considered the priority site.
[a] This tributary is not listed as impaired.

The highest priority site on Ramshorn Creek is contributing high sediment loads due to several factors. The road is directly adjacent to the stream at this site. Road grading practices contribute sediment directly to the stream because roads are not re-crowned and material from the road surface is piled at the edge of the road and stream (Appendix F- #RAM14). Grading can contribute high sediment loads over time because additional material is loosened and delivered to the channel every time roads are maintained. Additionally, water is not diverted from the surface before it can flow into the stream at a low spot in the road. Livestock concentrate on the road, exacerbating the problem further by creating a path from the road surface to the stream and kicking loose material from grading into the stream.

Irrigation/Water Management

Excess sediment is delivered by irrigation returns to several listed water bodies, including Mill Creek, Ramshorn Creek, Wisconsin Creek, Indian Creek, California Creek, and Sweetwater Creek. Irrigation returns also may deliver nutrients. Suspended sediment and nutriment monitoring on selected irrigation returns should be incorporated into a future monitoring system and the acquired data should be incorporated into future TMDL reviews as an adaptive management approach.

Dewatering has likely contributed to excess sediment deposition in some stream reaches where flows are not adequate to flush sediments downstream. This effect is particularly evident in the lower Ruby River and Ramshorn Creek, and may affect other stream reaches. Managing irrigation diversions and Ruby Dam operations to accommodate bank full flows on the lower Ruby River and lower Ramshorn Creek during accommodating spring weather conditions may help sort sediment in these two stream segments.

10.2.2 Metals

Impairment from metals in the Ramshorn Creek watershed is generally related to priority abandoned mine sites, other mine sites, and potentially roads and grazing (Appendix A -Map 7). The Goldschmidt/Steiner priority abandoned mine located along the middle reach of Current Creek, a tributary of Ramshorn Creek, appears to contribute metals loading during runoff events although roads and grazing sources in this area are elevated. A combination of other abandoned mine sites in Ramshorn Creek watershed above the Current Creek confluence are likely contributing metals to the stream during runoff events, but these mines can not be prioritized at this time because of lacking data. Further monitoring in upper Ramshorn Creek is needed to refine the source assessment before mine reclamation is funded with clean water act funds. Roads and grazing have been identified as large sediment contributors in the Ramshorn Creek watershed and should be addressed by restoration activities identified in Section 10.2.1. The sediment production from grazing and roads are likely contributing sediment to the stream.

In Mill Creek watershed, the Buckeye abandoned mine site is currently being restored and will further reduce sediment related metals loading for that water body even though no TMDL for Mill Creek is needed based on existing data. The Buckeye mine site was identified as a source of metals associated with sediment in Mill Creek, but did not increase sediment metals above criteria provided in Section 4.0. Monitoring near Smuggler Mine in Mill Creek indicates that metals conditions are not impairing uses in this area. The Middle Fork of Mill Creek may be impaired due to metals near the Uncle Sam priority abandoned mine site, but further data should be collected in this vicinity. Uncle Sam mine site may become a water quality restoration priority depending on the outcome of further monitoring.

Further monitoring for mercury sources in the Alder Creek Watershed is needed before most restoration priorities can be identified, although intensive sediment mercury sampling indicates that Junction Mill is a large source of mercury in the watershed that could be addressed with clean water act funding prior to a TMDL being completed. Other mercury sources are not understood well and can not be prioritized. More mercury monitoring and TMDL formation will be completed in the future.

Water chemistry, sediment chemistry and biological samples all indicate that metals are impacting use in Browns Gulch, a tributary to Alder Creek. Future 303(d) listing will incorporate this new data into the impairment determination process. The Pacific mine site in Brown’s Gulch is a priority for addressing heavy metals in the Ruby watershed. Restoration of the Pacific Mine site should include removing the impacts from the road on the headwaters of Brown’s Gulch, restoring a natural channel form, and re-establishing vegetation on streambanks and disturbed slopes. The Belle mine may be contributing lead to Mill Gulch, a small tributary to Alder Creek, but further monitoring is needed to determine the impacts of this mine to aquatic life before restoration could be funded by clean water act funds.

Priority abandoned mines are also present in the Wisconsin Creek watershed. The Lakeshore Mine may be contributing metals to Crystal Lake. Further sediment, water and biological monitoring should occur in Crystal Lake. Lakeshore mine could become a water quality restoration priority based on future monitoring results. There are no metals water quality restoration priorities in the Indian Creek Watershed although a priority abandoned mine is located here.

10.3 Summary of Restoration Priorities by Water Body

Restoration recommendations are summarized for each water body in Table 10-4.

Table 10-4. Summary of Restoration Priorities for Impaired Water Bodies.

Water Body	Restoration Recommendations	Stakeholders Involved
Alder Creek/Browns Gulch/Mill Gulch	• Pacific Mine site restoration, Browns Gulch. • Improvements in road runoff management and grading practices. • Reconnect natural surface channel at downstream end of placer tailings. • Modify grazing management to reduce riparian grazing; includes Browns Gulch and Granite Creek tributaries. • Re-establish riparian shrubs at severely eroding banks in downstream reaches. • Streambank restoration and stream channel realignment to restore problematic/eroding straightened sections. • Improve fish passage.	Private NRCS BLM Madison County
Basin Creek	• Review suitability of current grazing management. • Implement grazing BMPs, focusing on off-site water and hardened crossings. • Manage for riparian shrubs and aspen where appropriate.	USFS
Burnt Creek	• Review suitability of current grazing management. • Implement grazing BMPs, focusing on off-site water and hardened crossings. • Manage for riparian shrubs and aspen where appropriate.	USFS

Table 10-4. Summary of Restoration Priorities for Impaired Water Bodies.

Water Body	Restoration Recommendations	Stakeholders Involved
California Creek	• Improvements in road runoff management and grading practices. • Manage grazing to allow riparian shrub regeneration, especially in areas adjusting from placer mining. • Manage to maintain beaver populations in areas destabilized by placer mining. • Reduce leakage from canal crossing. • Increase riparian buffer along corrals, decrease width of water gaps and harden the approach. • Improve headgates and weirs. • Improve irrigation diversions/headgates to prevent fish from entering ditches.	Private NRCS USFS BLM Madison County
Coal Creek	• Review suitability of current grazing management. • Implement grazing BMPs, focusing on off-site water and hardened crossings. • Manage for riparian shrubs and aspen where appropriate.	USFS
Cottonwood Creek	• Review suitability of current grazing management; consider sensitive soils in meadows. • Implement grazing BMPs, focusing on off-site water and hardened crossings. • Manage for riparian shrubs.	Private NRCS BLM Madison County
Currant Creek	• Improvements in road runoff management and grading practices. • Manage grazing to allow riparian shrub regeneration.	Madison County USFS BLM
E. Fork Ruby River	• Increase riparian buffer along corrals. • Review suitability of current grazing management in lower reaches.	USFS
Garden Creek	• Review suitability of current grazing management; consider sensitive soils in meadows. • Implement grazing BMPs. Examine potential for off-site water and hardened crossings. • Improvements in road runoff management and grading practices.	Private NRCS BLM Madison County

Table 10-4. Summary of Restoration Priorities for Impaired Water Bodies.

