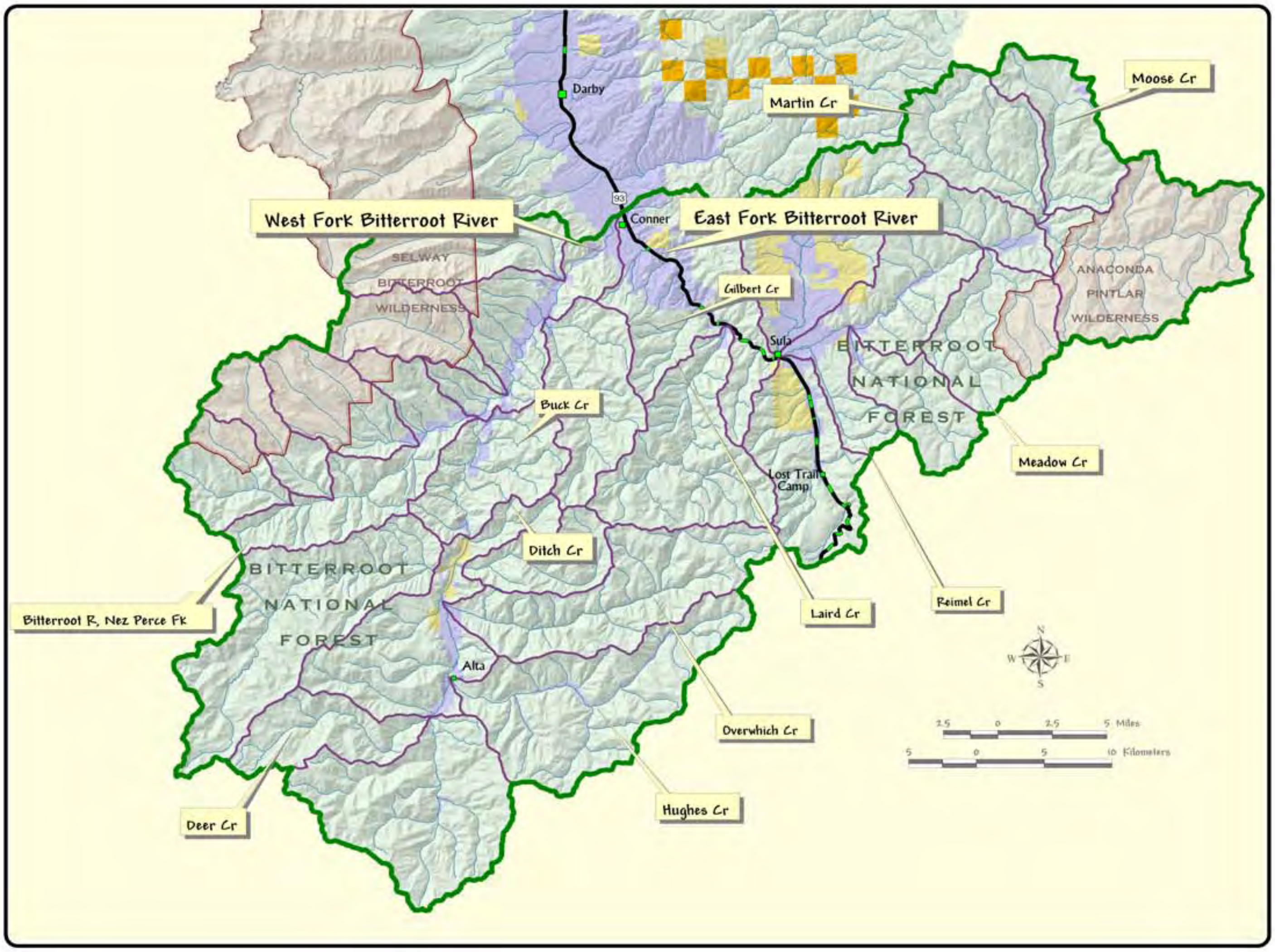
WATER QUALITY RESTORATION PLAN and TOTAL MAXIMUM DAILY LOADS FOR THE BITTERROOT HEADWATERS PLANNING AREA



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EXECUTIVE SUMMARY

The Bitterroot Headwaters TMDL Planning Area (BHTPA) encompasses a geographic area of approximately 618,000 acres. The watershed originates high in the Bitterroot Mountains along the Montana/Idaho border to the west and south, and in the Sapphire Mountains to the east where the Continental Divide marks its boundary with the Beaverhead-Deerlodge National Forest. The downstream terminus of the watershed is located near Conner, Montana, at the confluence of the East and West Forks of the Bitterroot River.

Located entirely within Ravalli County, Montana, the Bitterroot Headwaters TMDL Planning Area is comprised predominately of lands managed by the United States Forest Service (USFS). Its major streams include the East and West Forks of the Bitterroot River, and their larger tributaries, including Martin and Meadow Creeks in the East Fork, and Overwhich Creek and Nez Perce Fork in the West Fork. Fourteen streams within the planning are currently on the Montana 303(d) list and are the subject of ongoing TMDL development efforts in support of which this report has been assembled. The listed causes of impairment include flow alteration, habitat alteration, thermal modification, siltation, suspended solids, noxious aquatic plants, nutrients, and lead. A watershed-scale approach was used to evaluate the beneficial uses in the following waterbodies:

- East Fork Bitterroot River
- West Fork Bitterroot River
- Deer Creek
- Ditch Creek
- Buck Creek
- Hughes Creek
- Overwhich Creek
- Nez Perce Fork
- Laird Creek
- Gilbert Creek
- Reimel Creek
- Moose Creek
- Meadow Creek
- Martin Creek

Table E-1, provides a summary of how each of these waterbodies was addressed in this Water Quality Restoration Plan (WQRP).

During the course of the investigations that were conducted in preparing this document, it was determined that several changes to the listing status of streams in the watershed were in order:

Beneficial uses in Deer Creek, Moose Creek and Martin Creek are fully supported; therefore, no TMDLs were developed for these streams.

Beneficial uses in Overwhich Creek are not impaired by lead and noxious aquatic plants do not impair beneficial uses in the West Fork Bitterroot River; therefore no TMDLs were developed for these causes. However a TMDL was developed for thermal modifications in Overwhich Creek and for siltation and thermal modifications in the West Fork.

Finally, while the East Fork Bitterroot River was not formally listed as impaired for thermal modifications, source assessment activities indicated that elevated temperatures do impair uses in the East Fork. Therefore, a temperature TMDL for the East Fork was developed as part of this WQRP.

To help address any assumptions or uncertainties that arose, a monitoring plan and an adaptive management strategy are developed as part of this WQRP. Additionally, a phased study is suggested that will help better define potential flow issues in the BHTPA.

Table E-1. Summary of Required TMDL Elements for the Bitterroot Headwaters Planning Area.

Waterbodies & Pollutants of Concern	Individual waterbody/pollutant combinations described as follows: - Buck Creek (pollutants: siltation, suspended solids. Non pollutants: habitat alterations). - Ditch Creek (pollutants: siltation, suspended solids. Non pollutants: habitat alterations). - Deer Creek (no listed pollutants; non pollutants: habitat alterations – Recommending stream be listed as fully supporting all beneficial uses in 2006). - Hughes Creek (pollutants: siltation, suspended solids, thermal modification; non pollutants: habitat alterations). - Overwhich Creek (pollutants: thermal modification, lead. Non pollutants: flow alteration. Recommending that lead and flow alterations be de-listed as causes). - Nez Perce Fork Creek (pollutant: thermal modification). - West Fork Bitterroot River (pollutants: siltation, thermal modification. Non pollutants: habitat alterations, noxious aquatic plants; flow alteration). Recommending that noxious aquatic plants and flow alteration be de-listed as causes. - Moose Creek (pollutants: siltation and nutrients) Recommending that stream be listed as fully supporting all beneficial uses in 2006. - Martin Creek (pollutant: thermal modifications. Non pollutant: flow alteration) Recommending that stream be listed as fully supporting all beneficial uses in 2006. - Meadow Creek (non pollutants: habitat alterations) Recommending stream be listed as fully supporting all beneficial uses in 2006). - Reimel Creek (pollutants: siltation, suspended solids. Non pollutants: habitat alterations). - Gilbert/Laird Creek (pollutants: siltation, suspended solids. Non pollutants: habitat alterations). - East Fork Bitterroot River (pollutant: siltation. Non pollutants: habitat alterations, flow alteration. Recommending thermal modification be added as a cause**).**
Section 303(d)(1) or 303(d)(3) TMDL	- 303(d)1
Impaired Beneficial Uses	- Buck Creek (impaired uses: aquatic life; cold water fish;). - Ditch Creek (impaired uses: aquatic life; cold water fish). - Deer Creek (impaired uses: cold water fish – recommended for delisting). - Hughes Creek (impaired uses: aquatic life; cold water fish; agriculture). - Overwhich Creek (impaired use: cold water fish, drinking water – recommend delisting for drinking water, subject to additional). - Nez Perce Fork Creek (impaired use: cold water fish). - West Fork Bitterroot River Creek (impaired uses: aquatic life; cold water fish). - Moose Creek (impaired uses: aquatic life; cold water fish – recommended for delisting). - Martin Creek (impaired use: cold water fish – recommended for delisting). - Meadow Creek (impaired use: cold water fish – recommended for delisting). - Reimel Creek (impaired uses: aquatic life; cold water fish). - Gilbert/Laird Creek (impaired uses: aquatic life; cold water fish; agriculture). - East Fork Bitterroot River (impaired uses: aquatic life; cold water fish).
Pollutant Sources	Silviculture, agriculture, range land, channelization, dredge mining, resource extraction, irrigated crop production, highway/road/bridge construction, abandoned mining, bank or shoreline modification/destabilization, highway/road/bridge runoff, logging road contruction/maintenance, highway maintenance and runoff.

Table E-1. Summary of Required TMDL Elements for the Bitterroot Headwaters Planning Area.

Targets and Indicators	- In stream temperature targets (12 & 15 degrees Celsius) developed to protect bull trout specific life stages. Surrogate shade targets (% 's in 5, 10 and 15 years). - Wolman pebble count % fines < 2mm, % fines < 6mm, and D50. Vary by stream type. - Macroinvertebrate Clinger Richness of at least 14. - Residual Pool Depth $\geq$ 1.5 feet. - At least 20 LWD/mile in large streams and at least 50 in tributary streams. - Pool frequency – varies by stream size. - Supplemental suspended solids and turbidity targets comparable to reference condition. - Achieve full support of macroinvertebrate biological conditions (at least 75% of Montana Foothill, Valley and Plains IBI, high % clinger taxa scores, and EPT richness $\geq$ 22). - Increasing or stable trends in juvenile native trout. - No preventable human pollutant sources. - No fish passage barriers except to protect native salmonid genetics.
TMDLs	- 36 to 68 percent reduction road related sediment loads. - 75% reduction in human-caused stream bank instability. - In-stream sediment loads comparable to complete application of forest road BMPs. - Near-stream reductions in road sediment production equivalent to full application of Montana road BMPs. - 35 to 50% reduction in solar loading to temperature impaired streams.
Allocations	- Sediment: Load allocations proposing % reductions from forest roads and unstable streambanks. - Temperature: Increased stream vegetation allocated to fire and timber harvest. Phased studies proposed to address other sources, i.e. roads, & mining.
Restoration Strategies	- Use 9 priority restoration strategies for sediment and temperature restoration. - Form a Water Quality Implementation Team (IT) consisting of Bitterroot Conservation District, Ravalli County Planning Office, MFWP, Bitterroot National Forest, MDEQ, & USEPA to conduct annual road inventories, compile watershed data, oversee implementation of TMDL tasks, coordinate the restoration and monitoring efforts of agencies and stakeholders, address new threats to water quality, and work with private land owners and land management agencies to address bank instability.
Margin of Safety	- The Bitterroot Headwaters Water Quality Protection Monitoring Plan will be implemented on an annual basis. - Acknowledge natural variability in target variables and the high degree of measurement error that is typically associated with natural resource monitoring. A broad suite of in-stream, near-stream, and biological targets have been developed to reflect the full range of conditions that might reasonably be thought to influence beneficial use support. - Targets will be evaluated at least every five years for suitability and may be modified based on identification of more suitable reference and/or identification of a better indicator of habitat condition required to support aquatic life.
Seasonal Considerations	- Sediment targets consider seasonal variations by setting, related habitat targets and biological targets that are affected by year round processes. - An adaptive management approach (reaching percent shading and solar loads) is being used for meeting temperature targets.

Water Quality Restoration Plan and Total Maximum Daily Loads for the Bitterroot Headwaters Planning Area

VOLUME I
WATER QUALITY PROBLEM DESCRIPTION

Preface

The following document has been divided up into four separate volumes, each containing separate "sections" that all carry a common theme. While the sections flow numerically from 1.0-11.0, the volumes provide a transitional placeholder between themes for the reader. Additionally, the volumes guide the reader to required specific elements within each section and the entire document.

Volume I *Water Quality Problem Description*, contains Sections 1.0 through 3.0. These Sections include: Section 1.0: Introduction, Section 2.0: Watershed Characterization, and Section 3.0 Water Quality Concerns and Impairment Status. Together, these sections lay out the general characteristics of streams in the Bitterroot Headwaters Planning Area (BHPA), the existing conditions of these streams, their impairment status history and their current impairment status.

In addition to serving as a precursor for the rest of the document, the primary function of Volume I is to clearly describe and identify the existing conditions of all the waterbodies in the BHPA that were formally on the 303(d) list and determine their current impairment status. The findings in Volume I determine whether or not a Total Maximum Daily Load (TMDL) and subsequent restoration strategies for each waterbody are required.

A detailed outline of each section within Volume I is provided below.

Section 1.0: This introductory section identifies and displays each waterbody that is currently on the 1996 and 2002 303(d) lists. It also describes the impairments for which these streams are formally listed.

Section 2.0: This section, the Watershed Characterization, provides a detailed discussion and inventory of the physical processes and characteristics specific to the BHPA. These include climate, hydrology, geology and soils, morphology and vegetative characteristics. This section also provides information on land ownership, land use and fire history. It is the first step in the TMDL process to help provide a fundamental understanding of the watershed and how the watershed may react to various changes.

Section 3.0: The Water Quality Concerns and Impairment Status Section is a decision point in this document. In order to carry out the required elements of the TMDL process, the waterbodies in question must first be adequately addressed to determine their current impairment status. This section begins by outlining the purpose of the 303(d) list and then identifying each stream on both the 1996 and 2002 303(d) list. The section then presents the applicable beneficial use classifications and State Water Quality Standards for all 303(d) listed streams in the BHPA. Next, this section compares existing 303(d)-listed streams to reference streams using numeric targets developed from reference conditions.

To develop a TMDL, it is necessary to establish quantitative water quality goals or endpoints referred to as targets. These targets must represent all the applicable narrative or numeric water quality standards. Section 3.0 describes the approach taken to develop these targets and compares those targets to the existing conditions of the listed waterbodies in the BHPA. The result of this comparison analysis is the current water quality impairment status for all waterbodies in the BHPA. Through this formal TMDL process, some waterbodies were found to be fully supporting and thus TMDLs and restoration strategies were not developed for these waterbodies. These conclusions are summarized in Table 3-68.

A transitional discussion is provided at the beginning of each succeeding volume in this document. As noted earlier, these discussions will guide the reader through the context of each volume and their sections similar to what was described above.

SECTION 1.0
INTRODUCTION

This document describes a water quality restoration plan for the Bitterroot Headwaters Total Maximum Daily Load Planning Area (BHTPA), which is defined as the land area upstream of the confluence of the East and West Forks of the Bitterroot River. Fourteen streams with in the Bitterroot Headwaters TPA appear on Montana's 303(d) list of impaired waterbodies and are the subject of this report (Figure 1-1). These streams include:

- East Fork Bitterroot River[1]
- West Fork Bitterroot River
- Deer Creek
- Ditch Creek
- Buck Creek
- Hughes Creek
- Overwhich Creek
- Nez Perce Fork
- Laird Creek
- Gilbert Creek
- Reimel Creek
- Moose Creek
- Meadow Creek
- Martin Creek

The primary pollutants of concern in these fourteen streams are thermal modifications and sediment. For the purposes of this document, sediment is used to refer to a group of sediment-related pollutants including sediment, siltation, and/or suspended solids. Several additional pollutants are also an issue on a limited basis. These include lead in Overwhich Creek, nutrients in Moose Creek, and noxious aquatic plants in the West Fork of the Bitterroot. For all fourteen streams, total maximum daily loads are proposed for the pollutants of concern as required by Section 303 of the federal Clean Water Act. The exceptions to this, as described in Section 3.3, are instances where the available data indicate that beneficial uses are supported fully. This restoration plan also addresses other water quality issues, such as improving fish passage at stream crossing culverts, which are outside of the TMDL framework.

1 The East Fork of the Bitterroot River was removed from the 303(d) list by MDEQ in 2002, but was later restored to the list at the request of the Bitterroot Headwaters TMDL Technical Advisory Committee (TAC).