Water Body	Restoration Recommendations	Stakeholders Involved
Indian Creek	• Explore alternatives for increasing instream flow. These may include water leasing for instream flow and improving irrigation efficiency to reduce withdrawals. • Review suitability of current grazing management; consider impacts of livestock on road erosion as well as riparian areas. • Implement grazing BMPs. Examine potential for off-site water and hardened crossings. • Improve road grading practices; seek additional funding for road maintenance if necessary. • Improve road drainage near stream crossings, improve crossing at fords. • Improve fish passage and irrigation structures to prevent fish entrainment to ditches. • Streambank restoration and stream channel realignment to restore problematic/eroding straightened sections.	Private NRCS USFS BLM Madison County
Middle Fork Ruby River	• Manage grazing to allow riparian shrub regeneration. • Follow road BMPs to improve road crossings.	USFS
Mill Creek	• Improve headgates and weirs. • Improve irrigation diversions/headgates to prevent fish from entering ditches. • Improve monitoring of irrigation withdrawals. • Secure instream water through reduced withdrawal; reduce returns from ditches. • Education for urban issues: Include planting native riparian shrubs along streambanks in urban landscaping; avoid clearing native riparian vegetation; avoid dumping yard waste on streambanks. • Implement grazing BMPs in overgrazed reaches. • Continue Buckeye mine site reclamation and monitoring. • Improve road drainage and reduce delivery of runoff to streams. • Improve road grading practices; seek additional funding for road maintenance if necessary.	Private NRCS USFS Madison County
Mormon Creek	• Review suitability of current grazing management; consider sensitive soils in meadows. • Manage for riparian shrubs and aspen where appropriate.	Private NRCS BLM Madison County

Table 10-4. Summary of Restoration Priorities for Impaired Water Bodies.

Water Body	Restoration Recommendations	Stakeholders Involved
Poison Creek	• Review suitability of current grazing management; consider sensitive soils in meadows. • Manage for riparian shrubs and aspen where appropriate.	USFS
Ramshorn Creek	• Improve road grading practices; seek additional funding for road maintenance if necessary. • Improve road drainage and reduce delivery of runoff to streams. • Improve monitoring of irrigation withdrawals. • Manage grazing to reduce livestock access to road and stream. • Secure instream water through reduced withdrawal; reduce returns from ditches. • Improve headgates and weirs. • Improve irrigation diversions/headgates to prevent fish from entering ditches. • Manage grazing to allow riparian shrub regeneration, especially in areas adjusting from placer mining. • Manage to maintain beaver populations in areas destabilized by placer mining. • Streambank restoration and stream channel realignment to restore problematic/eroding straightened sections.	Private NRCS USFS BLM Madison County
Ruby Reservoir	• Research sedimentation in reservoir and unassessed tributaries.	DNRC MDEQ
Lower Ruby River	• Secure instream water through reduced withdrawal; reduce returns from ditches. • Manage for riparian shrubs; re-establish riparian vegetation through native planting in areas where shrub component is lacking. • Incorporate native vegetation in rip-rapped banks. • Assess diversion structures to ensure they are adequate to prevent fish entrainment to canals and ditches.	Private NRCS BLM DNRC Water Projects Division FWP Water Leasing Program
Upper Ruby River	• Secure instream water through reduced withdrawal; reduce returns from ditches. • Assess diversion structures to ensure they are adequate to prevent fish entrainment to ditches. • Manage for riparian shrubs; re-establish riparian vegetation through native planting in areas where shrub component is lacking. • Incorporate native vegetation in rip-rapped banks. • Follow grazing BMPs to reduce livestock grazing on streambanks.	Private NRCS USFS

Table 10-4. Summary of Restoration Priorities for Impaired Water Bodies.

Water Body	Restoration Recommendations	Stakeholders Involved
Sweetwater Creek	• Improve road-stream crossings that contribute sediment. • Follow grazing BMPs to reduce livestock grazing on streambanks. • Secure instream water through reduced withdrawal; reduce returns from ditches. • Manage for riparian shrubs; re-establish riparian vegetation through native planting in areas where shrub component is lacking. • Develop off-site water for pastures below the canyon. • Re-design large irrigation return below Sage Creek.	Private NRCS BLM Madison County DNRC
Warm Springs Creek	• Improve road drainage and replace leaking culvert at spring. • Manage to maintain beaver populations in areas destabilized by placer mining. • Manage grazing to reduce grazing on streambanks and increase riparian shrub cover in meadows.	USFS Private NRCS
West Fork Ruby River	• Manage grazing to reduce streambank erosion in sensitive areas. • Manage for riparian shrubs and aspen where appropriate.	USFS
Wisconsin Creek	• Improve headgates and weirs. • Improve monitoring of irrigation withdrawals. • Secure instream water, reduce returns from ditches. • Retrofit diversions to remove fish passage barriers (except where needed to protect genetic purity of upstream population). • Improve irrigation diversions/headgates to prevent fish from entering ditches. • Off-site water; riparian fencing in most impacted areas; and water gaps with hardened approach. • Improve road drainage near stream crossings, improve crossing at fords.	Private NRCS USFS BLM DNRC

10.4 Implementation Plan

The following sections provide information useful for stakeholders to identify priority restoration projects that are likely to be accomplished and for securing funding for implementing the restoration strategy. Tier 1 restoration priorities should be prioritized the highest for funding, as they address critical areas contributing the highest pollutant loads. Tier 2 priorities are also important for meeting allocations, but are not as critical as Tier 1 priorities. Tier 3 of the implementation plan is likely to evolve as new information is collected and the effects of newly-implemented restoration strategies become evident. The abandoned mine sites identified in the restoration strategy in the Ruby watershed are not high on the State's ranking of priority mine sites for clean-up, but for water quality restoration purposes the abandoned mines are identified in the tiered approach.

10.4.1 Tier 1 Restoration Priorities

Tier one recommendations include projects for higher priority focus areas and areas on private land where landowners are interested in participating in grant programs to implement projects that will improve their operations and water quality. Tier 1 priorities include the top 20 most severe grazing-related areas, except those sites on private land where the landowner cooperation is unknown or is not interested in improvements at this time. The 10 most severe road sites on impaired water bodies are also included in Tier 1. Table 10-5 lists recommendations for Tier 1 priority projects.

The most severe sediment sources occur in areas highly altered by past mining and channel straightening, where segments of road are directly adjacent to streams, or on open range lands on fragile soils on public lands. Eight of the top 20 highest near-stream sources for grazing were on impaired water bodies on National Forest land in the Gravelly landscape of the upper Ruby Watershed. Most of the impaired water bodies on National Forest land in the Ruby watershed are in the Gravelly landscape, which is characterized by unstable geology and highly erodible soils (Appendix A - Map 3 and 4).

The impaired water bodies in the Gravelly landscape include Poison, Burnt, Coal, and Basin Creeks, Upper Ruby River, and Middle Fork Ruby River. Several priority sites can be addressed by revising grazing management on these streams. Grazing on these water bodies is currently managed partly by riding to move cattle out of riparian areas based on riparian standards defined by the Beaverhead-Deerlodge National Forest (Bengeyfield and Svoboda, 1998). Grazing is still causing degradation of riparian habitat and water quality on these water bodies, partly because compliance with the riparian standards is not achieved in many areas.

Grazing management using the riparian standards is only beneficial if there is compliance to maintain acceptable levels of grazing in riparian areas. Riding often is not effective in areas with marginal upland forage suitability: in these areas livestock do not stay in uplands for long after being driven from the riparian area and grazing is concentrated primarily in riparian meadows. A management option that should be prioritized in these areas is to develop offsite water combined with hardened crossings for livestock. Hardened crossings concentrate livestock crossing in one area while reducing erosion from that area. Mineral blocks should be placed in uplands to attract livestock away from riparian areas and reduce forage on willows. In some cases limited riparian fencing may be needed. One option could also include developing limited areas of riparian pasture to control riparian access for shorter duration but high intensity grazing during specific time frames that have less impact due to browsing.

Other considerations for grazing management in the Gravelly landscape include changing distribution of livestock from year to year to keep cattle from becoming overly habituated to the same areas. Changing livestock distribution can be achieved by changing turn out points, collection points, and timing of grazing from year to year. In all public land allotments, range management personnel should review suitability of allotments to make sure they are operable as delineated.