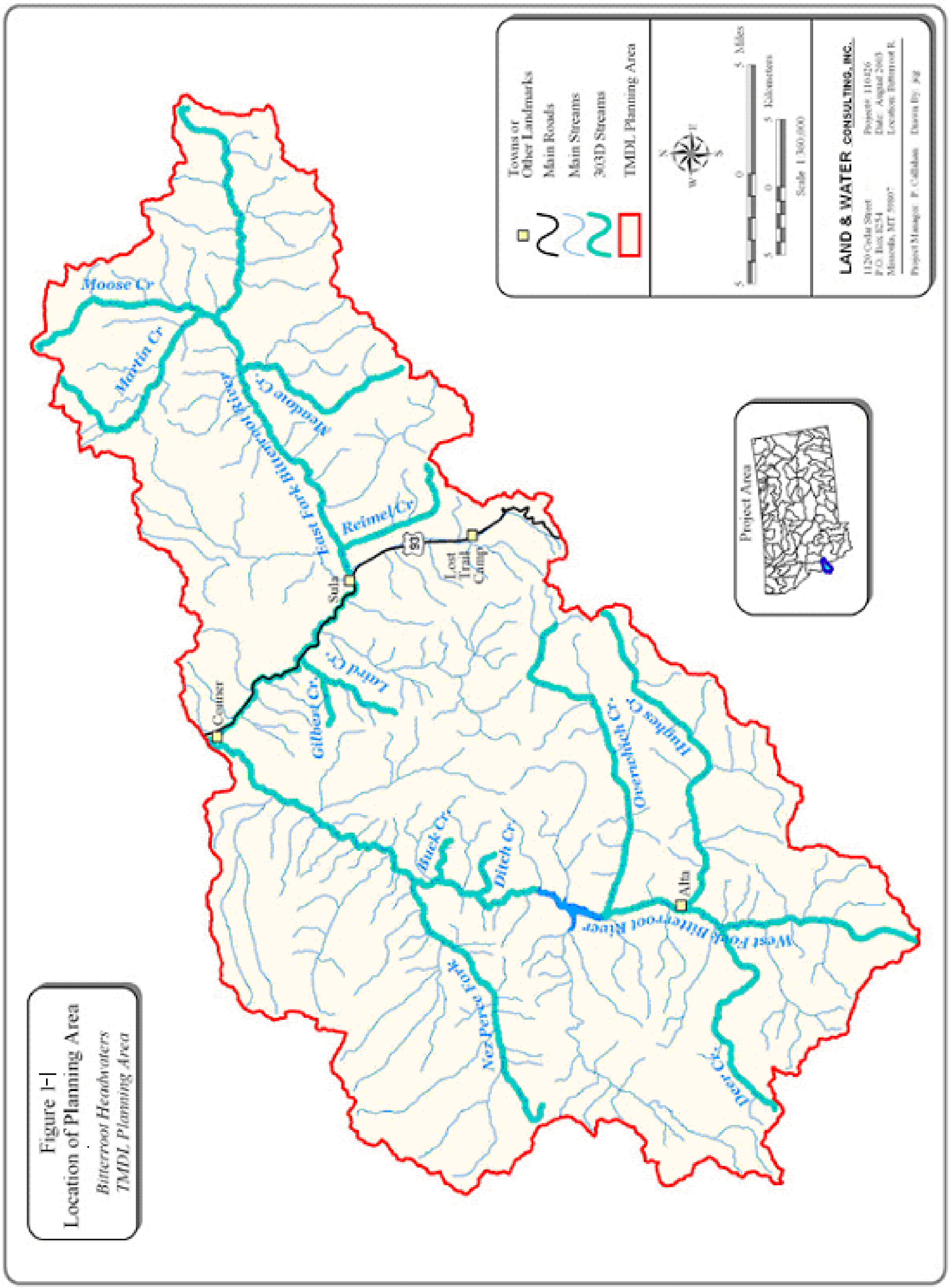

Figure 1-1. Location of Planning Area.

SECTION 2.0
WATERSHED CHARACTERIZATION

This section provides an overview of watershed characteristics in the Bitterroot Headwaters Total Maximum Daily Load Planning Area (BHTPA). It is intended to provide a general understanding of physical, climatic, hydrologic, and other ecological features within the planning area, and serve as a foundational support for TMDL planning and implementation.

2.1 Location

The Bitterroot Headwaters TMDL Planning Area (BHTPA) encompasses a geographic area of approximately 618,000 acres. The watershed originates high in the Bitterroot Mountains along the Montana/Idaho border to the west and south, and in the Sapphire Mountains to the east where the Continental Divide marks its boundary with the Beaverhead-Deerlodge National Forest. The downstream terminus of the watershed is located near Conner, Montana, at the confluence of the East and West Forks of the Bitterroot River.

Located entirely within Ravalli County, Montana, the Bitterroot Headwaters TMDL Planning Area is comprised predominately of lands managed by the United States Forest Service (USFS). Its major streams include the East and West Forks of the Bitterroot River, and their larger tributaries, including Martin and Meadow Creeks in the East Fork, and Overwhich Creek and Nez Perce Fork in the West Fork. Fourteen streams within the planning are currently on the Montana 303(d) list and are the subject of ongoing TMDL development efforts in support of which this report has been assembled (Figure 1-1).

Throughout this report, watershed characteristics are presented for the entire Bitterroot Headwaters watershed, and, where appropriate, for each of the 14 303(d) listed watersheds individually. For maps of watershed characteristics (referred to as Figure A-# in text that follows) and a comparison table of watershed characteristics in the 14 listed streams, refer to Appendix A.

2.2 Land Ownership

Approximately 92% (569,079 acres) of the Bitterroot Headwaters TMDL Planning Area is managed by the Bitterroot National Forest (Table 2-1 and Figure A-1). An additional 5.4% is in private ownership (33,063 acres) and less than 3% (16,351 acres) is managed by the state of Montana (including public trust land and surface water). Although private lands comprise only a small fraction of the total watershed area, they tend to be concentrated in near-stream floodplain areas and can thus have a disproportionately large impact on water quality in the basin. Table 2-2 presents the distribution of land ownership across the 14 303(d) listed watershed in the Bitterroot Headwaters TMDL Planning Area.

Land ownership information was obtained from the Land Ownership and Managed Areas of Montana Database, available at: http://nris.state.mt.us/nsdi/nris/ms4.html.

Table 2-1. Land Ownership within the BHTPA.

Ownership	Acres	%	Cum %
Bitterroot National Forest	569,079	92.0%	92.0%
Private land (undifferentiated)	33,063	5.4%	97.4%
Dept of Natural Resources & Conservation (state trust lands)	16,351	2.6%	100%
Total	**618,493**	**100.0%**	

Table 2-2. Distribution of Land Ownership in the 14 303(d) Listed BHTPA Watersheds (%).

Watershed	Bitterroot National Forest	Private land (undifferentiated)	DNRC (state trust lands)
Buck Creek	86.7	13.3	0
Deer Creek	99.8	0.2	0
Ditch Creek	100	0	0
East Fork	85.6	8.6	5.8
Gilbert Creek	100	0	0
Hughes Creek	97.6	2.4	0
Laird Creek	98.0	2.0	0
Martin Creek	100	0	0
Meadow Creek	100	0	0
Moose Creek	98.2	1.8	0
Nez Perce	96.5	3.5	0
Overwhich Creek	99.2	0.8	0
Reimel Creek	95.8	4.2	0
West Fork	96.6	3.1	0.3

2.3 Climate

The climate of the Bitterroot Headwaters TMDL Planning Area varies greatly with elevation, as is typical of mountainous regions of Montana. Average annual precipitation ranges from approximately 16 inches at the NOAA weather station at Sula, Montana, to more than 100 inches in the highest elevations of the watershed along the Montana/Idaho border. In the lower valleys, spring is typically the wettest time of the year, with approximately 37 percent of annual precipitation occurring in April, May, and June (WRCC, 2002). In the mountains, annual precipitation can exceed 70 inches, and is dominated by snowfall that can reach 500 inches in the highest peaks of the West Fork drainage (Finklin, 1983).

Average maximum temperatures at the NOAA weather station in Sula are near 80° F during the summer; average minimum temperatures drop below 10° F in January. The average annual maximum temperature in Sula is 57.2° F, while the average annual minimum temperature is 25.4° F (WRCC, 2002). Although no long-term temperature data could be located for the higher elevations of the Bitterroot Headwaters TMDL planning area, Finklin (1983) estimated that the adiabatic lapse rate in the Selway-Bitterroot Wilderness area is approximately 3° F per 1000 feet. This temperature gradient would produce an average annual maximum temperature of about 40° F, and an average annual minimum temperature of about 10° F at the highest elevations in the watershed. Finklin also reports that winter lows can drop to minus 30° F at elevations above 5000 feet.

2.4 Hydrology

The USGS online database (http://montana.usgs.gov/) lists 5 flow gages with current and historical flow data in the Bitterroot Headwaters TMDL Planning Area (Figure A-2). Two of these gauges are currently active, and long-term flow data are presented from these stations to obtain a general understanding of average monthly flow characteristics in the Bitterroot Headwaters TMDL planning area. These stations are the East Fork of the Bitterroot River near Conner, Montana and the West Fork of the Bitterroot River near Conner, Montana (Table 2-3).

Table 2-3. Active USGS Stream Gages in the BHTPA.

USGS #	Station ID	Start	End	Years Record	Drainage Area (mi2)
12342500	West Fork Bitterroot River near Conner	1942	2000	59	317
12343400	East Fork Bitterroot River near Conner	1956	1972, +2001	18	381

Average monthly flows for the two stations show similar seasonal patterns, with relatively constant base flows from late summer through fall and winter (Figure 2-1). Flows begin to increase in March, the hydrograph peaks in June, and the recessional limb begins in late June/early July. Peak flows are driven by snowmelt and especially rain-on-snow events. The hydrograph on the West Fork is controlled by the operations of the Painted Rocks Dam, which was constructed in 1939 and is immediately upstream of the USGS gauging station.

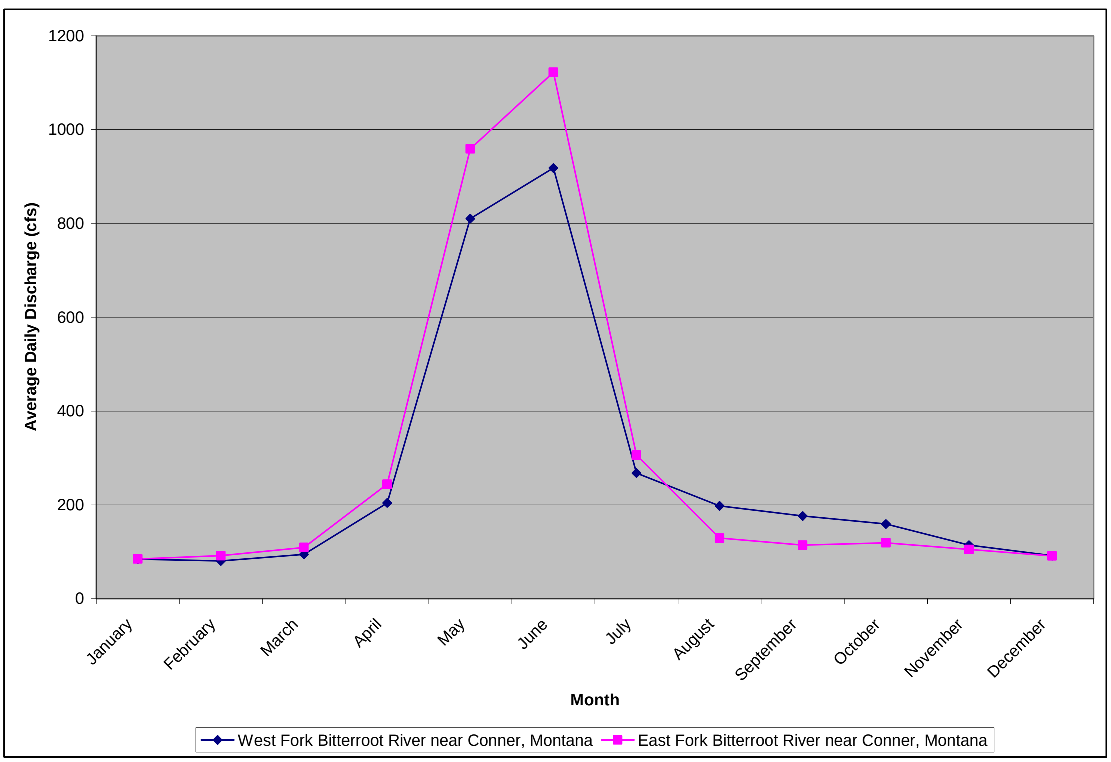

Figure 2-1. Monthly Flow in the East and West Forks of the Bitterroot River.

2.5 Channel Morphology

Limited information is available on the channel morphology of the Bitterroot Headwaters TMDL Planning Area. Most of the existing information is found in environmental impact statements written by the Bitterroot National Forest, including the Burned Area Recovery Final Environmental Impact Statement (USFS, 2001a), from which the following discussion was taken:

General Morphology

The majority of streams in the planning area are steep and narrow, dominated by step-pool morphology. Because they are narrow and confined, they can be sensitive to increases in peak flows. When the stream banks are composed of smaller sized particles, such as in portions of the West Fork and East Fork, they can be easily eroded because high flows (high stream energy) are concentrated in the channel rather than spread out over flood plains. Conversely, a few other streams, such as Canyon Creek near the trailhead, have boulder substrate and stream banks, and so are resistant to erosion caused by increases in stream flows. In general, most of these steep, narrow streams move sediment most of the year.

At lower elevations where valley bottoms widen and gradients become less steep, streams are generally less confined and can spread out during high flow. Such sections are typically the most stable stream type because they can dissipate energy on the floodplain. These streams carry sediment usually only during high flows, and drop alluvial deposits during low flows. These areas can be sensitive to increases in erosion (and sediment yields), as fine alluvial soil particles are easily moved. In these kinds of stream systems, stream bank vegetation is an important factor in maintenance in channel stability.

East Fork

The East Fork of the Bitterroot River originates high in glaciated basins of the Sapphire Range. Some basins are composed of metasedimentary rocks of the Belt Series, and others of granitic bedrock. Thus, glacial and alluvial deposits of mixed origins and sandy materials from granitic bedrock influence substrates of the East Fork. The East Fork flows alternately through low gradient montane valleys and confined narrow valleys, intermittently transporting sediment and then depositing it in low gradient reaches that run primarily through private land. The East Fork makes a bend at its midpoint and flows north to meet the West Fork. Below the bend, the valley narrows and smaller tributaries flowing through moderate- to high-relief landforms route runoff and sediments from weathered granitic outcrops to the main stem.

West Fork

Channel morphology, substrates, and gradient of tributary streams to the West Fork above Painted Rocks Reservoir are influenced by numerous faults, volcanic intrusions within metamorphic bedrock, and weathered granitics. Landforms are very diverse, ranging from low relief to very steep break lands. The dam forming the Painted Rocks Reservoir regulates flow and sediment routing in the lower half of the West Fork of the Bitterroot. Below the dam, the

West Fork is sediment-limited so the Nez Perce Fork is the major contributor of stream flow and sediment to the West Fork.

The majority of the streams within the West Fork drainage are steep and confined with narrow floodplains located in v-shaped valleys. The streams naturally have a high percentage of fine particles in the substrate, because of the geology (weathered granitics and volcanics that weather to fine grained particles). They can be sensitive to increases in water yield because there is little access to a floodplain where energy can be dissipated.

A few meandering, low-gradient stream types with relatively wide floodplains flow through small portions of National Forest land, although more flow through private land downstream from Deer Creek. They are sensitive to increases in water yields because the alluvial materials within the streams are easily detached and moved. These streams depend heavily on streamside vegetation and woody debris for channel stability (USDA, 2001a).

2.6 Topography and Relief

Figure A-3 displays the topography of the Bitterroot Headwaters TMDL Planning Area, Figure A-4 displays the distribution of slope, and a shaded relief map is presented in Figure A-5. Elevation in the Bitterroot Headwaters Planning Area ranges from about 4000 feet near the confluence of the East and West Forks of the Bitterroot River to 10,000 feet in the mountains (Table 2-4).

Approximately 60% Bitterroot Headwaters Planning Area is between 5000 and 8000 feet, with the largest fraction (37%) in the 6000 to 7000 feet category. Less than 5% of the planning area is above 8000 feet. Table 2-5 presents summary statistics, including minimum, maximum, range, and mean, for elevation and average slope in each of the 14 303(d) listed streams. Topography and relief data were obtained from the United States Geological Survey's National Elevation Dataset for Montana, available at: http://nris.state.mt.us/nsdi/nris/ned.html.

Table 2-4. Elevation in the BHTPA.

Category (ft)	Acres	%	Cum %
6,000-7,000	215,427	34.8%	34.8%
5,000-6,000	158,412	25.6%	60.4%
7,000-8,000	156,080	25.2%	85.7%
4,000-5,000	58,829	9.5%	95.2%
8,000-9,000	28,056	4.5%	99.7%
9,000-10,000	1,617	0.3%	100%
>10,000	9	0.0%	100.0%

Table 2-5. Elevation Summary & Average Slope for the 14 303(d) BHTPA Watersheds.

Watershed	Minimum Elevation (ft)	Maximum Elevation (ft)	Elevation Range (ft)	Mean Elevation (ft)	Average Slope (%)
Buck Creek	4403	6660	2257	5385	17.9
Deer Creek	5066	8376	3310	6854	15.1
Ditch Creek	4501	6968	2467	5629	18.9
East Fork	4003	9459	5456	6277	19.1
Gilbert Creek	4537	7536	2999	5960	18.7
Hughes Creek	4951	8861	3910	6747	10.6
Laird Creek	4203	8392	4189	5942	18.5
Martin Creek	5180	8665	3485	6810	20.2
Meadow Creek	5000	8848	3848	6888	19.1
Moose Creek	5246	8717	3471	6906	21.8
Nez Perce	4393	9751	5358	6101	25.8
Overwhich Creek	4731	8343	3612	6675	17.5
Reimel Creek	4462	7641	3179	6103	16.6
West Fork	4012	10118	6106	6499	18.2

2.7 Geology

Twelve USGS geologic mapping units occur with in the Bitterroot Headwaters TMDL Planning Area (Figure A-6). The majority of the planning area (596 square miles, or 62%) is comprised of calc-alkaline intrusive rock, which is defined by the USGS as a suite of rocks that are generally granodiorite to diorite, both of which are common in granitic formations (Table 2-6). Associated with the granitic geology of the Idaho Batholith, this type of rock is found in most of the 303(d) listed drainages, including Moose Creek, Meadow Creek, Martin Creek, Reimel Creek, Laird Creek, Gilbert Creek, Buck, Creek, Ditch Creek, Nez Perce Fork, the upper reaches of Overwhich Creek, the East Fork, and the West Fork below the Overwhich Creek confluence.

The second most common rock, meta-siltstone (23.4% of the planning area), is defined by the USGS as fine-grained metamorphic rock formed from siltstone (Table 2-6). Associated with the sedimentary rocks of the Belt Series, this type of rock is found in most of Deer and Hughes Creek, the upper West Fork, and the lower reaches of Overwhich Creek. The distribution of dominant geologic mapping units for the 14 303(d) listed streams is shown in Table 2-7.

Geologic information was obtained from the USGS Major Lithology Database, available at: http://www.icbemp.gov/spatial/min/. These data describe the local geology on a broad scale and do not fully capture localized variability.

Table 2-6. Geology of the Bitterroot Headwaters TMDL Planning Area.

Geologic Unit Code	Square Miles (% of Planning Area)	USGS Definition
Alluvium	61.2 (6.3%)	Unconsolidated sediment (clay, silt, sand, gravel). Includes glacial outwash deposits.
Calc-alkaline intrusive rocks	596.3 (61.7%)	Calc-alkaline suite of intrusive rocks. Generally granodiorite to diorite.
Calc-alkaline meta-volcanics	23.0 (2.4%)	Calc-alkaline suite of meta-volcanic rocks.
Felsic pyroclastics	0.2 (0.02%)	Rhyolitic pyroclastic rocks.
Glacial drift	0.1 (0.01%)	Material deposited by glacial processes. Includes till and moraine (unstratified) as well as outwash (stratified).
Granite	0.4 (0.04%)	Includes intrusive rhyolitic rocks.
Granitic Gneiss	51.8 (5.4%)	Dominantly granitic gneiss, migmatite, augen gneiss, and hornblende gneiss. Includes subordinate anorthosite, amphibolite, calc-silicate gneiss, schist, marble, and quartzite.
Interlayered meta-sediment	0.6 (0.06%)	Fine-to coarse-grained metamorphic rocks derived from clastic and carbonate sedimentary rocks.
Metamorphosed Carbonate and Shale	5.0 (0.5%)	Mixed sequences of metamorphosed carbonate rock and shale with subordinate sandstone and conglomerate.
Meta-siltstone	226.0 (23.4%)	Fine-grained metamorphic rock formed from siltstone.
Mixed miogeosynclinal rocks	1.6 (0.2%)	Mixed sequences of miogeosynclinal sedimentary rocks. Includes interlayered shale, siltstone, lithic sandstone, quartzite, and conglomerate.
Open Water	0.6 (0.1%)	Areas of water.

Table 2-7. Dominant Geologic Mapping Units in the 14 303(d) Listed BHTPA Watersheds.

Watershed	Dominant Geology
Buck Creek	Calc-alkaline intrusive rocks (92.7%)
Deer Creek	Meta-siltstone (86.1%) Granitic Gneiss (10.3%)
Ditch Creek	Calc-alkaline intrusive rocks (88.2%)
East Fork	Calc-alkaline intrusive rocks (78.0%) Alluvium (8.8%) Granitic Gneiss (6.6%)
Gilbert Creek	Calc-alkaline intrusive rocks (100%)
Hughes Creek	Meta-siltstone (90.1%)
Laird Creek	Calc-alkaline intrusive rocks (99.2%)
Martin Creek	Granitic Gneiss (61.5%) Calc-alkaline intrusive rocks (38.5%)
Meadow Creek	Calc-alkaline intrusive rocks (100%)
Moose Creek	Calc-alkaline intrusive rocks (99.9%)
Nez Perce	Calc-alkaline intrusive rocks (72.3%) Meta-siltstone (11.1%) Granitic Gneiss (10.0%)
Overwhich Creek	Calc-alkaline intrusive rocks (70.3%) Meta-siltstone (25.3%)
Reimel Creek	Calc-alkaline intrusive rocks (57.9%) Metamorphosed Carbonate and Shale (26.5%) Mixed miogeosynclinal rocks (11.2%)
West Fork	Calc-alkaline intrusive rocks (49.8%) Meta-siltstone (40.1%)

2.8 Soils

Eighteen Natural Resource Conservation Service (NRCS) soil-mapping units occur within the Bitterroot Headwaters TMDL Planning Area (Table 2-8 and Figure A-7). The predominant soil series within the Planning Area (Ovando and Elkner series) are excessively drained soils that formed in colluviums derived from granite. Ten of the 18 soil-mapping units that occur within the Bitterroot Headwaters TMDL Planning Area (75% of the planning area) are comprised at least in part by soil series derived from granite and/or gneiss. Soils derived from granite and/or gneiss exhibit minimal cohesion between soil particles and are thus susceptible to erosion, particularly when subjected to disturbance (e.g., fire, road building, and timber harvest). Complete descriptions of the soils series can be found in the NRCS online database (http://ortho.ftw.nrcs.usda.gov/osd/). The distribution of the dominant soil-mapping units in the 14 303(d) listed watersheds is presented in Table 2-9.

All soils data (series, permeability, USLE K-factor) were obtained from the United States Department of Agriculture's State Soil Geographic (STATSGO) database, available at: http://water.usgs.gov/GIS/metadata/usgswrd/ussoils.html.

Table 2-8. Major Soil Series within the BHTPA.

Map Unit Name	Acres	Sq. Mi.	%	Cum %
Ovando* – Elkner* – Rock Outcrop	183,480	286.7	29.69	29.69
Rock Outcrop – Rubble Land – Lolopeak*	68,000	106.3	11.00	40.69
Victor* – Yellowbay Family – Como*	61,650	96.3	9.98	50.67
Winkler – Evaro – Tevis	45,588	71.2	7.38	58.04
Lolopeak* – Rubble Land – Rock Outcrop	41,836	65.4	6.77	64.81
Worock – Garlet – Danaher	41,152	64.3	6.66	71.47
Petty* – Lolopeak* – Selway*	38,336	59.9	6.2	77.68
Ovando* – Elkner* – Shadow*	31,297	48.9	5.06	82.74
Winkler – Perma – Bignell	24,972	39.0	4.04	86.78
Rivra – Clark Fork* – Gallatin	19,346	30.2	3.13	89.91
Woodside* – Yellowbay Family – Como*	12,362	19.3	2.00	91.91
Rock Outcrop – Winkler – Rubble Land	12,216	19.1	1.98	93.89
Yellowbay Family – Victor* – Gas Creek Family	11,765	18.4	1.90	95.79
Bignell – Winkler – Crow	8,559	13.4	1.38	97.18
Fergus – Roy – Tetonview	8,434	13.2	1.36	98.54
Phillcher – Lolopeak* – Rubble Land	7,652	12.0	1.24	99.78
Rock Outcrop – Garlet – Rubble Land	845	1.3	0.14	99.92
Garlet – Worock – Maurice	515	0.8	0.08	100.00

* Denotes a soil series derived from granite and/or gneiss

Table 2-9. Dominant Soil Series in the 14 303(d) Listed BHTPA Watersheds.

Watershed	Map Unit Name
Buck Creek	Ovando* – Elkner* – Rock Outcrop (99.3%) Rivra – Clark Fork* – Gallatin (0.7%)
Deer Creek	Ovando* – Elkner* – Rock Outcrop (35.3%) Ovando* – Elkner* – Shadow* (31.1%) Winkler – Evaro – Tevis (22.7%) Lolopeak* – Rubble Land – Rock Outcrop (9.4%) Others combined (1.5%)
Ditch Creek	Ovando* – Elkner* – Rock Outcrop (100%)
East Fork	Ovando* – Elkner* – Rock Outcrop (33.8%) Victor* – Yellowbay Family – Como* (21.3%) Rock Outcrop – Rubble Land – Lolopeak* (9.7%) Ovando* – Elkner* – Shadow* (7.0%) Others combined (28.2%)
Gilbert Creek	Ovando* – Elkner* – Rock Outcrop (100%)
Hughes Creek	Winkler – Evaro – Tevis (52.0%) Worock – Garlet – Danaher (31.9%) Winkler – Perma – Bignell (14.5%) Others combined (1.6%)
Laird Creek	Ovando* – Elkner* – Rock Outcrop (92.2%) Lolopeak* – Rubble Land – Rock Outcrop (6.4%) Others combined (1.4%)
Martin Creek	Victor* – Yellowbay Family – Como* (54.3%) Ovando* – Elkner* – Shadow* (29.4%) Phillcher – Lolopeak* – Rubble Land (14.6%) Others combined (1.7%)
Meadow Creek	Ovando* – Elkner* – Rock Outcrop (65.7%) Rock Outcrop – Rubble Land – Lolopeak* (18.3%) Ovando* – Elkner* – Shadow* (15.0%) Others combined (1.0%)
Moose Creek	Victor* – Yellowbay Family – Como* (23.3%) Winkler – Evaro – Tevis (23.1%) Phillcher – Lolopeak* – Rubble Land (22.8%) Ovando* – Elkner* – Shadow* (16.7%) Rock Outcrop – Rubble Land – Lolopeak* (12.1%) Others combined (2.0%)
Nez Perce	Ovando* – Elkner* – Rock Outcrop (44.0%) Petty* – Lolopeak* – Selway* (25.7%) Rock Outcrop – Rubble Land – Lolopeak* (12.0%) Lolopeak* – Rubble Land – Rock Outcrop (8.7%) Others combined (9.6%)
Overwhich Creek	Worock – Garlet – Danaher (68.7%) Winkler – Perma – Bignell (18.4%) Lolopeak* – Rubble Land – Rock Outcrop (4.7%) Rock Outcrop – Rubble Land – Lolopeak* (4.6%) Others combined (3.6%)
Reimel Creek	Victor* – Yellowbay Family – Como* (80.3%) Ovando* – Elkner* – Shadow* (12.6%) Rivra – Clark Fork* – Gallatin (4.1%) Others combined (3.0%)
West Fork	Ovando* – Elkner* – Rock Outcrop (26.6%) Rock Outcrop – Rubble Land – Lolopeak* (12.0%) Winkler – Evaro – Tevis (11.7%) Worock – Garlet – Danaher (10.6%) Lolopeak* – Rubble Land – Rock Outcrop (10.3%) Others combined (28.8%)

Soils in the Bitterroot Headwaters TMDL Planning Area are characterized by a high degree of permeability. Weighted average minimum soil permeability over 68% of the planning area was 0.6 – 2.0 inches per hour, and an additional 30.1 % of the planning area in the 2.0 – 6.0 minimum permeability range (Table 2-10, Figure A-8). Only 1.4% of the planning area falls into the less permeable 0.2 – 0.6 average minimum permeability category. Soil permeability in the 14 303(d) listed watersheds is presented in Table 2-11.

Table 2-10. Soil Permeability within the BHTPA.

Minimum Permeability (in/hr)	Acres	Sq. Mi.	%	Cum %
0.6 - 2.0	423,599	661.9	68.5	68.5
2.0 - 6.0	185,973	290.6	30.1	98.6
0.2 - 0.6	8,434	13.2	1.4	100
Total	**618,006**	**965.7**	**100**	

Table 2-11. Distribution of Soil Permeability in the 14 303(d) Listed BHTPA Watersheds.

Watershed	0.2 – 0.6 in/hr Permeability	0.6 -- 2.0 in/hr Permeability	2.0 – 6.0 in/hr Permeability
Buck Creek	0%	100%	0%
Deer Creek	0%	59.3%	40.7%
Ditch Creek	0%	100%	0%
East Fork	3.3%	67.7%	29.0%
Gilbert Creek	0%	100%	0%
Hughes Creek	0%	98.6%	1.4%
Laird Creek	0%	93.3%	6.7%
Martin Creek	0%	56.0%	44.0%
Meadow Creek	0%	66.4%	33.6%
Moose Creek	0%	48.4%	51.6%
Nez Perce	0%	77.5%	22.5%
Overwhich Creek	0%	88.7%	11.3%
Reimel Creek	0%	87.4%	12.6%
West Fork	0%	69.0%	31.0%

The Universal Soil Loss Equation K-factor is a measure of a soils inherent susceptibility to erosion by rainfall and runoff. Values of K range from 0 to 1, with higher numbers indicative of greater erodibility.

Soils high in clay and coarse textured soils have low K values (0.05 to 0.2) because they are resistant to detachment. Medium textured soils, such as the silt loam soils, have moderate K values (0.25 to 0.4) because they are moderately susceptible to detachment and they produce moderate runoff. Soils with high silt content tend to have higher K values (greater than 0.4) since they are easily detached, tend to crust, and produce high rates of runoff (Michigan State University, 2002).

The K-factor was moderate throughout most of the planning area, with 40.2 percent of the area characterized by values in the 0.3 – 0.4 range, and 39.6 percent characterized by values in the 0.2 – 0.3 range. Soils in the remaining 20.2 percent of the planning area exhibited relatively low erodibility, with K-factor values in the 0.1 – 0.2 range. (Table 2-12, Figure A-9).

The distribution of soil erosion K factors in the 14 303(d) listed watersheds in presented in Table 2-13.

Table 2-12. Soil Erosion K factor within the BHTPA.

Weighted K Factor	Acres	Sq. Mi.	%	Cum %
0.3-0.4	248,552	388	40.22	40.22
0.2-0.3	244,734,	382	39.60	79.82
0.1-0.2	124,719	195	20.18	100
Total	**618,005**	**965**	**100**	

Table 2-13. Distribution of Soil K Factor in the 14 303(d) Listed BHTPA Watersheds.

Watershed	K = 0.1 to <0.2	K = 0.2 to < 0.3	K = 0.3 to < 0.4
Buck Creek	0%	99.3%	0.7%
Deer Creek	31.2%	44.8%	24.0%
Ditch Creek	0%	100%	0%
East Fork	22.0%	40.8%	37.2%
Gilbert Creek	0%	100%	0%
Hughes Creek	0%	1.4%	98.6%
Laird Creek	0.3%	98.6%	1.1%
Martin Creek	29.4%	15.2%	55.4%
Meadow Creek	33.6%	65.7%	0.7%
Moose Creek	28.8%	22.8%	48.4%
Nez Perce	12.6%	53.9%	33.5%
Overwhich Creek	4.6%	6.5%	88.9%
Reimel Creek	12.6%	0%	87.4%
West Fork	18.8%	38.6%	42.6%

2.9 Mineral Extraction and Mining

Mining for gold, silver, lead, copper, and zinc has been conducted within the Bitterroot Headwaters TMDL Planning Area intermittently on a small scale since the 1850's, with mining activity concentrated in the upper West Fork and Hughes Creek drainages (USDA, 1959). In more recent years, exploration for a variety of other mineral resources has been conducted. The locations of mines and prospects within the Bitterroot Headwaters TMDL Planning Area as documented by the U.S. Bureau of Mines Mineral Location Database are presented in Figure A-10, and a complete listing of mineral operations is found in Appendix B. The Mineral Location Database is available at: http://nris.state.mt.us/nsdi/nris/ms4.html.

2.10 Major Land Resource Areas

Major land resource areas (MLRAs) are geographically associated land resource units, usually encompassing several thousand acres, characterized by a particular pattern of soils, geology, climate, water resources, and land use. A unit can be one continuous area or several separate closely aligned areas. The majority of the Bitterroot Headwaters Planning Area is classified as Northern Rocky Mountains (81.63%). The remainder of the planning area (18.37%) is classified as Northern Rocky Mountain Valleys (Table 2-14 and Figure A-11). Table 2-15 shows the distribution of MLRAs in each of the 14 303(d) listed watersheds. Complete descriptions of both MLRAs are found in Appendix C.

MLRA data were obtained from the United States Department of Agriculture's State Soil Geographic (STATSGO) database, available at: http://water.usgs.gov/GIS/metadata/usgswrd/ussoils.html.

Table 2-14. Major Land Resource Areas of the BHTPA.

Classification	Acres	Square Miles	%	Cum %
Northern Rocky Mountain	504,448	788	81.6%	81.6%
Northern Rocky Mountains Valleys	113,557	177	18.4%	100%
Total	**618,005**	**966**	**100%**	

Table 2-15. MLRA Distribution in the 14 303(d) Listed BHTPA Watersheds.

Watershed	Northern Rocky Mountains (% of watershed)	Northern Rocky Mountain Valleys (% of watershed)
Buck Creek	99.3	0.7
Deer Creek	99.8	0.2
Ditch Creek	100	0
East Fork	63.8	36.2
Gilbert Creek	100	0
Hughes Creek	99.8	0.2
Laird Creek	98.6	1.4
Martin Creek	44.9	55.1
Meadow Creek	99.3	0.7
Moose Creek	75.9	24.1
Nez Perce	94.4	5.6
Overwhich Creek	98.6	1.4
Reimel Creek	15.6	84.4
West Fork	94.4	5.6

2.11 Vegetative Cover

The Gap Analysis Program (GAP) was developed by the USGS in the 1990's as a method for classifying vegetation using satellite imagery. This vegetation classification attempts to differentiate individual species within general community types (i.e., Ponderosa Pine vs. Conifer Forest). Ground truthing has indicated that GAP data does have limitations and classification of individual species polygons may be of variable quality. Nevertheless, GAP data represents the best available vegetation classification on a landscape scale. Vegetative data were summarized from GAP information in the Bitterroot Headwaters Planning Area (Table 2-16 and Figure A-12). GAP data were obtained from the Montana 90-Meter Land Cover Database, available from the Montana State Library Natural Resource Information System at: http://nris.state.mt.us/nsdi/nris/gap90/gap90.html.

Nearly 67 percent of the Bitterroot Headwaters Planning Area is dominated by four GAP vegetation types: Lodgepole Pine (20.7%), Mixed Subalpine Forest (17.4%), Douglas fir (16.7%), and Douglas fir/Lodgepole Pine (12.0%). An additional ten types of polygons with individual coverages of 1 to 6 percent account for most of the remaining area, cumulating to 95 percent of the planning area. Rock (3.13%) is one of these ten types of polygons. Seventeen other types of polygons had coverages of less than 1 percent, and account for the remaining percent of the watershed.

The distribution of GAP vegetation classification across the 14 303(d) listed watersheds is presented in Appendix D.

Table 2-16. Vegetation Classification (GAP) within the BHTPA.

Gap Vegetation Type	Acres	Sq. mi	%	Cum %
Lodgepole Pine	127,694.3	199.5	20.67	20.67
Mixed Subalpine Forest	107,645.2	168.2	17.42	38.09
Douglas-fir	103,051.7	161.0	16.68	54.76
Douglas-fir/Lodgepole Pine	74,246.0	116.0	12.02	66.78
Low/Moderate Cover Grasslands	35,604.9	55.6	5.76	72.54
Ponderosa Pine	20,711.6	32.4	3.35	75.89
Sagebrush	20,159.2	31.5	3.26	79.16
Rock	19,324.6	30.2	3.13	82.28
Mixed Mesic Forest	18,299.8	28.6	2.96	85.24
Mixed Xeric Forest	13,410.1	21.0	2.17	87.41
Mixed Whitebark Pine Forest	13,396.1	20.9	2.17	89.58
Mixed Xeric Forest	13,101.9	20.5	2.12	91.70
Montane Parklands and Subalpine Meadows	12,831.7	20.0	2.08	93.78
Mixed Broadleaf Forest	7,473.6	11.7	1.21	94.99
Altered Herbaceous	5,482.1	8.6	0.89	95.88
Mixed Xeric Shrubs	4,887.7	7.6	0.79	96.67
Mixed Barren Sites	3,870.9	6.0	0.63	97.29
Moderate/High Cover Grasslands	2,838.1	4.4	0.46	97.75
Mixed Broadleaf and Conifer Forest	2,255.7	3.5	0.37	98.12
Shrub Riparian	2,091.6	3.3	0.34	98.46
Conifer Riparian	1,833.4	2.9	0.30	98.75
Mixed Broadleaf and Conifer Riparian	1,182.9	1.8	0.19	98.94
Graminoid and Forb Riparian	1,180.9	1.8	0.19	99.14
Mixed Riparian	1,114.8	1.7	0.18	99.32
Water	1,070.8	1.7	0.17	99.49
Very Low Cover Grasslands	1,048.8	1.6	0.17	99.66
Standing Burnt Forest	946.7	1.5	0.15	99.81
Alpine Meadows	748.6	1.2	0.12	99.93
Snowfields or Ice	166.1	0.3	0.03	99.96
Broadleaf Riparian	130.1	0.2	0.02	99.98
Agricultural Lands - Dry	116.1	0.2	0.02	100
Total	**617,916.2**	**965.5**	**100**	

2.12 Land Use and Land Cover

General land use and land cover data for the Bitterroot Headwaters TMDL Planning Area were derived from the Montana 90 Meter Land Cover Database, available from the Natural Resource Information System at: http://nris.state.mt.us/nsdi/nris/gap90/gap90.html. (Table 2-17 and Figure A-13). The Land Use and Land Cover (LULC) data files describe the vegetation, water, natural surface, and cultural features on the land surface.