Several other Tier 1 priority sites occur on BLM and private land. Recommendations for the variety of situations present at these sites are outlined in Table 10-5. All improvements or actions are voluntary on private land and will only be pursued with full agreement from the private landowner. The priority sites and recommendations listed in Table 10-5 are based on monitoring conducted for TMDL assessment. Other sites not included in monitoring may also require restoration, and may be prioritized for restoration if they appear to be sources of impairment comparable to those included in the TMDL assessment.

Table 10-5. Tier One Priority Sites and Recommendations.

Tier 1			
Source of Impairment	**Focus Area**	**Recommendation**	**Parties Potentially Involved**
Grazing	Gravelly landscape: Poison, Burnt, Coal, and Basin Creeks, Upper Ruby River, Middle Fork Ruby River (includes reaches COA2B, BUR2C, BUR3B, RRU9C, BUR4A, MFR3A, MFR2C,BAS1C, POI1C, POI2B, COA1C)	Evaluate suitability of allotment; install off-site water, hardened crossings for livestock, change management to achieve compliance of riparian standards.	USFS
	Ramshorn Creek: Tobacco Root landscape and foothills (primarily in RAM5D)	Implement BMPs to reduce livestock access to road and stream in this area; evaluate feasibility of current grazing management (To be implemented along with Road restoration).	BLM, USFS
	Upper Ruby River: reach RRU7	Tentative restoration planned for revegetating eroding banks, improving aquatic habitat diversity and improving irrigation ditches.	NRCS, FWP, Landowner, Contractor
	Currant Creek: CUR1B	Allow recovery of understory vegetation on hillsides bordering stream, reduce bank alteration and riparian browse on shrubs.	USFS
Roads	Ramshorn Creek: RAM5B and RAM6B	Reengineer portions of Ramshorn Creek Road currently abutting the stream and monitor the outcome. If engineering can not meet sediment allocations conduct feasibility study to move segments of the road; revise road grading practices; improve drainage on road segments near stream.	Madison County, USFS, BLM

Table 10-5. Tier One Priority Sites and Recommendations.

Tier 1			
Source of Impairment	**Focus Area**	**Recommendation**	**Parties Potentially Involved**
	Cottonwood Creek: Site 136A	Implement road BMPs to manage runoff; frequent flow diversion and vegetation or other filter at drainsites are important here.	BLM
	Ramshorn Creek (North Fork): RAM_NF	Improve road crossing and drainage to prevent water from small tributary and spring from flowing on road; revise grazing management to reduce hillslope and streambank trampling near road.	USFS
	Alder Creek: Site 113	Reduce contributing road lengths by implementing BMPs to manage runoff.	County
	Alder Creek: Site 114	Reduce contributing road lengths by implementing BMPs to manage runoff.	County
	Alder Creek: Site 115	Reduce contributing road lengths by implementing BMPs to manage runoff.	County
	Brown's Gulch: Site 100	Road/stream restoration to separate stream and road and reduce erosion at Pacific Mine site.	County BLM Private
	Sweetwater Creek: Site 151	Improve road grading practices, implement road BMPs to improve road drainage. Provide better filter and buffer for road runoff.	Madison Co.
	Cottonwood Creek: Site 135	Address 3 gullies induced by the road; reduce contributing lengths and improve drainage.	Madison Co.
Irrigation	Sweetwater Creek, Indian Creek, Wisconsin Creek, Mill Creek, Ramshorn Creek, Lower Ruby River	Feasibility study for improving irrigation efficiency and leasing instream water (see Section 11.0)	NRCS, MDEQ, and/or Contractor
	Ramshorn Creek: Reach RAM2F	Reestablish natural channel if feasible; update headgates to minimize downcutting and erosion; reduce suspended sediment in Schoolhouse Ditch return.	Agency or Contractor
	Ditch returns	Monitoring flow and water quality; See Monitoring Strategy, Section 11.0.	Agency or Contractor
Mining	Alder Creek	Feasibility of mine clean-up at Junction Mill site.	RVTAC,U.S. EPA/MDEQ
	Browns Gulch	Feasibility of mine clean-up at Pacific Mine site.	RVTAC; U.S. EPA/MDEQ
	Mill Creek: Buckeye Mine site at Brandon	Finish ongoing mine site restoration.	Contractor, RVTAC, U.S. EPA/MDEQ

Table 10-5. Tier One Priority Sites and Recommendations.

Tier 1			
Source of Impairment	**Focus Area**	**Recommendation**	**Parties Potentially Involved**
General	Entire TPA	Solicit feedback for additional restoration sites and priorities.	MDEQ, RVTAC, public
	Private lands	Contact additional landowners regarding restoration of critical areas on private land.	RVTAC, NRCS
	Private lands	Education about riparian clearing.	RVTAC, NRCS
	Headwaters areas, especially Gravelly landscape	Feasibility study for identifying and expanding suitable habitat for beaver and expanding beaver populations in headwaters, incorporating moving beaver from problem areas in lower watershed.	Agency or Contractor

Improvements have recently been made in grazing or irrigation management on several private holdings. Table 10-6 summarizes recent improvements as well as future priorities for improving water quality on private lands based on landowner interviews. Projects included in Table 10-6 are likely to reduce pollutant loading if performed properly and should be prioritized for project funding. Information about specific landowners and project locations will be provided to NRCS for landowners interested in participating in grant programs.

Table 10-6. Recent Improvements and Project Priorities for Private Land, Based on Landowner Interviews.

Water Body	**Recent Improvements**	**Recommendations from Assessment**	**Landowner Priorities or Tentative Projects**
Sweetwater Creek	Pipeline/spring development, rotation grazing and cross-fencing.	Off-site water, time grazing to allow shrub and streambank restoration.	Possibly develop 2 more springs.
Lower Ruby River Reach RRL14A	Not noted.	None Noted.	Improve flood irrigation system; possible leveling/gated pipe or ditch lining.
Upper Ruby River	Not noted.	Stabilize banks: off site water, riparian fencing with water gaps in some areas, some replanting?	Improve irrigation ditches to reduce overflow and erosion.
Cottonwood, Garden, and Mormon Creek	Developed and rebuilt springs for off-site water; hired full-time rider.	Continue to make grazing improvements to keep livestock off stream; more off-site water if feasible and hardened crossings for livestock.	Not noted.

Table 10-6. Recent Improvements and Project Priorities for Private Land, Based on Landowner Interviews.

Water Body	Recent Improvements	Recommendations from Assessment	Landowner Priorities or Tentative Projects
Lower Ruby River RRL10G.3	Not noted.	Increase shrub cover, reduce grazing pressure on banks.	Install fencing with water gaps and hardened approaches for livestock; improve wildlife habitat-floodplain and bank planting; weed control.
Lower Ruby River RRL11C and Clear Creek	Pipeline installed.	Improve fencing, install vegetation in rip-rapped areas.	Bridge or hardened crossing on Clear Creek; rootwads or other armoring for banks.
Mill Creek	Not noted.	Off-site water; move corrals back; hardened approach for livestock; manage grazing timing for shrub regeneration.	Develop well with solar pump for livestock watering; bank stabilization to reduce erosion near structure.
Indian Creek north of Sheridan	Evaluated headgate replacement needs.	Retrofit diversions and headgates to improve fish passage and reduce erosion; protect or stabilize streambanks.	Stream enhancement; headgate improvements on all Indian Ck diversions to ranch property.
Lower Ruby River Reach RRL4H	Riparian planting, riparian fencing.	Good improvement; possibly install off-site water or more planting.	Replace water gaps with off-site water.
Wisconsin Creek Reach WIS3F	Installed wheel lines.	Work with upstream and downstream users to secure more instream flow.	Improve diversions and headgates to allow fish passage and prevent fish access to ditches; regulate irrigation withdrawals and otherwise address dewatering.
Willow Creek (not listed)	Habitat restoration project on Willow Creek to provide grayling spawning habitat (private lands)	Not assessed	Future priorities and efforts not known
Lower Ruby River Reach RRL11F-12E	Installed some water tanks, cross-fencing, rotation grazing.	Off-site water; possible fencing with water gap and riparian planting.	More off-site water, improve irrigation to reduce returns.
Privately funded only (not included in future grants)			
Lower Ruby River (several areas)	Riparian fencing for excluding grazing or with water gaps.	Varies by site.	Generally interested in improving aquatic and terrestrial habitat.
Lower Ruby River near Mill Creek confluence	Fencing, hardened approaches, water gaps; some biological control of weeds.	Increase weed control.	Nothing planned except weed control.