The Bitterroot Headwaters TMDL Planning Area is dominated by Evergreen Forest (82.54%). Five other classifications, Mixed Forest (6.24%), Brush Rangeland (3.28%), Grass Rangeland (2.76%), Mixed Rangeland (2.68%), and Exposed Rock (1.75%) account for all but 1% of the remaining area, which is covered by a mix of 12 LULC types that occur in incidental amounts. Table 2-18 presents the distribution of LULC types across the 14 303(d) listed watersheds in the BHTPA.

Table 2-17. Land Use and Land Cover within the BHTPA.

Classification	Acres	Sq. Mi	Percent	Cum %
Evergreen Forest	510,674	797.93	82.54	82.54
Mixed Forest	38,591	60.30	6.24	88.78
Brush Rangeland	20,271	31.67	3.28	92.06
Grass Rangeland	17,101	26.72	2.76	94.82
Mixed Rangeland	16,575	25.90	2.68	97.50
Exposed Rock	10,834	16.93	1.75	99.25
Crop/Pasture	2,919	4.56	0.47	99.72
Reservoir	489	0.76	0.08	99.80
Residential	424	0.66	0.07	99.87
Lake	183	0.29	0.03	99.90
Other Urban/Built-up	176	0.27	0.03	99.93
Transitional	161	0.25	0.03	99.96
Other Agricultural	86	0.13	0.01	99.97
Wetland	63	0.10	0.01	99.98
Mixed Urban/Built-up	62	0.10	0.01	99.99
Dry Salt Flats	41	0.06	0.01	100.0
Mines/Quarries	16	0.02	0.0	100.0
Sliver Polygon	10	0.02	0.0	100.0
Total	**618,678**	**966.67**	**100**	

Table 2-18. Distribution of LULC Types in the 14 303(d) Listed BHTPA Watersheds.

Watershed	Major Land Use & Land Covers
Buck Creek	Evergreen Forest (100%)
Deer Creek	Evergreen Forest (71%), Mixed Forest (29%)
Ditch Creek	Evergreen Forest (90.3%), Mixed Forest (9.7%)
East Fork	Evergreen Forest (86.4%), Grass Rangeland (5.7%), Mixed Rangeland (4.0%), Mixed Forest (0.6%); all others combined (3.4%)
Gilbert Creek	Evergreen Forest (93.3%), Grass Rangeland (6.4%)
Hughes Creek	Evergreen Forest (71.2%), Mixed Forest (24.1%), Brush Rangeland (4.0%), all others combined (0.6%)
Laird Creek	Evergreen Forest (96.4%), Grass Rangeland (3.6%)
Martin Creek	Evergreen Forest (96.5%), Brush Rangeland (3.5%
Meadow Creek	Evergreen Forest (92.1%), Mixed Rangeland (7.9%)
Moose Creek	Evergreen Forest (95.4%), Mixed Rangeland (4.3%), Brush Rangeland (0.3%)
Nez Perce	Evergreen Forest (87.9%), Brush Rangeland (4.4%), Mixed Rangeland (2.7%), Mixed Forest (2.6%), all others combined (2.4%)
Overwhich Creek	Evergreen Forest (80.0%), Mixed Forest (18.9%), all others combined (1.1%)
Reimel Creek	Evergreen Forest (73.1%), Grass Rangeland (15.3%), Mixed Rangeland (10.0%), all others combined (1.6%)
West Fork	Evergreen Forest (79.8%), Mixed Forest (10.3%), Brush Rangeland (4.3%), Exposed Rock (2.9%), Mixed Rangeland (1.7%), all others combined (1.0%)

2.13 Roads and Roadless Areas

Figure A-14 shows the locations of inventoried roadless areas within the Bitterroot Headwaters TMDL Planning Area. Table 2-19 presents the distribution of roadless areas and the size and density of the existing road network within the 14 303(d) listed watersheds. Road data were provided by the Bitterroot National Forest.

Table 2-19. Roadless Area, Road Miles, and Road Density in the BHTPA.

Watershed	Total Area (square miles)	Roadless Area (square miles)	% Roadless	Road Miles	Road Density (mi/m^2)
Buck	2.4	0.0	0.0	15.0	6.2
Deer	22.7	21.1	93.1	7.4	0.3
Ditch	1.7	0.01	0.6	8.3	4.8
East Fork	407.3	91.6	22.5	1481.8	3.6
Gilbert	2.4	0.91	37.7	4.6	1.9
Hughes	59.8	37.4	62.5	87.1	1.5
Laird	9.4	2.1	22.2	47.4	5.0
Martin	31.9	10.0	31.4	89.8	2.8
Meadow	32.1	6.7	20.9	81.9	2.5
Moose	24.9	18.2	72.9	37.7	1.5
Nez Perce	37.3	17.5	46.9	89.7	2.4
Overwhich	50.2	29.5	58.8	77.6	1.5
Reimel	9.2	5.7	62.1	6.4	0.7
West Fork	559.4	258.9	46.3	1272.3	2.3
BHTPA	966.7	350.5	36.3	2754.1	2.8

2.14 Fires of 2000

The fires of 2000 burned extensively throughout the Bitterroot Headwaters TMDL Planning Area. A map showing fire location and severity is included as Figure A-15. Table 2-20 presents acres and percent of watershed burned at low, moderate, and high severity across the entire planning area and in each of the 11 303(d) listed watersheds that burned in 2000. Three of the listed watersheds, Ditch, Buck, and Nez Perce were largely unaffected by the fires.

Fire severity is classified as high, moderate, or low by the USFS as follows:

Fire severity refers to the degree to which a site has been altered for the successional processes disrupted by fire. Fire severity, loosely, is a product of fire intensity and residence time. Fire severity is generally considered to be low, moderate, or high. A light severity burn is one that leaves the soil covered with partially charred organic material. A moderate severity burn results from a burn in which all of the organic material is burned away form the surface of the soil; any remaining fuel is deeply charred. A high severity burn results in all of the organic material being removed from the soil surface; organic material below the surface is consumed or charred (USFS, 2001a)

Table 2-20. Acres and Percent of Watershed Burned in the Fires of 2000.

Watershed	Low Severity		Moderate Severity		High Severity		Total Burned	
	Acres	%	Acres	%	Acres	%	Acres	%
Deer Creek	873	6.02	108	0.75	38	0.26	1,019	7.03
East Fork	53,593	20.56	26,990	10.35	49,237	18.89	129,820	49.81
Gilbert Creek	660	42.70	88	5.70	540	34.94	1,288	83.34
Hughes Creek	2,910	7.60	127	0.33	1,342	3.51	4,379	11.44
Laird Creek	2,084	34.47	640	10.59	2,332	38.57	5,056	83.63
Martin Creek	254	1.24	321	1.58	0	0.00	575	2.82
Meadow Creek	3,843	18.69	1,602	7.79	7,824	38.06	13,269	64.54
Moose Creek	985	6.17	317	1.99	0.29	0.00	1,302	8.16
Overwhich Creek	6,769	21.07	1,935	6.02	3,784	11.78	12,488	38.87
Reimel Creek	1,377	23.45	435	7.40	1,536	26.17	3,348	57.03
West Fork	24,167	6.75	6,751	1.89	16,920	4.73	47,838	13.36
BHTPA	77,760	12.6	33,741	5.5	66,157	10.7	177,658	28.7

Note: Buck, Ditch, and Nez Perce Fork were unaffected by the fires of 2000.

2.15 Water Rights and Irrigation

Figure A-16 presents the location of irrigated lands within the Bitterroot Headwaters TMDL Planning Area. In general, a very small fraction of the watershed is under irrigation. A total of 4,122 acres across the entire planning area (approximately 0.7% of the total watershed area) are irrigated, including 3,145 acres in the East Fork drainage and 977 acres in the West Fork drainage. As in shown on Figure A-16, most of this irrigation is concentrated in the vicinity of Sula and Conner. Two of the 303(d) listed drainages within the basin are affected by potentially significant irrigation practices: 80.2 acres in Reimel Creek, or 1.4 percent of the watershed, and 82.6 acres in Nez Perce Fork or 0.3 percent of the watershed.

Irrigation data were provided by the Montana Department of Natural Resources and Conservation from their November 1997 Water Resource Survey.

2.16 Painted Rocks Reservoir

Painted Rocks Dam is located on the West Fork of the Bitterroot River approximately 22 miles south of Darby, Montana. The Montana Department of Natural Resources and Conservation (DNRC) manages the dam primarily as an irrigation structure with some limited seasonal recreational uses.

The earthen embankment of the dam is 800 feet long and 143 feet high. When filled to the crest of the spillway, the dam impounds 31,706 acre-feet (AF) of water, which covers 655 acres. DNRC has contracts to deliver 15,000 AF for in-stream fisheries flows and 10,000 AF for irrigation. The contracts require delivery of the water between May 1 and September 30. The irrigation water is delivered as far north as Florence (approximately 65 miles downstream), and in-stream fisheries flows are protected as far as Bell Crossing (approximately 48 miles downstream). The minimum pool for the reservoir is 6,000 AF.

The target date for the reservoir to reach full pool is Memorial Day weekend (end of May) in a normal year and mid-May during drought years. Since the reservoir is used seasonally as a flat-water recreation area, DNRC strives to ensure that it is full for the unofficial start of the recreation season. The reservoir is filled as spring runoff accelerates. After the reservoir stops filling, the gates are adjusted weekly to ensure that inflows equal outflows and that the reservoir remains at full pool, until the water contracts are delivered.

The DNRC's Missoula Water Resources Regional Office staff acts as the dam tender, ensuring that the reservoir is filled in a timely fashion and that the contracts are delivered on demand. The contract water delivery is determined by representatives of the Painted Rocks Water Users Association and Montana Fish, Wildlife and Parks (MFWP). Contract water is usually called for starting in early July and is delivered until the end of September (Schock, 2003).

The summer release of stored water from the dam alters the summertime flow and temperature regime throughout the entire 23 miles of the lower West Fork. Generally, river flows are higher than normal until late summer or early fall, then drop rapidly as the pool in Painted Rocks Reservoir becomes depleted.

River temperatures in the lower West Fork typically climb throughout the summer as the surface waters of Painted Rocks Reservoir warmed up. It is not unusual for maximum summer water temperatures to exceed 17° C from late July through early September throughout the entire lower West Fork.

Painted Rocks Dam is a complete barrier to upstream fish movement, having split the bull trout population in the West Fork since its construction in the 1930's, and blocking what was once a sizeable spawning run into the West Fork headwaters.

2.17 Fish

Two species of trout are native to the Bitterroot Headwaters TMDL Planning Area. The status of these fish is described by MDEQ in the Preliminary Assessment Report for the Bitterroot Headwaters TMDL Planning Area:

> *Bull Trout (Salvelinus confluentus) are native to the East and West Forks of the Bitterroot River and its tributaries. As part of the Columbia River population, it was listed as Threatened under the Endangered Species Act in July of 1998. Bull trout also appear on the State of Montana's Animal Species of Concern list (Carlson, 2001) 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".*
>
> *Westslope cutthroat trout (Oncorhynchus clarki lewisi) are listed on the Animal Species of Concern list 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" (Carlson, 2001). It is also listed as "sensitive" by the USFS ("animal species … for which population viability is a concern as evidenced by significant downward trend is 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, 2001)* (MDEQ, 2001).

Both trout species occur throughout the Bitterroot Headwaters TMDL Planning Area and are thought to be present in nearly all of the 303(d) listed streams in the watershed (Figures A-17 and A-18).

Fisheries information was obtained from the Montana Fish, Wildlife and Parks Fish Distribution Database, available at: http://fwp.state.mt.us/insidefwp/fwplibrary/gis/metadata/Fishdist.htm

SECTION 3.0
WATER QUALITY CONCERNS AND IMPAIRMENT STATUS

This section of the document first presents the 303(d) list status of all listed waterbodies in the BHTPA (i.e., which waterbodies are listed as impaired or threatened and for which pollutants). This is followed by a summary of the applicable water quality standards and a translation of those standards into proposed water quality goals or targets. The remainder of this section is devoted to a waterbody-by-waterbody review of available water quality data and an updated water quality impairment status determination for each listed waterbody.

3.1 303(d) List Status

A summary of the 303(d) list status and history of listings is provided in Tables 3-1 and 3-2. As mentioned in Section 1.1, all necessary TMDLs must be completed for all pollutant waterbody combinations appearing on the 1996 303(d) list.

A total of fourteen waterbodies in the Bitterroot Headwaters TPA appeared on the 1996, 1998, 2000 and/or 2002 303(d) lists. All impairment causes and sources that have appeared on any of Montana's 1996 to 2002 303(d) lists have been included in the TMDLs and watershed restoration plans presented in this document. However, TMDLs were not prepared for impairments where convincing evidence suggests that the initial listings had been made in error or that conditions had improved since the listing to an extent that beneficial uses are no longer impaired. Where a source of impairment is recommended for removal from the 303(d) list, justification is provided in the sections that follow. Tables 3-1 and 3-2 provide a summary of 1996 and 2002 303(d) list for streams in the Bitterroot Headwaters TPA. Because Gilbert Creek is a tributary to Laird Creek and the streams are listed for the same reasons, they are treated as a single waterbody throughout this document.

Table 3-1. Bitterroot Headwaters Waterbodies Listed on the 1996 303(d) List in Need of a Restoration Plan and TMDL.

Waterbody	Probable Causes	Probable Sources	Beneficial Uses Impaired
Buck Creek MT76H002_060	Other Habitat Alterations Siltation Suspended Solids	Silviculture	Aquatic life Cold water fishery
Ditch Creek MT76H003_060	Other Habitat Alterations Siltation Suspended Solids	Silviculture	Aquatic life Cold water fishery
Deer Creek MT76H003_030	Habitat Alterations	Agriculture Channelization Range land	Cold water fishery
Hughes Creek MT76H003_040	Other Habitat Alterations Siltation Suspended Solids Thermal Modification	Dredge Mining Resource Extraction	Aquatic life Cold water fishery Agriculture
Overwhich Creek MT76H003_050	Flow Alteration Thermal Modification	Silviculture	Cold water fishery
Nez Perce Fork MT76H003_020	Thermal Modification	Silviculture	Cold water fishery
West Fork Bitterroot River MT76H003_010	Flow Alteration Noxious Aquatic Plants Other Habitat Alterations Thermal Modification	Agriculture Dredge mining Irrigated Crop Production Resource extraction Range Land Silviculture	Aquatic life Cold water fishery
Moose Creek MT76H002_040	Siltation	Agriculture Irrigated crop production Range land	Cold water fishery
Martin Creek MT76H002_050	Flow Alteration Thermal modifications	Silviculture	Cold water fishery
Meadow Creek MT76H002_030	Other Habitat Alterations	Agriculture Range land Highway/road/bridge construction	Cold water fishery
Reimel Creek MT76H002_020	Other Habitat Alterations Siltation Suspended Solids	Agriculture Range land	Aquatic life Cold water fishery
Gilbert/Laird Creek MT76H0002_080 & MT76H0002_070	Other Habitat Alterations Siltation Suspended Solids	Silviculture	Aquatic life Cold water fishery Agriculture
East Fork Bitterroot River MT76H002_010	Flow Alteration Other Habitat Alterations Siltation	Agriculture Irrigated crop production Range land	Cold water fishery

Table 3-2. Bitterroot Headwaters Waterbodies Listed on the 2002 303(d) List in Need of a Restoration Plan and TMDL.

Waterbody	Probable Causes	Probable Sources	Beneficial Uses Impaired
Buck Creek MT76H002_060	*Did not meet Sufficient and Credible Data requirements*	Did not meet Sufficient and Credible Data requirements	Did not meet Sufficient and Credible Data requirements
Ditch Creek MT76H003_060	*Did not meet Sufficient and Credible Data requirements*	Did not meet Sufficient and Credible Data requirements	Did not meet Sufficient and Credible Data requirements
Deer Creek MT76H003_030	*Did not meet Sufficient and Credible Data requirements*	Did not meet Sufficient and Credible Data requirements	Did not meet Sufficient and Credible Data requirements
Hughes Creek MT76H003_040	Other Habitat Alterations	Abandoned Mining Channelization Placer Mining	Aquatic life Cold water fishery
Overwhich Creek MT76H003_050	*Did not meet Sufficient and Credible Data requirements*	Did not meet Sufficient and Credible Data requirements	All uses except drinking water
	Lead	Abandoned Mining	Drinking Water
Nez Perce Fork MT76H003_020	*Did not meet Sufficient and Credible Data requirements*	Did not meet Sufficient and Credible Data requirements	Did not meet Sufficient and Credible Data requirements
West Fork Bitterroot River MT76H003_010	Other Habitat Alterations Siltation	Bridge construction Bank or shoreline modification/destabilization Highway/road/bridge runoff	Aquatic life Cold water fishery
Moose Creek MT76H002_040	Nutrients Siltation	Unknown	Aquatic life Cold water fishery
Martin Creek MT76H002_050	*Did not meet Sufficient and Credible Data requirements*	Did not meet Sufficient and Credible Data requirements	Did not meet Sufficient and Credible Data requirements
Meadow Creek MT76H002_030	*Did not meet Sufficient and Credible Data requirements*	Did not meet Sufficient and Credible Data requirements	Did not meet Sufficient and Credible Data requirements
Reimel Creek MT76H002_020	*Did not meet Sufficient and Credible Data requirements*	Did not meet Sufficient and Credible Data requirements	Did not meet Sufficient and Credible Data requirements
Gilbert/Laird Creek MT76H0002_080 & MT76H0002_070	Other Habitat Alterations Siltation	Silviculture Logging road construction/maintenance	Aquatic life Cold water fishery
East Fork Bitterroot River MT76H002_010	Other Habitat Alterations Siltation	Silviculture Logging Road Construction Highway Maintenance and Runoff	Aquatic life Cold water fishery

3.2 Applicable Water Quality Standards

Water quality standards include: the uses designated for a waterbody, the legally enforceable standards that ensure that the uses are supported, and a non-degradation policy that protects the high quality of a waterbody. 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 sediment and nutrients. This section provides a summary of the applicable water quality standards for each of these pollutants.

3.2.1 Classification and Beneficial Uses

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

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

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

Descriptions of Montana's surface water classifications and designated beneficial uses are presented in Table 3-3. All waterbodies within the Bitterroot Headwaters TPA are classified as B-1.