Table 10-6. Recent Improvements and Project Priorities for Private Land, Based on Landowner Interviews.

Water Body	Recent Improvements	Recommendations from Assessment	Landowner Priorities or Tentative Projects
Lower Mill Creek	Fencing, hardened approaches, water gaps; some biological control of weeds.	Increase weed control.	A couple more hardened crossings, possibly more weed control.
Warm Springs Creek	Livestock management-timing and rest, monitoring.	None noted.	Thin or remove juniper where encroaching, install native vegetation to stabilize banks if necessary.
Mill Creek reach M3-M4	Diversion retrofit for fish passage, installed pivot irrigation.	Move corrals further from stream, narrow water gap above bridge, improve irrigation, manage for riparian shrubs.	Options for winter pasture, off-site water, improve bird and other wildlife habitat.

Some improvements have also recently been made in grazing allotments on public land. For example, at least 30 gravity fed springs have been developed in the Tobacco Root Grazing allotment over the last 15 years. This improvement has undoubtedly had a positive effect on the condition of Mill, Ramshorn, and Currant creeks; however, grazing is still increasing erosion on Currant and Ramshorn Creeks, as indicated by the presence of critical sites on these water bodies (Table 10-2).

Livestock management of the approximately 223,721 acres of National Forest System Lands in the Ruby River watershed 49,332 acres (22%) are closed to livestock grazing. All or portions of 22 livestock grazing allotments lay within the watershed. Three of these allotments are closed and five have a very small portion within the watershed. All allotments are managed under an Allotment Management Plan. Updated Allotment Management Plans have been completed for 18 of the allotments. The Upper Ruby and Mill Ramshorn allotment in the Tobacco Root range were completed in 1993 and 1994. All others were completed in 1996 and 2000. All management plans include the Beaverhead riparian guidelines for managing livestock use in riparian areas. Long term monitoring has shown these guidelines to lessen livestock impacts to the streams and improve or maintain riparian condition. In addition to the riparian guidelines the District has installed a number of fences and water developments on these allotments to help with the distribution of livestock. With the updated allotment plans 74 troughs and 26 miles of pipeline has been installed helping reduce the need for cattle to water from the streams. Eight hardened crossings have been installed to significantly reduce the impacts of livestock crossing streams. Temporary and permanent fences have been installed around specific riparian areas to exclude livestock. The District puts on a riparian guideline/monitoring training for permittees and their riders on an annual basis. District Rangeland Management Specialists work closely with the permittees and riders throughout the grazing season to insure AMP guidelines are followed.

Additionally, the Dillon Field Office of BLM conducted the Middle Ruby Watershed Assessment during the summer of 2003 and assessed portions of Cottonwood Creek. The assessment report was issued in December of 2003. In 2004 revised management plans were developed. DEQ was provided copies of the reports and management plans. Two projects to protect spring sources, provide offsite water and draw cattle off Cottonwood Creek were implemented in 2005.

In 2000 portions of Garden Creek and Cottonwood Creek, as well as Hinch Creek and Peterson Creek, were assessed by BLM in association with the Garden Creek Allotment evaluation. An allotment management plan was developed to address stream conditions where streams were not meeting riparian health standards. A Grazing Decision was issued in March of 2002 which implemented a revised allotment management plan. Additional baseline monitoring was established during the 2002 field season. In 2006 the monitoring will be reread and management will be adjusted as necessary to meet defined objectives.

Other recent projects that should improve conditions on impaired water bodies are the Kelley Spring Pipeline, implemented in 2002, and the Sauerbier Ranch Pipeline, installed in 2001. These projects both influence upper Sweetwater Creek. Rotation grazing and cross-fencing were also installed on both project areas. Monitoring has been initiated, but it is still too early to tell how much improvement has resulted from these projects, especially in light of the recent dry years; however, cattle apparently have been spending noticeably less time in the stream and riparian area. The Monitoring Strategy (Section 11.0) will address effectiveness monitoring for recently implemented and proposed restoration projects.

The Madison District of the BDNF has completed a number of road and bridge improvement projects over the last ten years. The Ruby Centennial road has had all bridges reconstructed or re-set to reduce stream impacts by these structures. In addition drainage and surfacing was completed along twenty miles of the Ruby road. This includes the County portion from the Warmsprings Bridge north. Road drainage improvement and surfacing has been completed on the upper portion of the Warmsprings road. The Cottonwood bridge was replaced and the approaches improved. This bridge replacement corrected a significant stream/bridge misalignment. These improvements will reduce sediment input in to the drainage. Annual road maintenance occurs on the District with an emphasis on reducing or eliminating sediment input to streams. Heavy maintenance on the Mill Creek road in the Tobacco Roots occurred in 2005. Drainage and spot surfacing was completed along five miles of road.

10.4.2 Tier 2 Restoration Priorities

Tier 2 includes the 10 next highest priority road sites on impaired water bodies; grazing source priority sites in the top 20 critical sites but where the landowner has not yet been contacted or has not expressed interest in improvements at this time; and lower priority grazing source sites on public land. Tier 2 also includes implementing improvements based on the feasibility studies listed in Tier 1. Table 10-7 details Tier 2 restoration priorities. The priority sites and recommendations listed in Table 10-7 are based on monitoring conducted for TMDL assessment. Other sites not included in monitoring may also require restoration, and may be prioritized for restoration if they appear to be sources of impairment comparable to those included in the TMDL assessment.

Table 10-7. Tier 2 Restoration Priorities Based on Stream Assessments.

Tier 2			
Source of Impairment	**Focus Area**	**Recommendations**	**Potential Participants**
Roads	Currant Creek: Site 78	Improve road grading practices, implement road BMPs to improve road drainage. Provide better filter and buffer for road runoff.	BLM
	Middle Fork Ruby: Site 168	Install BMPs to manage drainage above jct. of Poison Creek Road.	USFS
	Sweetwater Creek: Site 148	Improve road grading practices, implement road BMPs to improve road drainage. Provide better filter and buffer for road runoff.	Madison County
	Middle Fork Ruby: Site 164B	Implement road BMPs to improve road drainage.	USFS
	Warm Springs Creek: Site 189	Implement road BMPs to improve road drainage.	USFS, Madison County
	Brown's Gulch: Site 106	Road/stream restoration to separate stream and road and reduce erosion at Pacific-Eastern Mine site.	Madison County BLM Private
	Middle Fork Ruby: MFR2B	Implement BMPs to improve runoff mgt, lower erosion from fill.	USFS
	Brown's Gulch: Site 107	Implement BMPs to improve runoff mgt, lower erosion from tread and fill.	Madison County BLM Private
	California Creek: Site 90	Implement road BMPs to improve runoff management.	Madison County BLM
Grazing	Sweetwater Creek: reaches SWC2C and SWC1A	Establish off-site water, maintain more instream flow, manage grazing to reduce duration of riparian grazing.	Landowner, NRCS or other agency funding
	Warm Springs Creek: reach WS6C, WS5D	Reduce riparian grazing through implementation of BMPs; emphasize reestablishment of riparian vegetation.	Private landowner and NRCS or Forest Service (ownership status may be changing)
	Wisconsin Creek: reach WIS2J	Riparian fencing with watergaps to allow willow regeneration; move corral back a few feet; provide off-site water and hardened crossings; replace riprap/rubble with bioengineered structures or mature willow.	Private landowner, NRCS or other agency funding
	Lower Ruby River: reach RRL1L	Increase buffer between cultivated area and streambanks; protect willow coming in on lower banks, encourage willow regeneration.	Landowner, NRCS or other agency funding
	Sweetwater Creek: reaches SWC7H, SWC5F	Off-site water, possible changes using riding or timing.	Landowners, NRCS
	Indian Creek: reach IND2H	Change timing or duration of grazing to reduce browse on shrubs.	Private