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

Classification	Designated Uses
A-CLOSED CLASSIFICATION:	Waters classified A-Closed are to be maintained suitable for drinking, culinary and food processing purposes after simple disinfection.
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.
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.
B-2 CLASSIFICATION:	Waters classified B-2 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
B-3 CLASSIFICATION:	Waters classified B-3 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-1 CLASSIFICATION:	Waters classified C-1 are to 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.
C-2 CLASSIFICATION:	Waters classified C-2 are to be maintained suitable for bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-3 CLASSIFICATION:	Waters classified C-3 are to be maintained suitable for bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers. The quality of these waters is naturally marginal for drinking, culinary and food processing purposes, agriculture and industrial water supply.
I CLASSIFICATION:	The goal of the State of Montana is to have these waters fully support the following uses: drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

3.2.2 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.

<u>Numeric</u> 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, 2001). The numeric human health standards have been developed for parameters determined to be toxic, carcinogenic, or harmful and have been established at levels to be protective of long-term (i.e., life long) exposures as well as through direct contact such as swimming.

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

High quality waters are afforded an additional level of protection by the nondegradation rules (ARM 17.30.701 et. seq.) and in statute (75-5-303 MCA). Changes in water quality must be "non-significant" or an authorization to degrade must be granted by the Department. However under no circumstance may standards be exceeded. It is important to note that, waters that meet or are of better quality than a standard are high quality for that parameter, and nondegradation policies apply to new or increased discharges to that the waterbody.

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 waterbody. 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 Bitterroot Headwaters TPA are summarized, one-by-one, below.

3.2.2.1 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 waterbody'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.

3.2.2.2 Metals

Numeric criteria for metals in Montana include specific standards for the protection of both aquatic life and human health. As described above, acute and chronic criteria have been established for the protection of aquatic life. The standards for cadmium, copper, chromium (III), lead, nickel, silver and zinc vary according to the hardness of the water. These standards have an inverse relationship to toxicity (decreasing hardness causes increased toxicity). The applicable numeric criteria for the metals of concern in the Bitterroot Headwaters TPA are presented in Table 3-5.

It should be noted that recent studies have indicated some metals concentrations 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 for Relevant Metals.

Parameter	Aquatic Life (acute) (µL)[a]	Aquatic Life (chronic) (µL)[b]	Human Health (µL)[a]
Lead (TR)	82 @ 100 mg/L hardness[c]	3.2 @ 100 mg/L hardness[c]	15

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

3.2.2.3 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 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 67º F, the maximum allowable increase is 0.5º F.

3.2.2.4 Nutrients

The term *nutrients* generally refer to the various forms of nitrogen and phosphorus found in a waterbody. Both nitrogen and phosphorus are necessary for aquatic life, and the natural amount of nutrients in a waterbody varies depending on the type of system. A pristine mountain spring might have little to almost no nutrients, whereas a lowland, mature stream flowing through wetland areas might have naturally high nutrient concentrations. Most waters of Montana are protected from excessive nutrient concentrations by narrative standards. The exception is the Clark Fork River above the confluence with the Flathead River, where numeric water quality standards for total nitrogen (300 ug/L) and total phosphorus (20 ug/L upstream of the confluence with the Blackfoot River and 39 ug/L downstream of the confluence) as well as algal biomass measured as chlorophyll a (summer mean and maximum of 100 and 150 mg/m^2, respectively) have been established.

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

Nutrients generally do not pose a direct threat to the beneficial uses of a waterbody. However, excess nutrients can cause an undesirable abundance of plant and algae growth. This process is called eutrophication or organic enrichment. Organic enrichment can have many effects on a stream or lake. One possible effect is low dissolved oxygen concentrations. Aquatic organisms require oxygen to live and they can experience lowered reproduction rates and mortality with lowered dissolved oxygen concentrations. Numeric criteria exist for dissolved oxygen concentrations and they are discussed in the Montana Water Quality Standards Circular WQB-7. Dissolved oxygen criteria are summarized in Table 3-6 (MDEQ, 2004).

Table 3-6. Numeric Dissolved Oxygen Criteria.

Time Period	Early Life Stages[1] (mg/L)	Other Life Stages (mg/L)
30-Day Mean	NA	6.5
7-Day Mean	9.5 (6.5)	NA
7-Day Mean (min)	NA	5.0
1 Day Min	8.0 (5.0)	4.0

[1] These are water column concentrations recommended to achieve the required inter-gravel dissolved oxygen concentrations shown in parentheses. For species that have early life stages exposed directly to the water column, the figures in parentheses apply.

3.3 Water Quality Targets

To develop a TMDL, it is necessary to establish quantitative water quality goals or targets. TMDL targets must represent the applicable numeric or narrative water quality standards and full support of all associated beneficial uses. For many pollutants with established numeric water quality standards, the water quality standard is used directly as the TMDL indicator. Only one of the pollutants of concern in the Bitterroot Headwaters TPA (lead) has established numeric water quality standards that can be directly applied as a TMDL target. Where targets and indicators are established for pollutants with only narrative standards, the indicator must be a waterbody-specific, measurable interpretation of the narrative standard.

In the case of the Bitterroot Headwaters, there is no single parameter that can be applied alone to provide a direct measure of beneficial use impairment associated with sediment, nutrients, or temperature. As a result, a suite of target and supplemental indicators has been selected to help determine when impairments are present (Tables 3-7, 3-8, and 3-9). In the case of the metals (lead) impairment, State numeric standards exist. These numeric standards shall be used as the sole target to measure beneficial use support associated with metals (or in this case, lead) (Table 3-10). In consideration of the available data for the Bitterroot Headwaters TPA, the targets are the most reliable and robust measures of impairment and beneficial use support available. As described in the one-by-one discussions of individual targets presented in the following paragraphs, there is a documented relationship between the selected water quality target values and beneficial use support, or sufficient reference data is available to establish a threshold value representing “natural” conditions. In addition to having a documented relationship with the suspected impaired beneficial use, the targets have direct relevance to the pollutant of concern. The targets, therefore, are relied upon as threshold values, that if exceeded (based on sufficient data) indicate water quality impairment. The targets will also be applied as water quality goals by which the ultimate success of implementation of this plan will be measured in the future.

The supplemental indicators provide supporting and/or collaborative information when used in combination with the core indicators. Additionally, some of the supplemental indicators are necessary to determine if exceedances of targets are a result of natural versus anthropogenic causes. However, the proposed supplemental indicators are not sufficiently reliable to be used alone as a measure of impairment because: 1) the cause-effect relationship between the supplemental indicator(s) and beneficial use impairments is weak and/or uncertain; 2) the supplemental indicator(s) cannot be used to isolate impairment associated with individual pollutants (e.g., differentiate between an impairment caused by excessive levels of sediment versus high concentrations of metals); or 3) there is too much uncertainty associated with the supplemental indicator(s) to have a high level of confidence in the result.

Targets and Supplemental Indicators Applied to Beneficial Use Impairment Determinations

The beneficial use impairment determinations presented in Section 3.8 are based a weight of evidence approach in combination with the application of best professional judgment. The weight of evidence approach is outlined in Figure 3-1 and is applied as follows. If none of the target values are exceeded, the water is considered to be fully supporting its uses and no TMDL is necessary. This is true even if one or more of the supplemental indicator values are exceeded. On the other hand, if one or more of the target values are exceeded, the circumstances around the exceedance are investigated and the supplemental indicators are used to provide additional information to support a determination of impairment/non-impairment. In this case, the circumstances around the exceedance of a target value are investigated before it is automatically assumed that the exceedance represents human-caused impairment (e.g., is the data reliable and representative of the entire reach? Might the exceedance be a result of natural causes such as floods, drought, fire or the physical character of the watershed? Are there significant human-caused sources that are leading to an impairment?). This is also the case where the supplemental indicators assist by providing collaborative and supplemental information, and the weight of evidence of the complete suite of core indicators and supplemental indicators is used to make the impairment determination.

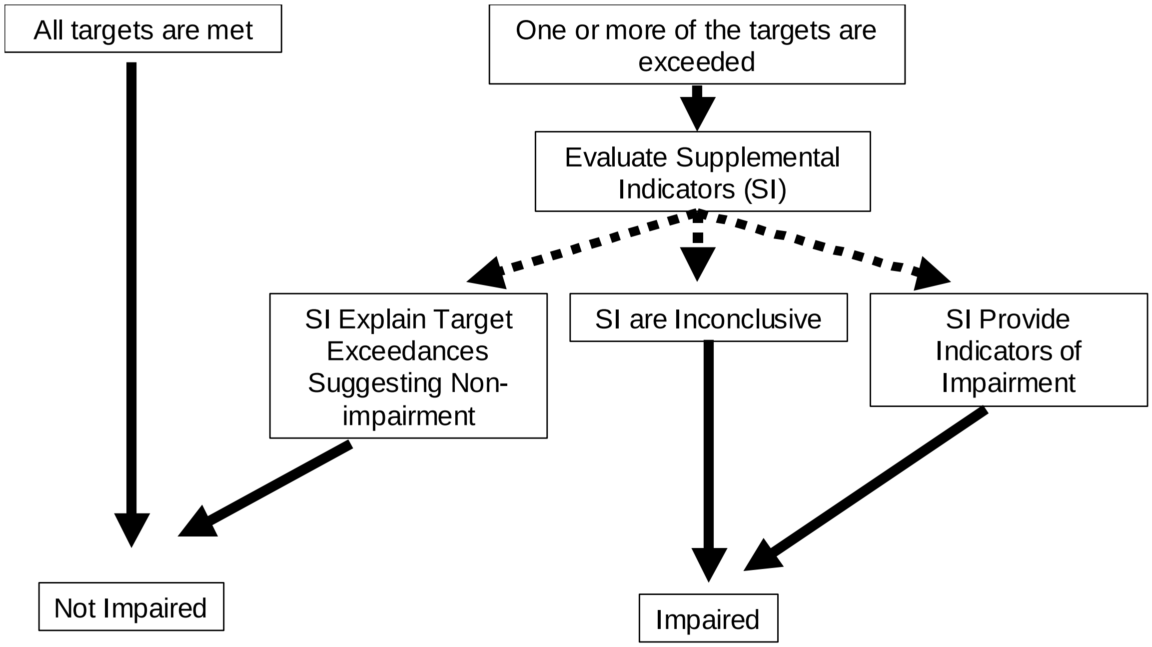

Figure 3-1. Weight of Evidence Approach for Determining Beneficial Use Impairments.

Targets and Supplemental Indicators as Water Quality Targets

In accordance with the Montana Water Quality Act (MCA 75-5-703(7) and (9)), the MDEQ is required to assess the waters for which TMDLs have been completed to determine whether compliance with water quality standards has been attained. This assessment will use the suite of targets and supplemental indicators specified in Tables 3-7, 3-8, 3-9, and 3-10 to measure compliance with water quality standards and achievement of full support of all applicable beneficial uses (Figure 3-2). The supplemental indicators will not be used directly as water quality goals to measure the success of this water quality restoration plan. If all of the target threshold values are met, it will be assumed that beneficial uses are fully supported and water quality standards have been achieved. Alternatively, if one or more of the target threshold values are exceeded, it will be assumed that beneficial uses are not fully supported and water quality standards have not been achieved. However, it will not be automatically assumed that implementation of this TMDL was unsuccessful just because one or more of the water quality target threshold values have been exceeded. As above, the circumstances around the exceedance will be investigated. For example, might the exceedance be a result of natural causes such as floods, drought, fire or the physical character of the watershed? Additionally, in accordance with MCA 75-5-703(9), an evaluation will be conducted to determine if:

- The implementation of a new or improved suite of control measures is necessary;
- More time is needed to achieve water quality standards, or;
- Revisions to components of the TMDL are necessary.

Detailed discussions regarding each of the targets and supplemental indicators are presented below.

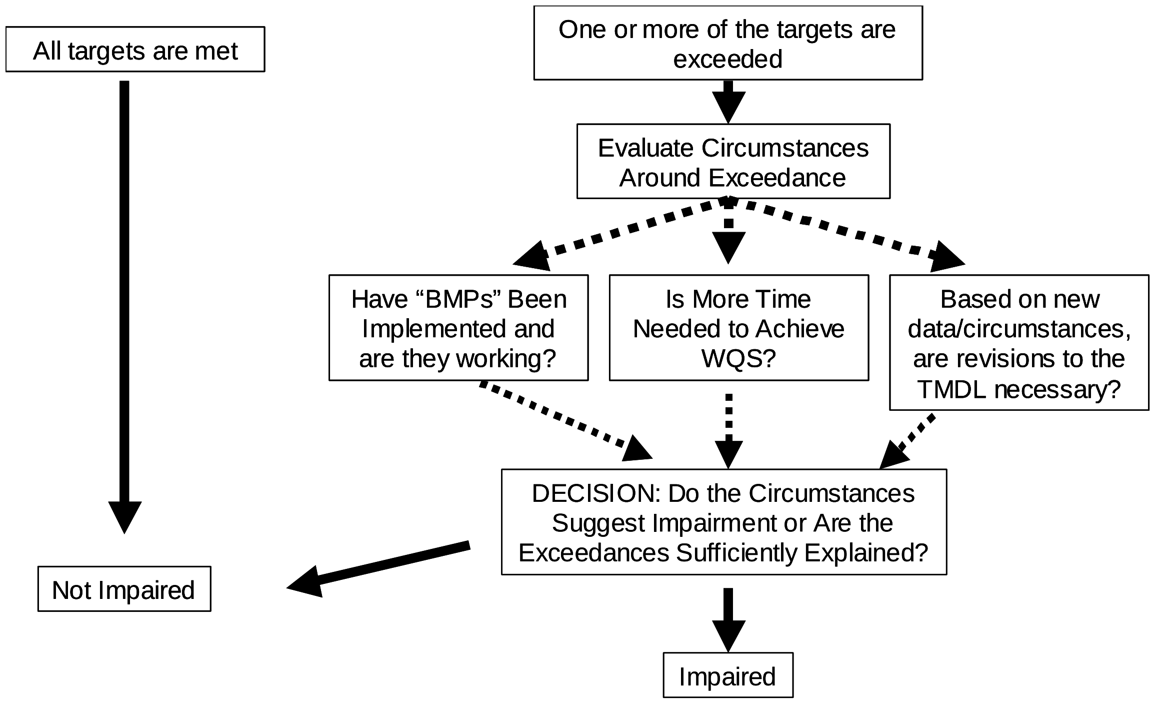

Figure 3-2. Methodology for Determining Compliance with Water Quality Standards.

Targets and indicators are presented in Tables 3-7, 3-8, 3-9, and 3-10 below. The derivation of the targets and indicators is discussed below.

Table 3-7. Summary of the Proposed Targets & Indicators for the Sediment[1] Impaired Streams in the Bitterroot Headwaters TPA.

Target Parameter	Proposed Metrics/Threshold	
Wolman pebble counts % Fines< 2mm (data collected in riffles)	B3 channels	Mean = 12%
		Range = 5-19%
	B4 channels	Mean = 19%
		Range = 11-27
	C3 channels	Mean = 13%
		Range = 6-20%
	C4 channels	Mean = 23%
		Range = 14-32%
Wolman pebble counts % Fines < 6mm (data collected in riffles)	B3 channels	Mean = 16%
		Range = 7-25%
	B4 channels	Mean = 27%
		Range = 16-38%
	C3 Channels	Mean = 16%
		Range = 8-24%
	C4 channels	Mean = 33%
		Range = 17-49%
Wolman pebble counts D_{50} (data collected in riffles)	B3 channels	64-256 mm
	B4 channels	7-64 mm
	C3 channels	71-89 mm
	C4 channels	3-47 mm
Clinger Richness	All	≥ 14
Supplemental Indicator Parameter[3]		
Residual Pool Depth	≥ 1.5 feet	
LWD/mile (at least 30 cm diameter and 10 meters long)	East and West Forks: > 20/mile Tributaries: > 50/mile	
Pools/mile	Stream width class (ft)	Pools/mile target
	0-5	39
	5-10	60
	10-15	48
	15-20	39
	20-30	23
	30-35	18
	35-40	10
	40-65	9
	65-100	4
Suspended Solids Concentration	Comparable to reference condition	
Turbidity	High Flow – ≤ 50 NTU instantaneous maximum Summer base flow – ≤ 10 NTU	
Montana Mountain Macroinvertebrate Index of Biological Integrity	> 75%	
Percentage of Clinger Taxa	“High”	
EPT Richness	≥ 22	
Juvenile Bull Trout & Westslope Cutthroat Trout Densities	Documented increasing or stable trend.	
Human Caused Sediment Sources[2]	No preventable sources	
Fish Passage Barriers	No barrier except to protect native salmonid genetics	

[1]Throughout this document, several related impairment, including sediment, siltation, suspended solids and habitat alterations are treated collectively as sediment for ease of presentation.
[2] This supplemental indicator is only applied to the verification of impairment determinations. This is not intended to be a water quality goal.
[3]The supplemental indicators are not Rosgen stream type dependent.

Table 3-8. Summary of the Proposed Targets & Indicators for the Thermally Impaired Streams in the Bitterroot Headwaters TPA.

Targets			
Parameter	**Stream**	**Proposed Metrics/Threshold**	**Monitoring Location**
In-stream Temperature[2]	Hughes Creek	Upper site: 15^0 C (59^0 F)	Mile 9.0
		Lower site: 15^0 C (59^0 F)	Mile 1.4
	Nez Perce Fork	Upper site: 12^0 C (53.6^0 F)	Mile 11.0
		Lower site: 15^0 C (59^0 F)	Mile 1.0
	Martin Creek	Upper site: 15^0 C (59^0 F)	Mile 1.0
		Lower site: 15^0 C (59^0 F)	Mile 7.0
	Overwhich Creek	Upper site: 12^0 C (53.6^0 F)	Mile 7.0
		Lower site: 15^0 C (59^0 F)	Mile 2.0
	West Fork Bitterroot River	Upper site: 12^0 C (53.6^0 F)	Mile 40.1
		Middle site: 15^0 C (59^0 F)	Mile 22.2
		Lower site: 15^0 C (59^0 F)	Mile 1.2
	East Fork Bitterroot River[1]	Upper site: 12^0 C (53.6^0 F)	Mile 31.4
		Middle site: 15^0 C (59^0 F)	Mile 17.8
		Lower site: 15^0 C (59^0 F)	Mile 0.5
	Supplemental Indicators		
% Shade	Hughes Creek	78%	Entire stream length
	Nez Perce Fork Creek	45%	
	Martin Creek	85%	
	West Fork Bitterroot River	45%	
	Overwhich Creek	73%	
	East Fork Bitterroot River[1]	55%	

[1] The East Fork has not been formally listed as impaired for thermal modifications.
[2] Mid-summer maximum as measured by a 7-day moving average.

Table 3-9. Summary of the Proposed Nutrient Targets and Supplemental Indicators for the Bitterroot Headwaters TPA.