Table 10-7. Tier 2 Restoration Priorities Based on Stream Assessments.

Tier 2			
Source of Impairment	**Focus Area**	**Recommendations**	**Potential Participants**
	California Creek: Reach CAL2D	Increase riparian buffer along corrals, decrease width of water gaps and harden the approach.	Private, NRCS or other agency funding
	Alder Creek: Reach ALD2C	Re-establish riparian shrubs at severely eroding banks.	Private, NRCS or other agency funding
	Granite Creek	Implement grazing BMPs to reduce riparian grazing.	Landowners, NRCS
Mining	Alder Creek: Reach ALD3	Reconnect channel through tailings.	Other funding
	See Map 7, Appendix A	Address priority abandoned mine sites not addressed in Tier 1.	Other agency funding
General	Alder Creek: Reach ALDF	Correct culvert grade for fish passage.	Madison County/ other funding?

10.4.3 Tier 3 Restoration Priorities

Tier 3 includes low priority areas and other priorities as they develop from the first two tiers. The restoration approach needs to be flexible to reflect changes in conditions, changes due to results of monitoring, and unforeseen changes in priorities and funding. Monitoring is part of all phases of the restoration approach, and is described in detail in Section 11.0.

10.5 Coordination

Restoration priorities are presented in Tables 10-5 through 10-7 (above) in a way that can be incorporated into grant applications. Securing funding and implementing restoration strategies will require coordination with private and public land managers of critical areas. The watershed coordinator, RVTAC and/or NRCS should contact landowners at reaches included as priority areas and arrange a meeting for grant applicants. Watershed Consulting conducted the landowner interviews under the understanding that the information for specific properties would remain confidential unless the landowner authorized its release and the landowner interviews were not paid for by TMDL funding efforts and are provided as an in-kind service to stakeholders in the Ruby Watershed. The information will be shared with the grant application committee upon landowners' approval.

Sixteen private landowners, generally those with large land holdings along listed water bodies, have been interviewed to date. Several landowners were called but were not available and were not interviewed. Many landowners were not contacted, as conducting phone interviews was not in the scope or budget of the TMDL analysis. The watershed committee should work with NRCS to contact additional landowners, especially those with property at critical areas. Landowners that were interviewed were asked about priorities for management of the property, their interest in implementing improvements with or without grant funding, their interest in participating in federal programs or funding, their perception of needed improvements for the property, and what improvements have recently been completed.

Restoration should reflect landowner priorities as well as agency management requirements and priorities. Based on feedback from the 11 interviews that included ranking priorities, the most important management objectives, listed in order of importance, are:

1. Long-term economic sustainability
2. Reduce erosion
3. Aesthetic value
4. Reduce noxious weeds
5. Improve irrigation/water supply

Also of importance were improving water quality, wildlife habitat, resale value, and ecologic sustainability, followed closely by improving fish and aquatic habitat. Of lesser importance were short-term economic gain, removing the water body from the impaired waters list, and guiding for hunting or fishing or other alternative income. This cursory survey provides some general information about priorities for management of private lands in the Ruby watershed, but each individual project application will reflect different management priorities. Interviews should be continued in the future to acquire more thorough information about potential projects for private land and a better understanding of landowner priorities.

SECTION 11.0
MONITORING STRATEGY AND ADAPTIVE MANAGEMENT

11.1 Introduction

This section provides a monitoring strategy to strengthen the TMDLs presented in this report, assess water quality issues on water bodies that are not currently listed but may be impaired, and determine the effectiveness of restoration activities recommended in Section 10.0 once they are implemented. Funding for future monitoring is uncertain and variable due to economic and political change. Prioritization of monitoring activities depends on stakeholder priorities for restoration activities and funding opportunities.

11.2 Future Monitoring Guidance

There are a few objectives for future monitoring in the Ruby Watershed. Monitoring identified in this section is needed to observe sediment, metal and nutrient conditions over time as restoration activities occur. Another goal of monitoring identified in this section is to strengthen current TMDL source assessments in a few areas before well-informed restoration can occur. A third objective of monitoring identified in this section will identify streams and pollutants that should be investigated further because there are indications that TMDLs may be needed.

11.2.1 Strengthening Source Assessment Prior to Restoration Work

The primary focus of this section identifies weak links in the existing source assessments. Strengthening source assessments should also include assessment of future sources as they arise. Urban land use may continue to expand near the town of Sheridan. Mining activities may be initiated if heavy metal prices continue to rise. Recreational use of the watershed also continues to increase. If these new sources occur, new data should be used to update TMDL allocations.

11.2.1.1 Nutrients

Sweetwater Creek is the only water body listed for nutrients in the Ruby River TPA. Further monitoring is recommended to strengthen our understanding about existing instream conditions. Monitoring should include sampling for Total nitrogen (TKN+NO2/3), total phosphorus, and orthophosphorus at above the canyon and near the confluence with the Ruby River (see Maps 14 and 15, Appendix A). Monitoring at these locations will also aid in tracking nutrient conditions over time if restoration activities occur. Chlorophyll *a* samples should be collected in coordination with nutrient sampling during the warmest portion of the summer. Associated flow measurements should be collected with all nutrient and chlorophyll *a* samples.

Further investigation of sources of nutrients in ground water, including management history, is recommended for Sweetwater Creek. Currently there is not enough information to determine if fertilizer additions in irrigated areas are affecting nutrients conditions Sweetwater Creek. The first step to addressing potential inputs of fertilizer to Sweetwater Creek in surface water or ground water is to work with landowners to determine the history of fertilizer application. Nutrients from fertilizer application may persist in ground water for several years.

11.2.1.2 Sediment

Quantifying sediment and nutrient loads from irrigation returns is recommended to refine TMDLs developed for the Ruby TPA. Future assessment should include monitoring ditch return flows for discharge volume, water temperature, TSS, and nutrients for Mill, Indian, Wisconsin, Sweetwater, Ramshorn, and California Creeks and the upper and lower Ruby River. Irrigation withdrawals should be quantified for streams that do not already have a commissioner or monitoring program. Quantifying the influence of dewatering on sediment transport should also be part of future analysis efforts.

If there is stakeholder interest to do so, future TMDL reviews could refine the allocation approach to include a source assessment specific to road ownerships such as BLM, county, private and USFS areas. Allocations and restoration activities would likely benefit from this.