Targets	**Threshold**
Benthic Chlorophyll-*a*	< 33 mg/m^2
USEPA Ecoregion II, Total Phosphorus (P25)	< 0.01 mg/L
USEPA Ecoregion II, Nitrate+Nitrite (NO_2/NO_3) (P25)	< 0.014 mg/L
Clark Fork Total Phosphorous Guidelines	< 0.039 mg/L
Clark Fork Total Nitrogen	< 0.3 mg/L
Supplemental Indicators	**Threshold**
Montana Mountain Macroinvertebrate Index of Biological Integrity	> 75%
Dissolved Oxygen, 7-Day Mean	> 9.5 mg/L
Dissolved Oxygen, 1-Day Minimum	> 8.0 mg/L
USEPA Ecoregion II, Chlorophyll-*a*, Water Column (P25)	< 1.08 µg/L
Fire	Evaluated on a case-by-case basis
Equivalent Clear Cut Acres	<25%
Water Yield	<10%

Table 3-10. Montana Numeric Surface Water Quality Standards for Lead (Metals).

Parameter	Aquatic Life (acute) (μL)[a]	Aquatic Life (chronic) (μL)[b]	Human Health (μL)[a]
Lead (TR)	82 @ 100 mg/L hardness[c]	3.2 @ 100 mg/L hardness[c]	15

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

3.3.1 Sediment Targets

The proposed sediment targets include Wolman Pebble Count surface substrate fines, D_{50} substrate percentages, and macroinvertebrate clinger richness. A range of sediment supplemental indicators is also included.

Wolman Pebble Counts - Percent Surface Substrate Fines < 6mm, < 2mm & D_{50}

Measurements of the size range of substrate material in the streambed are indicative of salmonid spawning and incubation habitat quality. Fine sediment is often used to describe spawning gravel quality. Increased sediment affects spawning gravels in the following ways: 1) cementing the gravels place and reducing their viability as spawning substrate, 2) reducing the oxygen available to fish embryos, 3) reducing intragravel water velocities and the delivery of nutrients to and waste material from the interior of the redd, 4) and impairing the ability of fry to emerge as free-swimming fish (Meehan, 1991). Substrate fine materials less than 6 mm are commonly used to describe potential success of fry emergence, and this size class includes the range typically generated by land management activities (Weaver and Fraley, 1991). Weaver and Fraley (1991) observed a significant inverse relationship between the percentage of material < 6 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. Other 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).

The D_{50} is the median value of the size distribution in a sample of surface particles, and is typically calculated by use of the Wolman pebble count (Wolman 1954). It is a measure of the central tendency of the stream substrate, and thus is one of several indicators of how "fine" or "coarse" the substrate is overall. In a study that evaluated the relationship between hillslope disturbance and various in-stream indicators, Knopp (1993) found that a clear trend of decreasing particle sizes in riffles was evident with increasing hill slope disturbance. Moreover, Knopp found a statistically significant difference in average and minimum D_{50} values when comparing reaches in undisturbed and less disturbed watersheds with reaches in moderately and highly disturbed watersheds.

Percent surface fines <2mm and <6mm, and the D_{50} are measured in riffles with the pebble count method described by Wolman (1954). For the purposes of developing in-stream sediment targets for the Bitterroot Headwaters TPA, reference conditions were estimated using the Bitterroot National Forest's reference stream database. Reference streams were determined by their ability to function properly through efficient sediment transport. The reference streams were typically unmanaged or minimally managed drainages. These streams do not necessarily represent pristine conditions, but are instead places where beneficial uses are supported in the presence of minor anthropogenic impacts.

To develop the percent < 2mm, percent < 6mm, and D_{50} targets, reference stream data were stratified by Rosgen level 2 classification (A3, A4, B3, etc.) (Rosgen, 1996). For percent < 2mm, reference values for B3 channels in the BNF database averaged 12 percent, with 68 percent (+/- one standard deviation) of the reference values falling between 5 and 19 percent. In B4, C3, and C4 streams, the mean reference values were 19, 13 and 23 percent respectively, with 68 percent ranges of 11 to 27 percent for B4 streams, 6 to 20 percent for C3 streams, and 14 to 32 percent for C4 streams.

For percent < 6mm, reference values for B3 channels in the BNF database averaged 16 percent, with 68 percent (+/- one standard deviation) of the reference values falling between 7 and 25 percent. In B4, C3, and C4 streams, the mean reference values were 27, 16 and 33 percent respectively, with 68 percent ranges of 16 to 38 percent for B4 streams, 8 to 24 percent for C3 streams, and 17 to 49 percent for C4 streams.

The D_{50} would be expected to vary widely for each Rosgen stream type, and thus this target has been set simply as the range of conditions found in BNF reference streams. For B3 channels the target range is 64 to 256 mm; for B4 channels the range is 7 to 64 mm; for C3 channels the range is 71 to 89 mm; and for C4 channels it is 3 to 47 mm.

In Section 3.8 below, percent fines and D_{50} targets are compared to current conditions in each of the sediment-listed streams. The current condition of percent fines and D_{50} targets was evaluated by the Bitterroot National Forest, which conducted post-fire Wolman pebble counts at selected sites in riffles in the sediment-listed streams. Sampling locations are summarized in Table 3-13.

Macroinvertebrates

Macroinvertebrate data help to provide a better understanding of the cumulative and intermittent impacts that may have occurred over time in a stream, and they are a direct measure of the aquatic life beneficial use. Analytical methods used to interpret macroinvertebrate data are constantly evolving, based on new data and information offered from research. With this in mind, the macroinvertebrate core indicators and supplemental indicators are intended to integrate multiple stressors/pollutants to provide an assessment of the overall aquatic life use condition. The macroinvertebrate core indicators are also intended to provide information regarding which pollutant(s) might be causing the impairment.

Several biological indicators were considered for the BHTPA. These indicators include: the Mountain Index of Biological Integrity (IBI) (Bukantis, 1998), several individual biological metrics, and the relative stressor tolerance of dominant benthic and macroinvertebrate taxa. Many of these provide an indication of overall water quality, but do not specifically identify sediment as the cause of the impairment. Of the evaluated metrics, the ***number of clinger taxa*** provides the strongest indication of a sediment impairment. Clinger taxa have morphological and behavioral adaptations that allow individuals to maintain position on an object in the substrate even in the face of potentially shearing flows. These taxa are sensitive to fine sediments that fill interstitial spaces, one of the main niches. This metric is calculated as the number of clinger taxa in a sample, and decreases in the presence of stressors. A minimum of 14 clinger taxa are expected in unimpaired Montana streams, and this is proposed as a target for streams in the Bitterroot Headwaters TPA (Bollman, 1998). Other biological metrics and indexes are discussed as supplemental indicators in Section 3.3.2.

3.3.2 Sediment Supplemental Indicators

As stated previously, the proposed supplemental indicators are not sufficiently reliable to be used alone as a measure of sediment or thermal impairment in the streams within the BHTPA. These indicators are used as supplemental information, in combination with the other targets and indicators, to provide better definition to potential sediment impairments.

Pools/mile, Residual Pool Depth & Large Woody Debris (LWD)/mile

Pool frequency (pools/mile) is a critical measure of the availability of rearing and refugia habitat for salmonids in the Bitterroot Headwaters TPA. Residual pool depth, a discharge-independent measure of pool depth, is included as an indicator of the quality of pool habitat and as an indirect measurement of sediment inputs to listed streams. An increase in sediment loading would be expected to cause pools to fill, thus decreasing residual pool depth over time. Large woody debris (LWD) is also a critical component of quality salmonid habitat, and it is a primary influence on stream function, including sediment and organic material transport, channel form, bar formation and stabilization, and flow dynamics (Bilby and Ward, 1989).

Although pool, LWD, and residual pool depth reference conditions have not been formally established for streams on the Bitterroot National Forest, informal interim targets have been developed by resource specialists on the forest, and these targets have been adopted for the use in this TMDL and watershed restoration plan. Pool targets were adopted from research conducted by Overton et al., 1995 in the Salmon River Basin of Idaho and are dependent on the wetted width of the stream (Table 3-7). The LWD target has been set as at least 20 pieces of woody debris/mile in the East and West Forks of the Bitterroot River and at least 50 pieces of woody debris/mile in the tributary streams. LWD targets would be applied in forested settings and are based on criteria established in Overton et al., 1995 and used by the US Fish and Wildlife Service in the Bull Trout Matrix (USFWS, 1998).

The residual pool depth target has been set at $\geq$ 1.5 feet for all streams based on typical conditions found in reference streams. However, reference data for residual pools depths was very limited. As more data are collected this target may change, particularly for small streams were the 1.5 feet target may be unrealistically high.

In Section 3.8 below, Pool, LWD and residual pool depth targets are compared to existing conditions on a stream-by-stream basis in all of the sediment-listed streams. Existing condition data were provided by the Bitterroot National Forest. Unless otherwise noted, existing pool counts were adopted from those reported in Burned Area Recovery Final EIS (USFS, 2001a).

The existing condition of residual pool depths was evaluated by BNF hydrologists and fish biologists during the summers of 2002 - 2004.

Pool, Residual pool depth and LWD metrics are summarized in Table 3-7.

Suspended Solids Concentrations and Turbidity

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. Monitoring for sediment and turbidity requires long-term, intensive sampling to adequately characterize trends or loads in these parameters. Studies have suggested that 10 years of monthly sampling would be required to detect a statistically significant trend of 7-12%/year in suspended sediment (i.e. 70-120% change in sediment concentrations over 10 years (Hirsh et al., 1985, 1991). The inherent seasonal variability of suspended sediment concentrations and turbidity, and indirect link to biological impacts makes this a challenging variable to use for siltation impairment targets. Nevertheless, turbidity is easily measured and can provide a rapid means of assessing potential sediment supply and sources. Additionally, high suspended sediment and turbidity values can lead to impaired beneficial uses (Newcombe et al., 1996).

Montana's water quality standard for turbidity varies according to stream classification. The subject waters within the BHTPA are all classified as B-1. For B-1 waters, the standard is no more than a 5 NTU (instantaneous) increase above naturally occurring turbidity. In the absence of sufficient data to characterize "naturally occurring turbidity," it is not possible to directly apply this standard as a TMDL target.

As a result, where turbidity data is available it will be used only as collaborating evidence when combined with other more robust measures of sediment impairment. The State of Idaho's standard to protect cold-water aquatic life is used as a supplemental indicator value. In accordance with Idaho's Water Quality Standards and Wastewater Treatment Requirements (58.01.02.250.02.e), turbidity below any applicable mixing zone should not be greater than 50 NTU (instantaneous) (Newcombe et al., 1996). This value will be applied to high flow events or during the time of annual runoff. Some evidence suggests that detrimental effects to biota can occur with turbidity as low as 10 NTU. The State of Idaho therefore has recommended that chronic turbidity not exceed 10 NTU during summer base flow, and this recommendation has been adopted as a supplemental sediment indicator for listed streams in the BHTPA.

Suspended sediment and turbidity conditions in the sediment-listed streams are not known at this time. As part of the monitoring and implementation plan, suspended sediment and turbidity monitoring will be conducted in the listed streams as well as in reference streams. The long-term goal is for discharge-normalized suspended sediment concentrations in the sediment-listed streams to be approximately equal to those in appropriate reference streams and for turbidity values to meet targets metrics summarized in Table 3-7.

Macroinvertebrates

Macroinvertebrate data are typically organized according to a multimetric index of biological integrity (IBI), or a "multimetric index." Individual metrics (e.g. clinger taxa, percent EPT) are designed to indicate biological response to human-induced stressors. Scores are assigned to individual metrics, summed across several of them, and the total used to compare among samples or sampling sites. Three possible multimetric indices have been developed for Montana: 1) Mountain; 2) Foothill Valley and Plains (MFVP); and 3) Plains. The Mountain IBI was chosen for streams in the Bitterroot Headwaters TPA based on site characteristics, primarily elevation. The sites in the Bitterroot Headwaters TPA are located within the Northern Rockies ecoregion (Woods et al., 1999) and range in elevation from 4000 to 6000 feet. MDEQ uses a scoring procedure with 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). This score is proposed as a supplemental indicator for streams in the Bitterroot Headwaters TPA. Streams scoring between 25 and 75 are considered partially supporting their aquatic life uses and scores lower than 25 percent represent non-supported uses.

Individual Metrics

To date, the strongest candidate metric relating to possible sediment impacts includes the number of clinger taxa, typically referred to as clinger richness. Additional metrics were collectively evaluated and used as supplemental information to assess overall stream condition. The *number of EPT taxa* is a metric describing the richness of mayflies (Ephemeroptera), stoneflies (Plecoptera), or caddisflies (Trichoptera) in a sample. Invertebrates that are members of these groups are generally understood to be sensitive to stressors in streams, whether physical, chemical, or biological. Consequently, they are less common in degraded streams. Metric values decrease in the presence of stressors. Bahls et al. (1992) determined that average EPT taxa richness for mountain streams in Montana was 22 taxa. A minimum of 22 EPT taxa is proposed as a supplemental indicator in the BHTPA.

The *percentage of clinger taxa* in a sample is also proposed as a supplemental indicator. This metric is calculated as the number of individuals categorized as belonging to clinger taxa as a proportion of the total sample, and decreases in the presence of stressors. Literature values or other information on the expected percentage of clingers is not available. A higher percentage of clingers suggests little impact from sediment. This metric, used in conjunction with the number of clinger taxa (Section 3.3.1.), will provide supplemental information on the overall impacts of sediment.

Juvenile Trout Densities

Fisheries are an important designated use in freshwater. Fish represent the highest trophic level of the aquatic community in streams and lakes. They serve as a surrogate for many physical and biological parameters such as: adequate flow, spawning and rearing habitat, appropriate food sources, and proper environmental conditions.

Montana Fish, Wildlife and Parks has been collecting population estimates in many of the BHTPA streams since 1990. Population densities provide a direct measure of the cold-water fishery beneficial use and therefore provide an important indicator. The proposed indicator is stable or increasing trends in juvenile population densities.

For the short-term, redd counts, as a beneficial use indicator, are not part of this WQRP's target strategy. Redd counts for cutthroat trout are not typically conducted because cutthroat spawn during high flows, rendering redd counting impractical. Bull trout redd counts are used in areas where large migratory fish are known to exist. Currently, within the Bitterroot River system, large numbers of migratory bull trout are not known to exist. Therefore conducting redd count surveys would not be an efficient use of resources because not enough redds would be detected to produce usable data at this time. As discussed in Section 9.0, efforts will be made in the future to better identify spawning bull trout locations in the Bitterroot system. Additionally, once population density data shows sufficient concentrations of migratory bull trout, a redd count survey study would be incorporated into the beneficial use indicator strategy.

Juvenile population density and potential future redd count data are used with caution herein due to a number of complicating factors that have little to do with the condition of the spawning tributaries. As described in Sections 2.17 and 7.3.4, Bull Trout are listed as threatened species under the federal endangered species act and as a species of concern by the State of Montana. Bull Trout inhabit all of the 303(d)-listed streams in the Bitterroot Headwaters TPA except for Buck, Ditch Creeks, Gilbert and Reimel Creeks (bull trout are incidental in Reimel Creek, with 1-2 having been found in the past decade (Jakober pers. com. 2004)). The historic status of bull trout in these streams is unknown; some or all of them may have supported bull trout populations in the past.

Fish populations might change due to effects outside of management control such as temperature, peak runoff, primary productivity, and competition from other fish species, and invertebrate populations. For this reason, the proposed fisheries indicators must be used in combination with the full suite of targets to avoid misinterpretation associated with future conditions that may be outside of the control of the responsible management agencies. Also, a future downward trend in juvenile trout populations, in and of itself, will not arbitrarily indicate that the goals of this plan are not being met. Rather, contingencies in the Monitoring and Adaptive Management Strategy (see Section 9.0) will be implemented if a downward trend is noted in this target.

Human Caused Sediment Sources

The Bitterroot National Forest and Land & Water Consulting conducted detailed sediment source assessments in 2002 and 2003 focusing on the identification of active sediment sources associated with historical and current management activities and road networks on both BNF and non-forest lands (Appendix E). A GIS and aerial photography assessment was conducted to identify managed areas with potential for erosion and sediment delivery to streams. This was followed by site reconnaissance visits to field verify the results.

Additionally, crews completed driving and walking surveys on a sample of open, closed, and decommissioned roads in the 303(d) listed watersheds. (See Appendix E, and Section 4.0).

In order to make accurate impairment decisions, it is important to consider ALL significant sources for any one pollutant. The value in this approach helps differentiate between natural and human-caused conditions. For example, if target values were determined to be exceeding the proposed threshold values, yet no significant sources exist, this in turn, may point towards a "natural" condition. Therefore, for purposes of determining impairment status, ALL significant sources will be evaluated as supplemental indicators.

The human caused sediment sources "supplemental indicator" has only been applied to assist in verifying water quality impairment determinations. A detailed consideration of sources is provided in Section 4.0 for those waters found to be impaired in Section 3.8.

Culverts/Fish Passage

The Bitterroot National Forest has conducted an assessment of culverts in the Bitterroot Headwaters TPA to determine the locations of culverts that block fish passage. The base condition for this parameter has been set as no fish passage barrier except to preserve native salmonid genetic integrity as directed by state and federal fisheries biologists. Fish passage barriers are a performance-based measure that address cold-water fish and aquatic life beneficial uses and do not address pollutant loading.

Forest fisheries biologists used the following method to determine which culverts in the BHTPA are functioning as fish passage barriers.

Step #1. Electro shocking surveys and the forest's fish presence/absence database (a compilation of all of the fish surveys conducted on the forest over the years) were used to identify which culverts had the potential to affect fish.

Step #2. During the 2003 field season, a dedicated culvert survey field crew visited each of the culverts and measured a set of culvert and hydrologic variables.

Step #3. The field data was entered into the Fish Passage Assessment Database. This database predicts whether or not a culvert is likely to be a barrier to juvenile and/or adult bull trout and westslope cutthroat trout. The model is conservative. It's designed to assess passage for the weakest swimming life stages and sizes of a given species. Sometimes, this database will predict that a given culvert is a barrier to fish movement when field observations confirm that some fish are able to pass through it. It is therefore imperative that the database predictions be validated by a site visit and the knowledge and experience of the field biologist.

Step #4. Forest fisheries biologists used a combination of the database predictions, field observations, and their local knowledge and experience of culverts and fish populations to pinpoint which culverts are likely to impede or block fish passage.

Results of the culvert passage analysis for listed streams in the BHTPA are presented on a stream-by-stream basis in Section 8.2.

This supplemental indicator will be used on a case-by-case basis and must be used in combination with the full suite of indicators to avoid misinterpretation. The primary purpose of this supplemental indictor is to identify and prioritize restoration efforts.