Additional monitoring is recommended to gain a better understanding of streambank retreat rates. Streambank retreat rates are part of the equation for calculating sediment loading from near-stream sediment sources for sediment TMDLs and allocation. The current sediment TMDLs are calculated using literature values for streambank retreat rates. Measuring streambank retreat rates on water bodies within the Ruby TPA would be useful to verify or revise the current TMDLs and would also be useful for completing or revising sediment TMDLs in other watersheds throughout southwest Montana and other areas with similar settings. Bank retreat rates can be determined by installing a series of bank pins at different positions on the streambank at several transects in sites placed in a range of landscape settings and stability ratings. Bank erosion is documented after high flows and throughout the year for several years to capture retreat rates under a range of flow conditions.

11.2.1.3 Temperature

Irrigation returns can contribute to sediment and nutrient loading in the water bodies to which they drain. Irrigation withdrawals can cause increases in stream temperature and reduce the efficiency of sediment routing. These effects potentially affect the TMDLs for several streams in the Ruby River TPA, but the scope of the TMDL assessment did not include many monitoring locations that included flow and water quality of irrigation withdrawals and returns. Irrigation also has a large influence on ground water in the Ruby valley, which in turn, influences surface water conditions.

A previous study (Payne, 2004) has preliminarily examined ground water and irrigation for the lower Ruby River. Some irrigation inflows and outflows have been identified in the ground water study. An aerial assessment of temperature trends in the lower Ruby using Forward-Looking Infrared (FLIR) technology also identified some influences of irrigation on the temperature of the lower Ruby River (See Appendix G). The initial assessment of irrigation contributions conducted in these studies should be expanded upon with comprehensive monitoring that will characterized and map all irrigation withdrawals and surface returns and will monitor a subset of them to document water quality (temperature, nutrients, TSS).

A water balance and irrigation efficiency study was recently conducted for the lower Ruby valley (Payne, 2004). This study could be expanded upon to examine further the effects of changing current flood irrigation and implementing ditch lining on surface and ground water. Additionally a feasibility study is needed to determine if the irrigation infrastructure can be modified to reduce irrigation returns and retain more instream flow. Once feasible irrigation improvements are identified and planned, additional monitoring should be conducted to quantify irrigation effects to ground water conditions and ultimately surface water before improvements are implemented. As irrigation efficiency projects are implemented, effectiveness monitoring should occur to see how much water is saved by each project. An economic analysis of each irrigation efficiency project should also occur to determine the cost of the saved water. See a recently completed report for the Upper Jefferson River for an example of determining the most cost effective saving water alternatives. This effort would need local initiation. Funding would likely come from both local match and also federal and state sources.

11.2.2 Impairment Status Monitoring

MDEQ will provide the lead agency for developing and conducting impairment status monitoring. Other agencies or entities may work closely with MDEQ to provide compatible data if interest arises. Impairment determinations are conducted by the State of Montana but can use data from other collection sources. The following section provides general guidance for future impairment status monitoring.

11.2.2.1 Sediment

TMDLs for Shovel Creek and the West Fork Ruby River are provided even though impairment linkage is poorly understood. A plan to link grazing impacts to increased sediment loading and ultimately to impacts on the fisheries should be completed if there is a need to understand fishery impacts prior to any restoration activities. Biological metrics are near thresholds used for determining impairment and sediment sources are present, therefore trend monitoring may be useful. The monitoring would include more robust stream bank erosion, channel cross-section, stream bottom content and riparian vegetation monitoring. This monitoring would likely occur via funding from MDEQ or USFS.

Pool conditions are very relevant targets for sediment TMDLs because they relate directly to sediment conditions in the stream, sediment transport, and to the fishery use. Pool related targets could not be used for the Ruby TMDL because pool reference conditions are ill defined in southwest Montana. A more robust regional study that would assess pool characteristics in reference streams would be useful for setting pool related TMDL targets. Pool frequency and residual pool depth are useful indicators of sediment impairment.

Future TMDL related monitoring should consider measuring at least 3 Rosgen cross sections per assessment reach. Also if pebble counts are used, at least a 300 count measure should be used to help overcome uncertainty and bias of the method. McNeal cores should be considered in areas identified as important spawning locales. A more quantified approach, such as greenline transects, should be to assess riparian conditions that influence bank erosion. All eroding bank heights and lengths should be measured in an assessment reach for future assessments.

MDEQ is currently considering overall biological health and also sediment related metrics for macroinvertebrates and periphyton assessments. These new metrics will have more confidence than those used in this document and should be considered during future TMDL reviews.

11.2.2.2 Metals

Wisconsin Creek was listed for metals on the 2004 303(d) List. The listing for metals is based primarily on sediment sampling and because a discharge adit from the Lakeshore Mine enters Crystal Lake, from which Wisconsin creek flows. Crystal Lake also contains mine tailings. Sediment sampling on Wisconsin Creek revealed high concentrations of metals in sediments downstream of Crystal Lake and an increase in metals sediments from above Leiterville down to below the confluence of Noble Fork. Metals found in high levels in sediments include copper, mercury, lead, zinc, and cadmium, arsenic, and iron. No water quality samples had metal targets exceedences. Although the biology, water chemistry and sediment chemistry do not indicate metals are impacting uses when compared to the process presented in Section 4.0 of this document, further monitoring for metals is needed on Wisconsin Creek to track metals conditions because of their presence in benthic sediments. Monitoring should include sediment sampling for the metals, above and below the Lakeshore mine adit, above Leiterville, below Crystal Lake, above and below the confluence of Noble Fork, and just above the confluence on Noble Fork. Water quality sampling at high and low flow and biomonitoring at low flow should be conducted as well to determine if contaminated sediments are entering the water column or harming aquatic life. Due to the presence of low levels of mercury in sediments in Wisconsin Creek, biomonitoring should include fish tissue sampling for mercury. Water column sampling will include low-level mercury analysis.

Mill Creek is listed in 2004 303(d) List for lead, zinc, and metals, as well as other pollutants. High concentrations of metals were found in sediment samples collected from abandoned mine sites on the Middle Fork of Mill Creek. More recent water quality monitoring did not indicate impairment from metals. See Section 5.0 for details of the impairment status review for Mill Creek. Due to the potential concern of impairment in the Middle Fork of Mill Creek, and water column sampling at high and low flow as well as sediment metals sampling are recommended for the Middle Fork of Mill Creek. Biomonitoring, including fish tissue sampling for mercury, is recommended at low flow.

Section 5.0 provides a detailed impairment status review for Alder Gulch and Browns Gulch. Mercury was the only metals found in the sediment and fish at levels that are likely injurious to aquatic life or humans in Alder Creek mainstem. Further mercury source assessment is needed for TMDL development for the Alder Watershed.

Browns Gulch is a major tributary to Alder Creek that also contains priority abandoned mine sites. Water chemistry, sediment chemistry, and biomonitoring data all indicate metals, specifically mercury and lead, impact uses in Browns Gulch. Instream sediment chemistry data collected in 1993 shows elevated levels of lead below the Kearsage Mine in Mill Gulch, another tributary to Alder Creek. Monitoring recommendations for Alder Gulch and its tributaries include lead sediment, water column, and biomonitoring above and below priority abandoned mine sites on Mill Gulch and Browns Gulch.

The Goldschmidt-Steiner priority abandoned mine site is directly adjacent to Currant Creek, a tributary to Ramshorn Creek. Metals have not been listed as a cause of impairment for Currant Creek, however, a number of water quality samples collected during runoff conditions yielded lead and copper levels that exceeded hardness-based chronic standards for aquatic life. Because of the presence of mining sources, water chemistry samples slightly above chronic aquatic life standards and metals concentrations found in stream sediments, monitoring future metal and toxicity trends in this watershed is recommended. Monitoring should include high flow and low flow water column sampling including lead, copper, and low-level mercury, sediment metal sampling, and biomonitoring including benthic periphyton, aquatic macroinvertebrates and fish tissue samples. Monitoring metals in Currant Creek will help fulfill a portion of the adaptive management strategy provided for the Ramshorn Creek lead TMDL. Due to the limited availability of data for Ramshorn Creek, adaptive management and future monitoring are key components of the metals TMDL. Sediment and water column samples should be collected above the confluence of Currant Creek to further delineate the magnitude of sources in this area.

Poison Creek has not been listed for metals, but samples from 2001 detected levels of cadmium exceeding water quality standards for aquatic life support. Samples collected in 2004 found detectable levels of cadmium but no exceedences. Further monitoring is needed to determine if anthropogenic influences are causing high levels of cadmium in Poison Creek. Monitoring should include water sampling at high and low flows, sediment metals monitoring and biomonitoring above and below known mine locations. Future 303(d) listing review for Poison Creek should consider newly collected data. The State of Montana will list cadmium as a cause of impairment in Poison Creek if human caused sources are identified.

11.2.2.3 Nutrients

Several streams not currently listed for nutrients as a cause of impairment showed nutrient exceedences of values selected as targets for Sweetwater Creek. However, natural conditions for nutrients in these other tributaries are not understood well. More monitoring for nutrients is recommended on all streams showing exceedences of values selected as targets for Sweetwater Creek and should include establishing reference conditions to make comparisons to.

These water bodies include Ramshorn Creek, lower Mill Creek, Currant Creek, Alder Creek, and the Middle Fork of Ruby River. The impairment determination for these water bodies (Section 5.0) includes a discussion of indicators of high nutrient levels. Additionally, the City of Sheridan has a permit for wastewater treatment lagoon discharge to a branch of Indian Creek, which may actually be returning partially to Mill Creek in subsurface flow. Nutrients should be monitored above and below sections of stream with the most potential influences from agriculture, generally at the top of the foothills/pediment landscape and just above the confluence, for water bodies in the lower Ruby valley. Monitoring should include the same the same parameters as outlined for Sweetwater Creek.

11.2.2.4 Other Water Bodies

Several water bodies that are not included on the 303(d) list of impaired waters and were not part of the detailed TMDL assessment nevertheless exhibit signs of impairment or have potentially significant pollutant sources, such as road-related sediment inputs or signs of riparian or channel degradation in assessments completed by public land management agencies. These water bodies include Robb, Ledford, Willow, Barton, Idaho, and Granite Creeks, and Browns Gulch. Recommended monitoring for these water bodies includes MDEQs monitoring for 303(d) listing review. Road-related sediment source inventory has been completed for most of these water bodies. Montana's statewide monitoring efforts include assessing streams with no previous data. The statewide monitoring program may address other streams in the Ruby Watershed that are not identified in this document.

11.2.3 Effectiveness Monitoring for Restoration Activities

The following recommendations are categorized by the type of restoration practice to which they apply.

11.2.3.1 Road BMPs

Monitoring road sediment delivery is necessary to determine if BMPs are effective, to determine which are most effective, and to determine which practices or sites require modification to achieve water quality goals. Effectiveness monitoring should be initiated prior to implementing BMPs at treatment sites.

Monitoring actual sediment routing is difficult or prohibitively expensive. It is likely that budget constraints will influence the number of monitored sites. A detailed monitoring study design should be developed once specific restoration projects are identified. Monitoring at specific locations should continue for a period of 2-3 years after BMPs are initiated to overcome environmental variances.

Specific types of monitoring for separate issues and improvements are listed in Table 11-1.

Table 11-1. Monitoring Recommendations for Road BMPs.

Road Issue from Section 10.0 (Restoration)	Restoration Recommendations	Monitoring Recommendation	Recommended Methodology
Ditch Relief Combined with Stream Crossings	• Re-engineer & rebuild roads to completely disconnect inboard ditches from stream crossings. Techniques may include: o Ditch relief culverts o Rolling dips o Water Bars o Outsloped roads o Catch basins o Raised road grade near stream crossing	• Place silt trap directly upslope of tributary crossing to determine mass of sediment routed to that point • Rapid inventory to document improvements and condition	• Sediment yield monitoring based on existing literature/USFS methods • Revised Washington Forest Practices Board methodology

Table 11-1. Monitoring Recommendations for Road BMPs.

Road Issue from Section 10.0 (Restoration)	Restoration Recommendations	Monitoring Recommendation	Recommended Methodology
Ditch Relief Culverts	• Consider eliminating the inboard ditch and outsloping the road or provide rolling dips • When maintaining/ cleaning ditch, do not disturb toe of cutslope • Install culverts with proper slope and angle following Montana road BMPs • Armor culvert outlets • Construct stable catch basins • Vegetate cutslopes above ditch • Increase vegetation or install slash filters, provide infiltration galleries where culvert outlets are near a stream	• Rapid inventory to document improvements and condition • Silt traps below any ditch relief culvert outlets close to stream	• Revised Washington Forest Practices Board methodology • Sediment yield monitoring based on existing literature/USFS methods
Stream Crossings	• Place culverts at streambed grade and at base of road fill • Armor and/or vegetate inlets and outlets • Use proper length and diameter of culvert to allow for flood flows and to extend beyond road fill	• Repeat road crossing inventory after implementation • Fish passage and culvert condition inventory	• Revised Washington Forest Practices Board methodology • Montana State (DNRC) culvert inventory methods
Road Maintenance	• Avoid casting graded materials down the fill slope & grade soil to center of road, compact to re-crown • Avoid removing toe of cut slope • In some cases (primarily Ramshorn Creek Road) graded soil may have to be removed or road may have to be moved	• Repeat road inventory after implementation • Monitor streambed fine sediment (grid or McNeil core) and sediment routing to stream (silt traps) below specific problem areas	• Revised Washington Forest Practices Board methodology • Standard sediment monitoring methods in literature
Oversteepened Slopes/General Water Management	• Where possible outslope road and eliminate inboard ditch • Place rolling dips and other water diverting techniques to improve drainage following Montana road BMPs • Avoid other disturbance to road, such as poor maintenance practices and grazing	• Rapid inventory to document improvements and condition	• Revised Washington Forest Practices Board methodology

11.2.3.2 Agricultural BMPs

Management improvements related to grazing, irrigation, and crop production have been implemented in many areas throughout the Ruby River TPA. These projects have been implemented through NRCS or private funds, and often include monitoring specific to those projects. Additional monitoring is recommended below for future improvements and projects.

Grazing BMPs function to reduce grazing pressure along streambanks and riparian areas. Recovery resulting from implementing BMPs may be reflected in improved water quality, channel narrowing, cleaner substrates, and recovery of vegetation along streambanks and riparian areas. Effectiveness monitoring for grazing BMPs should be conducted over several years, making sure to start monitoring prior to BMP implementation. If possible, monitoring reaches should be established in pastures keeping the same management as well as in those that have changed. Where grazing management includes moving livestock according to riparian use level guidelines, it is important to monitor changes within the growing season as well as over several years. Monitoring recommendations to determine seasonal and longer-term changes resulting from implementing grazing BMPs are outlined below in Table 11-2.

Table 11-2. Effectiveness Monitoring Recommendations for Grazing BMPs by Restoration Concern.