3.3.3 In-Stream Temperature Targets

Salmonids, often referred to as cold-water fish, appear to be highly sensitive to temperature. In particular, bull trout (*Salvelinus confluentus*) are believed to be the most sensitive native fish species in the BHTPA. Fraley and Shepard (1989) reported that bull trout prefer relatively cold-water temperatures and that water temperatures above 15 degrees Celsius (59 degrees Fahrenheit) are believed to limit their distribution. In-stream temperature targets set in this document are designed to protect bull trout, with the assumption that if the targets protect the most sensitive species, all other native species will also be protected.

As noted in Section 3.2.2.3, the temperature standards for the BHTPA are narrative and designed to represent reference conditions. USFWS, 1998 has suggested temperature thresholds for bull trout; however these may not be comparable to the Bitterroot Headwater streams. Currently, insufficient temperature reference data from the BHTPA exists to adequately set reference-based targets for the temperature-impaired waterbodies. Therefore, temperature targets were set based on literature values.

It is also recognized that in-stream temperatures may vary across a single stream and fish use within a single stream can vary by reach. Therefore the targets will account for cold-water fish life stages, specifically targeting the time of the year and life stage believed to be the limiting factors in the Bitterroot Headwaters TPA streams.

USFWS, 1998 equated specific in-stream threshold temperature values to the success of various life stages of cold-water fish. These primary life stages are spawning, incubation, rearing, and migration. In the Bitterroot Headwaters TPA, it is believed that spawning and incubation temperatures are not limiting cold-water fish (particularly bull trout). Instead, warm mid-summer temperatures may be influencing migration or rearing. While critical temperatures have been shown to trigger spawning and other activities and are believed to be critical for the propagation success of cold-water species, it is felt that sufficient research has not yet adequately proven specific temperatures that trigger or hinder spawning exclusively in the BHTPA. Additionally, existing in-stream data in the Bitterroot Headwaters TPA has shown that late summer/early fall temperatures routinely drop due to day length. Therefore the focus of this WQRP and the in-stream temperature targets is on mid-summer maximum temperature (measured as the 7-day average maximum). This target addresses migration and rearing life stages when cold-water fish appear most vulnerable in the Bitterroot Headwaters TPA streams.

As stated previously, the 7-day average maximum temperature will be the metric used to measure the attainment of the temperature standards. This statistic is a running average of daily maximum temperatures in a seven-day period. The maximum of all 7-day running averages for the period of record is then reported as a single temperature. While many other metrics exist by which to report temperature, Gamett (2002) looked at 18 temperature matrices and correlated them to bull trout population metrics. He found that the correlation between temperature metrics did not vary considerably (i.e. mean period of record temperatures versus 7-day maximum had an R^2 of .94), depending on how he characterized his bull trout population. Therefore, since very little difference exists between temperature matrices, the 7-day average maximum will be used for this WQRP.

Moreover, temperatures in excess of the 7-day maximum target do not necessarily equate to temperature impairment. Instead, this 7-day target would serve as a threshold that would trigger further investigation into the temperature values across the entire season of record and verify whether or not temperatures from that season of record are adversely affecting cold-water fish.

Finally, an adaptive management approach is also incorporated into the BHTPA temperature targets. This strategy was developed because the in-stream temperature targets developed for this WQRP are the most protective, but may not be applicable to the BHTPA streams. Not all of the temperature-listed streams in the BHTPA may have historically supported all life stages of bull trout; thus targets set at protecting all life stages of bull trout in these streams may prove too restrictive and not representative of natural conditions (for example, the lower reaches of the East and West Forks of the Bitterroot). Additional reference data is needed to adequately develop temperature targets based on local references. This approach would be based on 3 variables, 1) the stream's potential temperature; 2) studies on the effects of temperature on bull trout and other salmonid species; and 3) reference conditions. Therefore, it is important to note that in-stream targets are considered starting points and could change as new information surfaces. The adaptive management strategy is further discussed in Section 9.10.

In Section 3.8 below, temperature targets are compared to current temperatures in the streams listed for thermal impairments. Current temperature data were provided by the Bitterroot National Forest and Montana Fish, Wildlife and Parks, who maintain a network of continuously recording temperature monitors in the Bitterroot Headwaters.

3.3.4 Temperature Supplemental Indicators

Percent Shade

Riparian vegetation, stream morphology, hydrology, climate and geographic location all influence in-stream temperature. Stream morphology is discussed in the sediment section of this WQRP (See Section 4.0). Hydrology is made up of both surface water and ground water flow. Surface water flow and potential return flows from irrigation are discussed under the flow section of this WQRP (See Section 6.0). Ground water flows are not being addressed as part of this WQRP.

Forested headwater streams rely heavily on streamside shade to maintain cool water temperatures and maintenance of riparian shade can be achieved through proper management techniques. Effective shade screens the water's surface from direct rays of the sun. Highly shaded streams often experience cooler stream temperatures due to reduced input of solar energy (Beschta et al., 1987; Li et al., 1994). Given the forested environment, current timber management practices and headwater stream setting of the BHTPA, riparian vegetation was judged to be the variable that would result in the most achievable and measurable targets. The source assessment conducted as part of this project concluded that riparian degradation from road building, timber harvest, and agricultural practices are most likely the primary human causes of increased stream temperatures due to decreases in riparian shade. While the effects of these past practices are still apparent today, in much of the watershed the initial restoration steps have been taken, and recovery of these areas will be monitored as outlined in Section 9.0.

Aerial photo analysis and subsequent field site verification were used to determine the existing shade condition of the BHTPA streams. Additionally, modeling was used to predict the potential shade and solar load of each site in 5-year increments and develop shade targets. Further details on the shade targets are discussed in Section 5.0.

Water temperature can warm as a result of increased solar radiation loads. A loading capacity for radiant heat energy (i.e., incoming solar radiation) is used to define a reduction that forms the basis for identifying a surrogate. The specific surrogate (supplemental indicator in this case) used is percent effective (potential) shade (expressed as the percent reduction in potential solar radiation load delivered to the water surface). The solar radiation loading capacity is translated directly (linearly) by effective solar loading. The definition of effective shade allows direct measurement of the solar loading capacity (Oregon DEQ, 2002).

Supplemental indicator values of percent shade were calculated for forest stands at 5-year, 10-year, and 15-year benchmark intervals and at their late seral potential (Tables 3-8, 5-8, 5-10, 5-12, 5-14, 5-16, and 5-18). All growth and yield curves extended to 120 years and thus the age of all forest stands at late seral condition was set at 120 years. In several cases, the existing tree heights determined via the PI assessment were found to be exceeding the site index growth curve identified in the TSMRS or STATSGO soils databases. In those cases, forest stands were assumed to be at the late seral potential heights and no further growth was assigned for them. However, canopy density varies across the ecological evolution of a forest stand. The greatest canopy densities tend to occur during mid-seral stages with a decrease in densities occurring at the late seral stage. This decrease in canopy density is a result of natural decay and decadence that occurs as a forest matures to an old growth state that includes forest gaps resulting from fallen trees, broken top trees, etc.

It is important to note that shade will be used as supplemental indicator, not a true target in this WQRP. This indicator is based on the assumption that riparian disturbance and subsequent loss of shade are the primary sources of thermal modifications in the BHTPA. While no scientific link has been made between actual in-stream temperatures and percent riparian shade, it is assumed that once the riparian vegetation has reached its full potential, in-stream temperatures will be at their natural potential, regardless of climatic conditions.

3.4 Nutrient Targets

Benthic Chlorophyll-a

Benthic algae (also known as *periphyton*) are found growing on substrate surfaces in streams, as opposed to free-floating organisms found in the water column (phytoplankton). Benthic algae data helps to provide a better understanding of the cumulative and intermittent impacts that may have occurred over time in a stream, and are useful for determining if impairments due to nutrients are present. USEPA has proposed benthic algae criteria for Nutrient Ecoregion II streams (Western Forested Mountains), based on the measured amount of chlorophyll-a (milligrams) divided by the total substrate area (square meters). The USEPA proposed criteria, based on the 25^{th} percentile of an ecoregional dataset, is a median value of less than 33 mg/m^2. A 5-year median value of less than 33 mg/m^2 is proposed as a target for the BHTPA.

Nutrient Concentrations

USEPA Ecoregion Nutrient Criteria
USEPA has proposed nutrient criteria for ecoregions throughout the United States. Criteria for Nutrient Ecoregion II (Western Forested Mountains) are proposed as targets for the BHTPA (USEPA, 2000). Median total phosphorus and nitrate plus nitrite concentrations and are proposed here as 5-year median core indicators for the BHTPA (Table 3-11).

VNRP Nutrient Criteria
The Voluntary Nutrient Reduction Plan for the Clark Fork River contains guidelines for maximum nutrient concentrations for the prevention of nuisance growth of aquatic algae (Watson et al., 1999). These nutrient criteria have been proposed as nutrient targets for the BHTPA. Although these targets were developed for the Clark Fork River, they are the most scientifically rigorous nutrient guidelines yet developed for any stream in western Montana and have been used as a benchmark against which to compare nutrient concentrations throughout the state (Table 3-11).

The USEPA targets for total phosphorous are more restrictive than those developed by the VNRP for the Clark Fork River. At the time of this report, Montana DEQ was still in the process of evaluating the suitability of the USEPA guidelines as TMDL targets for mountain streams in western Montana. Because of the uncertainty associated with the USEPA total phosphorous targets, phosphorous concentrations in the BHTPA will be evaluated using a weight of evidence approach that relies simultaneously on the USEPA and VNRP target guidelines. Comparisons of current total phosphorous concentrations to target thresholds will be conducted in the context of other target and indicator-based evidence of potential eutrophication, including benthic and water column chlorophyll a levels, macroinvertebrate communities, and the presence or absence of anthropogenic phosphorous sources.

Table 3-11. Nutrient Concentration Targets for the Bitterroot Headwaters TPA.

Nutrient Parameter	Threshold Value
USEPA Ecoregion II, Total Phosphorus (P25)	< 0.01 mg/L
USEPA Ecoregion II, Nitrate+Nitrite (NO_2/NO_3) (P25)	< 0.014 mg/L
Clark Fork Total Phosphorous Guidelines	< 0.04 mg/L
Clark Fork Total Nitrogen	< 0.3 mg/L

3.5 Nutrient Supplemental Indicators

The proposed supplemental indicators are not sufficiently reliable to be used alone as a measure of nutrient impairment in the streams within the BHTPA. These indicators are used as supplemental information, in combination with the other core indicators and indicators, to provide better definition to potential nutrient impairments.

Mountain IBI

Macroinvertebrate data are typically organized according to a multimetric index of biological integrity (IBI), or a "multimetric index." Individual metrics (e.g. clinger taxa, percent EPT) are designed to indicate biological response to human-induced stressors. Scores are assigned to individual metrics, summed across several of them, and the total used to compare among samples or sampling sites. Three possible multimetric indices have been developed for Montana: 1) Mountain; 2) Foothill Valley and Plains (MFVP); and 3) Plains. The Mountain IBI was chosen for streams in the Bitterroot Headwaters TPA based on site characteristics, primarily elevation. The sites in the Bitterroot Headwaters TPA are located within the Northern Rockies ecoregion (Woods et al., 1999) and range in elevation from 4000 to 6000 feet. MDEQ uses a scoring procedure with 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). This score is proposed as a supplemental indicator for streams in the Bitterroot Headwaters TPA. Streams scoring between 25 and 75 are considered partially supporting their aquatic life uses and scores lower than 25 percent represent non-supported uses.

Water Column Chlorophyll-a

USEPA proposed water column chlorophyll-*a* concentrations as part of the ecoregional nutrient criteria. It is measured as the amount of chlorophyll-*a* in the water column, and can provide an indication of the amount of algal biomass in the stream. High chlorophyll-*a* concentrations suggest that there is an excessive amount of algae in a stream, and therefore suggest that excessive organic loading is present. Water column chlorophyll-*a* is referred to as a *response variable* as opposed to a direct nutrient measurement, and as such, is included as a supplemental indicator. USEPA (2000) suggested that median water column chlorophyll-*a* values for Western Forested Mountain streams should not exceed 1.08 μg/L. This is proposed as a supplemental indicator for the BHTPA.

Dissolved Oxygen

Nutrients generally do not pose a direct threat to the beneficial uses of a waterbody. However, excess nutrients can cause an undesirable abundance of plant and algae growth. This process is called eutrophication or organic enrichment. Organic enrichment can have many effects on a stream or lake.

One possible effect is low dissolved oxygen concentrations. Aquatic organisms require oxygen to live and they can experience lowered reproduction rates and mortality with lowered dissolved oxygen concentrations.

Montana DEQ's numeric dissolved oxygen criteria are shown in Table 3-12, and are proposed as core indicators for the determination of nutrient impairments (MDEQ, 2004). Because several streams in the BHTPA are used by several species of fish for spawning (including bull trout), the more stringent water column criteria are proposed to insure that inter-gravel dissolved oxygen concentrations are met**.**

Table 3-12. Numeric Dissolved Oxygen Criteria.

Time Period	Early Life Stages[1]	Other Life Stages
30-Day Mean	NA	6.5
7-Day Mean	9.5	NA
7-Day Mean (min)	NA	5.0
1 Day Min	8.0	4.0

Nutrient Sources

As with sediment, it is not appropriate to assume that deviations from the core indicators and/or other supplemental indicators are necessarily a result of man's actions. Consideration of sources, therefore, is important given that TMDLs are only necessary for nutrient impairments caused by anthropogenic sources. Three indicators were chosen Fire, Equivalent Clear-Cut Area, and Water Yield. Fires have the potential to directly increase inorganic nutrient loading to a stream by converting organic matter to soluble, inorganic nutrients. ECA also captures the effects of fire, and therefore is included as a supplemental indicator. Furthermore, clear-cuts and increased water yield can result in increased nutrient concentrations in a stream (Hauer and Blum 1991).

3.6 Lead (Metal) Targets

As stated previously, Montana has numeric water quality standards for lead. Therefore these values will be used as the water quality targets (Table 3-10).

3.7 Uncertainty Associated with Targets and Supplemental Indicators

The targets and supplemental indicators all apply under normal conditions of natural background loading and natural disturbance. It is recognized that under some natural conditions such as a large fire or flood event, it may not be possible to satisfy some of the targets or indicators such as percent fines for some period of time. The goal under these conditions will be to ensure that management activities within the watershed or individual tributaries are undertaken in such a way that the recovery time to conditions where the targets can be met is not delayed. Another goal will be to ensure that potentially negative impacts to beneficial uses from natural events are not significantly increased due to human activities.

The targets and supplemental indicators were developed to represent desired conditions and achievement of water quality standards. However, a shortage of local reference data and the inherent variability in natural conditions in aquatic ecosystems combine to introduce a degree of uncertainty into the targets and indicators. As a result, reference conditions upon which the target and indicator thresholds were based may not accurately represent local potential, and thus targets and indicators may be difficult to achieve. This also introduces uncertainty into the impairment status decisions made later in this document. In response, targets will be evaluated at least every five years (Section 9.0). This evaluation will include consideration of target suitability and could result in modification of the targets and indicators as more suitable reference data become available. Nevertheless, the target and indicator thresholds presented in this document are reasonable approximations of reference conditions based on the available data and science.

In-stream temperature targets were developed based from literature values of bull trout thresholds. While this is a conservative target that logically protects the most sensitive use, uncertainties still remain about the BHTPA streams and their actual temperature potential. Therefore, additional reference monitoring is proposed in Section 9.0 to help better define the BHTPA temperature potential.

Percent riparian shade targets are based on projecting the growth of the existing forest type to its late seral potential height using the associated growth and yield curves. Habitat type tree species were not used because 1) not all reaches assessed contained habitat type data, and 2) the ecological evolution of forest stands is often delayed, or set back, due to natural or human-caused disturbances such as flood or fire. Thus, projecting the time it may take for a forest to evolve into its late seral habitat type forest conditions is not possible. Moreover, even in the event that no disturbance delays ecological evolution, determining the number of years needed to transition from the existing forest type to the late seral habitat type forest, with any degree of confidence, is not easily accomplished.

3.8 Water Quality Status and Data Review

The following section summarizes all relevant available data in a waterbody specific format. Inferences about the current impairment status are made from this existing data. All relevant available physical, chemical and biological data are presented specifically by waterbody in the text below. Additionally, comparisons between the WQ Targets developed in Section 3.3 and the existing conditions are made in each waterbody specific sub-section. Table 3-13 below summarizes sources of target and supplemental indicator data.

USEPA considers habitat alterations, stream bank erosion, stream flow alterations, and the like, to be a generic types of water quality impairment (termed “pollution”) that do not require resolution via formal TMDL water quality restoration plans. On the other hand, sediment/siltation, nutrients, temperature, and metals are considered to be conventional "pollutants" that do require TMDL development. It is USEPA's position that TMDLs are only required for "pollutants" that are causing or contributing to impairment of a waterbody. Therefore, the focus of this water quality restoration plan is on resolving sediment/siltation, temperature, nutrient, and metals problems. Nonetheless, habitat and flow alterations in the BHTPA watershed are certainly inter-related to the sediment and temperature issues. As such, habitat alterations will be addressed within the context of this TMDL and water quality restoration plan, and flow alterations will be addressed via a phased approach. TMDLs were not prepared for impairments where convincing evidence suggests that the initial listings had been made in error or that conditions had improved since the listing to an extent that beneficial uses are no longer impaired. Where a source of impairment has not been addressed with a TMDL, justification is provided in the sections that follow.

Table 3-13. Sources of Existing Condition Data for Sediment-Listed Streams in the Bitterroot Headwaters TMDL Planning Area.

Stream	Targets/Indicators	Sampling Location	Rosgen Channel Type	Date of Sampling	Sampling Method	Data Location
Deer Creek	%<2mm, %<6mm, D_{50}	Mile 0.3	C4	7/17/03	BNF Hydro survey	BNF hydro survey database
	Pools/mile	Mile 0-1.7	C4	10/24/00	BNF Fish Habitat Inventory	USFS 2001
	LWD/mile	Mile 0-1.7	C4	10/24/00	BNF Fish Habitat Inventory	USFS 2001
	Macroinvertebrates (Clinger Richness, IBI, % Clinger taxa; EPT richness)	Mile 0.3	C4	7/17/03	MDEQ	Bollman 2003
Buck Creek	%<2mm, %<6mm, D_{50}	Mile 0.5	B4	7/28/03	BNF Hydro survey	BNF hydro survey database
	Pools/mile	Mile 0.7-0.9	B4	11/03/04	BNF Fish Habitat Inventory	BNF Habitat database
	LWD/mile	Mile 0.7-0.9	B4	11/03/04	BNF Fish Habitat Inventory	BNF habitat database
	Macroinvertebrates (Clinger Richness, IBI, % Clinger taxa; EPT richness)	Mile 0.5	B4	10/9/02	MDEQ	Bollman 2003
Ditch Creek	%<2mm, %<6mm, D_{50}	Mile 0.4	B4	7/29/03	BNF Hydro survey	BNF hydro survey database
	Pools/mile	Mile 0-0.2	B4	9/19/02	BNF Fish Habitat Inventory	BNF habitat database
	LWD/mile	Mile 0-0.2	B4	9/19/02	BNF Fish Habitat Inventory	BNF habitat database
	Macroinvertebrates (Clinger Richness, IBI, % Clinger taxa; EPT richness)	Mile 0.4	B4	10/8/02	MDEQ	Bollman 2003

Table 3-13. Sources of Existing Condition Data for Sediment-Listed Streams in the Bitterroot Headwaters TMDL Planning Area.