Recovery Concern	Monitoring Recommendations	Methodology or Source
Seasonal impacts on riparian area and streambanks	Seasonal monitoring during grazing season using riparian grazing use indicators • Streambank alteration • Riparian browse • Riparian stubble height at bank and "key area"	BDNF/BLM riparian standards (Bengeyfield and Svoboda, 1998)
Long-term riparian area recovery	• Photo points • PFC/NRCS Riparian Assessment (every 5-10 yrs) • Vegetation Survey (transects perpendicular to stream and spanning immediate floodplain) every 5-10 years o Strip transects- Daubenmire 20cm x 50cm grid or point line transects	Harrelson et al., 1994; Bauer and Burton, 1993; NRCS, 2001 Stream Assessment Protocols
Streambank stability	Greenline including bare ground, bank stability, woody species regeneration (every 3-5 years)	Modified from Winward, 2000
Channel stability	Cross-sectional area, with % fines/ embeddedness • Channel cross-section survey • Wolman pebble count • Grid or McNeil core sample	Rosgen, 1996; Harrelson et al., 1994
Aquatic habitat condition	• Aquatic macroinvertebrate sampling • Pool quality • R1/R4 aquatic habitat survey	MDEQ biomonitoring protocols; Hankin and Reeves, 1988; USFS 1997 R1R4 protocols
General stream corridor condition	EMAP/Riparian Assessment (every 5-10 yrs)	NRCS 2001 Stream Assessment Protocols; U.S. EPA 2003.

Irrigation is an important influence in the Ruby River TPA. The potential positive and negative effects of improving the efficiency of irrigation practices is a topic of research in an ongoing study of irrigation and ground water dynamics (Payne, 2004). This study should be continued to determine the best irrigation BMPs and improvements to establish in the future. Further study should include an analysis of natural flow dynamics, the influence of current irrigation management, and feasibility of maintaining instream flow.

Some detrimental effects of current irrigation practices have been documented in stream assessments and need to be addressed. These impacts generally involve irrigation returns and outdated diversions or headgates (see Section10.0). Recommendations in Section 10.0 include repairing problem headgates and diversions and reducing irrigation return flow or implementing BMPs to reduce pollution in irrigation return water. Irrigation return flows and withdrawals should be monitored more thoroughly as part of the effort to understand the influences of irrigation on pollution levels and dewatering in listed water bodies. Monitoring should include collecting water quality samples for nutrients (TP, TN, NO2_3, chlorophyll a), temperature, and TSS directly upstream and downstream of irrigation return sites before and after improvements are implemented. Monitoring should be conducted before, during, and after water use periods for several years.

Fish passage is an issue associated with dewatering and poorly-designed or damaged diversions, especially in Wisconsin, Ramshorn, and Indian Creeks. Fish population surveys and fish passage inventory are recommended for these streams before and after improvements are made.

11.2.3.3 Mine Site Restoration

The Buckeye and Uncle Sam mine sites on Mill Creek are potential sources of pollution due to metals and are sources of metals-laden sediment above the town of Sheridan. Restoration of the Buckeye mine site on Mill Creek has been initiated, and includes some monitoring. Effectiveness monitoring for this site and for future remediation at other priority mine sites in the watershed should include consideration of water quality, vegetation, and channel and floodplain stability. Recommendations for mine site remediation effectiveness monitoring are outlined in Table 11-3. These recommendations may change according to site-specific needs.

Table 11-3. Recommendations for Mine Site Remediation Effectiveness Monitoring.

Issue	Monitoring Recommendations
Water quality	Sample for heavy metals and TSS in water column and channel substrate at high and low flow above and below mine site. Monitoring should be initiated prior to remediation efforts and continue for at least 10 years after site restoration. Monitoring should include biomonitoring at low flow every 3 years.
Channel and floodplain stability	Wolman pebble counts for substrate embeddedness; Aquatic macroinvertebrate sampling every 3 years. Measure streambank stability and percent bare ground at greenline and on floodplain immediately prior to and after restoration, and again every 3 years.
Vegetation re-establishment	Greenline survey every 3 years, including bank stability, shrub regeneration, and bare ground. Vegetation transects across floodplain for vegetation community structure and regeneration.

11.2.3.4 Other Restoration Activities

This TMDL assessment has revealed the importance of beaver to stream systems within the Ruby River TPA. Several agencies and landowners with interests in the Ruby TPA have recognized the importance of beaver as well. A fledgling program to live-trap problem beaver and move them to headwaters areas has met with mixed success, partially due to a lack of information about habitat and behavioral requirements for successful reintroduction. Beaver are important for managing water and sediment runoff and allowing recovery of riparian zones in headwater streams. Re-establishing populations in those areas may be an important tool for restoring natural channel dynamics and healthy riparian zones. Monitoring is needed to identify areas that can support beaver populations, define habitat requirements to be able to assess likelihood of reintroduction success in potential sites, and determine positive and negative influences of beaver reintroduction on channel stability, water quality and quantity, riparian habitat, and aquatic and terrestrial wildlife. Specific monitoring needs will depend on the nature of reintroduction efforts and site-specific requirements.

11.2.3.5 Watershed-Scale Monitoring

Monitoring should be conducted at a watershed scale over several years to determine if restoration activities are improving water quality, instream flow, and aquatic habitat and communities. It is important to remember that degradation of aquatic resources happens over many decades, and that restoration is also a long-term process. Long-term monitoring should be an understood component of any restoration effort.

Trends in water quality are difficult to define, and even more difficult to relate directly to restoration or other changes in management, due to the natural high variability in water quality conditions. Improvements in water quality or aquatic habitat resulting from restoration activities on listed streams are most likely to be evident in increases in instream flow, changes in communities and distribution of fish and other bioindicators, improvements in bank stability and riparian habitat, changes in channel cumulative width/depths, fine sediment deposition and channel substrate embeddedness. Specific monitoring methods, priorities, and locations will depend heavily on the type of restoration projects implemented, landscape or other natural setting, the land use influences specific to potential monitoring sites, and budgetary and time constraints. A priority watershed scale monitoring site should be located at the mouth of the Ruby Watershed prior to the water entering the Beaverhead River.

SECTION 12.0
PUBLIC AND STAKEHOLDER INVOLVEMENT

Public and stakeholder involvement is a component of water quality restoration planning and TMDL development. This involvement is supported by U.S. EPA guidelines, the Federal Clean Water Act and Montana State Law. Public and stakeholder involvement is desirable to ensure development of high quality, feasible plans and toincrease public acceptance. Stakeholders, including the Ruby Watershed Council, Ruby Valley Conservation District, the Beaverhead-Deerlodge National Forest, Montana Fish Wildlife and Parks, the Bureau of Land Management, the Natural Resource Conservations Service, Montana Department of Natural Resources and Conservation were involved with initial project planning, interim product reviews, and public outreach components of the plan. Also, this group of stakeholders was given the opportunity to attend a meeting to discuss various aspects of the draft document during a Ruby Watershed Council meeting that was open to the public. This review also included additional internal peer reviews by MDEQ management and a MDEQ water quality standards representative.

An important opportunity for public involvement was the 30-day public comment period. This public review period was initiated on January 25, 2006 and extended to March 10, 2006. A public meeting on January 26th in Alder, Montana provided an overview of the Water Quality Protection Plan and TMDLs for the Ruby River Watershed and an opportunity to solicit public input and comments on the plan. This meeting and the opportunity to provide public comment on the draft document were advertised via a press release by MDEQ and was included in a number of local newspapers. Copies of the main document were available at the Sheridan City Library and via the internet on MDEQs web page or via direct communication with the MDEQ project manager.

Through the public comment process, significant comment was received by 8 different individuals, groups, agencies, or other entities. Appendix I includes a summary of the public comments received and the MDEQ response to these comments. As noted in the introduction of Appendix I, many of the comments led to significant modifications captured within the final version of the this plan. The original comment letters are located in the project files at MDEQ and may be reviewed upon request.

MDEQ also provides an opportunity for public comment during the biennial review of the Montana’s Integrated Water Quality Report that includes the 303(d) list. This includes public meetings and opportunities to submit comments either electronically or through traditional mail. MDEQ announces the public comment opportunities through several media including press releases and the Internet.

SECTION 13.0
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