Stream	Targets/Indicators	Sampling Location	Rosgen Channel Type	Date of Sampling	Sampling Method	Data Location
Meadow Creek	%<2mm, %<6mm, D_{50}	Mile 4.2 and 5.3. Data were averaged for Table 3-12	C4	7/29/02 at mile 4.2; 8/20/03 at mile 5.3	BNF Hydro survey	BNF hydro survey database
		Mile 7.3 3 (above managed area)	B3	7/31/03	BNF Hydro survey	BNF hydro survey database
	Pools/mile	Mile 0-8	B3	7/1995	BNF Fish Habitat Inventory	USFS 2001
	LWD/mile	Mile 0-8	B3	7/1995	BNF Fish Habitat Inventory	USFS 2001
	Residual Pool Depth	Mile 7.	B3	7/31/03	BNF Hydro survey	BNF hydro survey database
	Macroinvertebrates (Clinger Richness, IBI, % Clinger taxa; EPT richness)	Two sites. One near confluence with East Fork; one above confluence with Spruce Ck. Data were averaged for Table 3-12	Unknown	10/8/02 and 10/9/02	MDEQ	Bollman 2003
Reimel Creek	%<2mm, %<6mm, D_{50}, and Residual Pool Depth	Mile 2.9, 3.0 and 4.3. Data were averaged for Table 3-16.	B4	7/29/03 at mile 2.9; 7/10/03 at mile 3.0 and 4.3	BNF Hydro survey	BNF hydro survey database
		Mile 3.8	C4	7/10/03	BNF Hydro survey	BNF hydro survey database
	Pools/mile	Unknown	Unknown	Unknown	BNF habitat inventory	USFS 2000
	LWD/mile	Unknown	Unknown	Unknown	R1/R4	BNF habitat database
	Macroinvertebrates (Clinger Richness, IBI, % Clinger taxa; EPT richness)	Two sites. One near confluence with East Fork; one above confluence with Wallace Ck. Data were averaged for Table 3-16	Unknown	10/10/02	MDEQ	Bollman 2003
East Fork	%<2mm, %<6mm, D_{50}	Mile 29.8 (above Martin Creek)	C4	10/21/94. Note no post-fire data were available at this location	BNF Hydro survey	BNF hydro survey database
		Mile 9.8 and 12.9	C3	Not reported. Data from 3 years at each site averaged for Table 3-16	BNF Hydro survey	BNF hydro survey database

Table 3-13. Sources of Existing Condition Data for Sediment-Listed Streams in the Bitterroot Headwaters TMDL Planning Area.

Stream	Targets/Indicators	Sampling Location	Rosgen Channel Type	Date of Sampling	Sampling Method	Data Location
		Mile 3.7, 3.8, 19.7 and 25.1	B3	Not reported. Data from 3 years at each site averaged for Table 3-16	BNF Hydro survey	BNF hydro survey database
	Pools/mile	Mile 9.7-29.2	B3	7/2003	BNF Fish Habitat Inventory	BNF Habitat Database
	LWD/mile	Mile 9.7-29.2	B3	7/2003	BNF Fish Habitat Inventory	BNF Habitat Database
	Macroinvertebrates (Clinger Richness, IBI, % Clinger taxa; EPT richness)	Downstream of USFS gauging station	Unknown	August 2001	MDEQ	Bollman 2002
Gilbert/Laird Creeks	%<2mm, %<6mm, D_{50}, Residual Pool Depth	Laird Creek mile 1.4 and 1.6; Gilbert Creek mile 0.2. Data from all 3 sites averaged for Table 3-23	B4	7/31/03 at Laird 1.4; 7/23/02 at Laird 1.6; 7/24/02 at Gilbert 0.2	BNF Hydro survey	BNF hydro survey database
	Pools/mile	Unknown	Unknown	Unknown	BNF habitat inventory	USFS 2000
	LWD/mile	Unknown	Unknown	Unknown	R1/R4	BNF habitat database
Hughes Creek	%<2mm, %<6mm, D_{50}, Residual Pool Depth	Mile 0.5	B4	7/23/03	BNF Hydro survey	BNF hydro survey database
		Mile 4.4 and in the BNF restoration reach. Data were averaged for Table 3-26	C4	7/22/03 at 4.4; 8/22/03 in restoration reach	BNF Hydro survey	BNF hydro survey database
	Pools/mile	Unknown	Unknown	Unknown	BNF habitat inventory	USFS 2000
	LWD/mile	Unknown	Unknown	Unknown	R1/R4	BNF habitat database
Moose Creek	%<2mm, %<6mm, D_{50}, Residual Pool Depth	Mile 1.4 and 4.1. No RPD at mile 1.4.	B3	9/4/03	BNF Hydro survey	BNF hydro survey database
	Macroinvertebrates (Clinger Richness, IBI, % Clinger taxa; EPT richness)	Unknown	Unknown	August 2001	MDEQ	Bollman 2002
West Fork	%<2mm, %<6mm, D_{50}, Residual Pool Depth	Mile 30.3	C4	7/22/03	BNF Hydro survey	BNF hydro survey database
	Pools/mile	Unknown	Unknown	Unknown	BNF habitat inventory	USFS 2000
	LWD/mile	Unknown	Unknown	Unknown	R1/R4	BNF habitat database
	Macroinvertebrates (Clinger Richness, IBI, % Clinger taxa; EPT richness)	At Conner Cutoff Bridge	Unknown	Mid-August and early September 1997	MDEQ	Bollman 1998

3.8.1 Deer Creek

Deer Creek is small third order tributary of the West Fork of the Bitterroot River. The Deer Creek Watershed is approximately 22.7 square miles in size, and the Bitterroot National Forest manages more than 99% of lands within the watershed. Private land is located adjacent to the stream in the lower ½ mile of the watershed. Characterized by a Douglas fir, Lodgepole pine, and a mixed subalpine forest, the Deer Creek watershed has been relatively unimpacted by human activities. Ninety three percent of the watershed is unroaded and Deer Creek is considered to be in reference condition by the Bitterroot National Forest. Approximately 7% of the watershed burned in the fires of 2000.

3.8.1.1 Summary of 303(d) List

A brief reference to a Montana Fish, Wildlife, and Parks (FWP) habitat survey that noted channelization and bank trampling by livestock was the only explanation found for the listing of Deer Creek. No report or field forms from the survey were located.

The 1996 Montana 303(d) list reported that Deer Creek was threatened for support of its cold-water fishery beneficial use. Impairments to Deer Creek were thought to result from habitat alterations caused by agriculture, channelization, and rangeland. In reviewing the 303(d) list in 2000 and 2002, however, Montana DEQ determined that the existing data did not meet the requirements for sufficient and credible data, and thus no beneficial use support determination could be made, and Deer Creek was scheduled for reassessment.

The 303(d) status of Deer Creek is summarized in Table 3-14.

Table 3-14. 303(d) Status of Deer Creek: MT76H003_030.

Year	Estimated size	Use support status	Probable impaired uses	Probable causes	Probable sources
1996	12.5 miles	Threatened	Cold water fishery	Habitat Alterations	Agriculture Channelization Range land
2000/02	12.5 miles	Needs reassessment	No Sufficient Credible Data (SCD)	No SCD	No SCD

A review of the available and relevant sediment data in Deer Creek is provided in the sections below. This review includes all currently available target and indicator data, and Table 3-15 compares current data for target and indicator variables to proposed reference thresholds.

3.8.1.2 Sediment Target Data

As described in Section 3.3.1, sediment targets were developed to account for variability in stream response. It was determined that Deer Creek's natural evolutionary classification stage is a Rosgen C4 stream channel. Therefore, the target data summarized below are for a B4 channel type.

% Fines--Wolman Pebble Counts < 2mm in Riffles

The Bitterroot National Forest collected pebble count data in Deer Creek in July of 2003. Thirty nine percent of the substrate sample was < 2mm, which exceeded the target of 32%, the upper limit of the reference range.

% Fines--Wolman Pebble Counts < 6mm in Riffles

The Bitterroot National Forest collected pebble count data in Deer Creek in July of 2003. Forty percent of the substrate sample was < 6mm, which was within the reference range.

D_{50}

The Bitterroot National Forest collected pebble count data in Deer Creek in July of 2003. The D_{50} was 24 mm, within the target range of 3-47 mm.

Clinger Richness

Montana DEQ collected macroinvertebrate data in October 2002. Clinger richness was 21, meeting the target of at least 14.

3.8.1.3 Sediment Supplemental Indicator Data

Residual Pool Depth

The Bitterroot National Forest measured the residual pool depth in Deer Creek in July of 2003. The RPD was 3.5, meeting the indicator threshold of at least 1.5.

LWD

The Bitterroot National Forest counted 26 pieces of LWD/mile in Deer Creek, failing to meet the indicator threshold of at least 50 pieces/mile.

Pool/Mile

The Bitterroot National Forest counted 44 pools/mile in Deer Creek, failing to meet the indicator threshold of at least 60 pools/mile.

Suspended Solids Concentrations

No data have been collected.

Turbidity

No data have been collected.

Mountain IBI

Montana DEQ collected macroinvertebrate data in October 2002. The Mountain IBI was 84%, meeting the proposed indicator threshold of at least 75%.

EPT Richness and Percent Clinger Taxa

The EPT richness in Deer Creek was 24, meeting the indicator threshold of at least 22. The percent clinger taxa was 72; no numeric threshold has been established for this indicator.

Juvenile Trout Densities

Insufficient data.

Human Caused Sediment Sources

None identified.

Fish Passage Barriers

No barriers to fish passage are known to exist in the watershed.

3.8.1.4 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

Sediment & Habitat

As previously indicated, 7% of the Deer Creek watershed burned in 2000. There have been no significant fires in the basin since that time.

The BNF Sensitive Watershed Analysis (Decker et al., 1991) determined that in Deer Creek Watershed there were 6.0 miles of forest roads and 12 stream crossings resulting in, a road density of approximately 0.3 and a crossing density of 0.6. At the time, approximately 10% of the watershed appeared from air photos to have been impacted by timber harvest. Soils in the watershed were determined to be predominately a mix of hard granitics and quartzites, both of which were classified as having a low rate of erosion. For these reasons, Decker classified the Deer Creek watershed as "apparently healthy with low road densities, a small percentage of timber harvest and few other impacts such as roads in riparian areas."

USFS personnel interviewed for this report, expressed surprise that Deer Creek was considered an impaired stream. They described the Deer Creek Watershed as largely unroaded and unharvested, in near reference condition with healthy populations of both bull and cutthroat trout. If channelization or bank trampling have occurred along Deer Creek, they agreed that it was likely to be on private ground in the lower 0.5 miles of the stream, as no such activities were known to have occurred on USFS ground (Jakober pers. com., 2002; Wildey pers. com., 2002).

Periphyton

Periphyton was sampled by MDEQ in October 2002 as part of its reassessment of Deer Creek. The sampling site was located on lower Deer Creek, upstream of the West Fork confluence. Periphyton was evaluated based on 7 standard MDEQ metrics, all of which indicated full support of beneficial uses.

Chemistry

Water chemistry and metals in sediment data collected by MDEQ in October 2002 indicated no violations of state water quality standards.

3.8.1.5 Deer Creek Current WQ Impairment Summary

Table 3-15 below compares existing sediment data with the proposed target and indicator values in Deer Creek. Target and indicator development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

Table 3-15. Existing Conditions and Water Quality Targets and Supplemental Indicators for Deer Creek.

Targets			
Rosgen Stream Type	**Parameter**	**Existing Condition**	**Proposed Thresholds**
C4	% Fines < 2 mm (data collected in riffles)	39%	Mean: 23%; Range: 14-32%
	% Fines < 6 mm (data collected in riffles)	40%	Mean: 33%; Range 17-49%
	D_{50} (data collected in riffles)	24 mm	3-47 mm
	Clinger Richness	21 mm	≥14
Supplemental Indicators			
C4	Mountain IBI	84%	> 75%
	% Clinger Taxa	72	High
	EPT Richness	24	≥ 22
	Pools/mile	44	60
	LWD/mile	26	50
	Residual Pool Depth	3.5	1.5 feet
	Suspended Solids Concentration	Unknown	Comparable to reference
	Turbidity	Unknown	High flow – ≤50 NTU instantaneous maximum Summer base flow – ≤10 NTU
	Juvenile bull trout & westslope cutthroat trout densities	Insufficient Data	Documented increasing or stable trend
	Human Caused Sediment Sources	None	No Preventable Sources
	Fish Passage Barriers	None	No Barriers except to protect native salmonid genetics

See Section 3.3 for an explanation of target development.

Deer Creek was listed in 1996 as "threatened" by habitat alterations resulting from agriculture, channelization, and rangeland. In its 2002 303(d) list review, MDEQ determined that sufficient and credible data did not exist on Deer Creek, and the agency collected reassessment data on Deer Creek in October 2002. The fine sediment target %<2mm is currently higher than expected; the %<6 mm, D50 and clinger richness targets are within expected reference ranges. Although the % < 2mm target was not met, it is important to remember that because of the method used to develop the target, approximately 16% of the reference streams in the BHTPA would not meet the fine sediment targets. Thus some interpretation will be required to determine impairment status in 303(d) listed streams where the % fines targets are not met. The supplemental indicators are included to provide the context necessary to make such interpretations. Although pool and LWD frequencies are lower than the target thresholds, the existing frequencies are not believed to be affected by human activities. Most of the watershed is roadless and unharvested, and no significant anthropogenic sediment or habitat impacts are known to exist. During its 2002 assessment of the stream, MDEQ found no evidence of agricultural or rangeland impacts except for a single small headgate on an irrigation ditch approximately one mile upstream of Deer Creek's confluence with the West Fork of the Bitterroot. The stream has not been channelized, it supports a significant bull trout population, biological data indicate full support of beneficial uses, and Deer Creek is considered a reference stream by the Bitterroot National Forest.

Although the rationale for the 1996 listing could not be determined, two explanations seem possible in light of the relatively unmanaged condition of the watershed: 1) Deer Creek is a common name for streams in Montana, and it is possible that data for one of the other Deer Creeks was mistakenly attributed to the Deer Creek in the upper West Fork watershed; or 2) agricultural and range impacts, as well as channelization, do occur on the West Fork of the Bitterroot in the vicinity of the Deer Creek confluence. At their confluence, the West Fork of the Bitterroot and Deer Creek are approximately the same size. It is conceivable that at some time in the past, a stream survey was conducted on the West Fork but mistakenly attributed to Deer Creek.

Based on the review of all available data, sediment and habitat conditions in Deer Creek appear to result from natural forces and there are no indications that Deer Creek is impaired. Since Deer Creek is not impaired, no TMDL has been developed in this WQRP.

3.8.2 Buck Creek

Buck Creek is small fourth order tributary of the West Fork of the Bitterroot River. The Buck Creek Watershed is approximately 2.4 square miles in size, and lands within the watershed are managed predominately by the Bitterroot National Forest except for a few private residences adjacent to the channel in the lower watershed near the West Fork Bitterroot River. Characterized by a mixed evergreen forest of Douglass fir, Ponderosa pine, and Lodgepole pine, the Buck Creek watershed has been heavily roaded, with approximately 15.0 miles of roads and a road density of approximately 6.2 mi/mi^2. The Buck Creek watershed did not burn in the fires of 2000. Lower Buck Creek is intermittent, and connectivity exists with the West Fork only at high flows.

3.8.2.1 Summary of 303(d) List

The primary source of information for the listing of Buck Creek appears to have been the Buck–Little Boulder Timber Sale EIS, dated August 1993. Further evidence of impairment was provided in the BNF Sensitive Watershed Analysis (Decker et al., 1991). The conclusions from these two documents appear to be the primary reasons for listing Buck Creek.

The 1996 Montana 303(d) list reported that Buck Creek partially supported its aquatic life and cold-water fishery beneficial uses as a result of habitat alterations, siltation, and suspended solids. The source of these impairments was listed as silviculture. In the 2000 and 2002 303(d) lists, Montana DEQ revised these conclusions to indicate that the available data did not meet the requirements for sufficient and credible data, and thus no beneficial use support determinations could be made. Buck Creek was subsequently scheduled for reassessment in order to gather the needed data. The 303(d) status of Buck Creek is summarized in Table 3-16.

Table 3-16. 303(d) Status of Buck Creek: MT76H002_060.

Year	Use Support Status	Probable Impaired Uses	Probable Causes	Probable Sources
1996	Partial support	Aquatic life Cold water fishery	Habitat Alterations Siltation Suspended solids	Silviculture
2000/02	Needs Reassessment	No Sufficient Credible Data (SCD)	No SCD	No SCD

A review of the available and relevant sediment data in Buck Creek is provided in the sections below. This review includes all currently available target and indicator data, and Table 3-17 compares current data for target and indicator variable to proposed reference thresholds.

3.8.2.2 Sediment Target Data

As described in Section 3.3.1, sediment targets were developed to account for variability in stream response. It was determined that Buck Creek's natural evolutionary classification stage is a Rosgen B4 stream channel. Therefore, the target data summarized below is for a B4 channel type.

% Fines--Wolman Pebble Counts < 2mm in Riffles

The Bitterroot National Forest collected pebble count data in Buck Creek in July of 2003. The average percent fines values for less than 2 mm was 32%, which exceeded the target of 27%, the upper limit of the reference range.

% Fines--Wolman Pebble Counts < 6mm in Riffles

The Bitterroot National Forest collected pebble count data in Buck Creek in July of 2003. The average percent fines values for less than 6 mm was 32%, which exceeded the target of 38%, the upper limit of the reference range.

D_{50}

The Bitterroot National Forest collected pebble count data in Buck Creek in July of 2003. The average size class values for the D_{50} was 12 mm, within the target range.

Clinger Richness

Montana DEQ collected macroinvertebrate data in October 2002. Clinger richness was 11, failing to meet the proposed threshold.

3.8.2.3 Sediment Supplemental Indicator Data

Residual Pool Depth

BNF measured residual pool depth in 2004 and found an average RPD of 5 inches, below the indicator threshold of at least 1.5 feet.

LWD

The USFS conducted large woody debris inventories in Buck Creek in 2004 and found only 5 pieces/mile, well below the indicator threshold of at least 50/mile.

Pools/Mile

The USFS conducted habitat inventories in Buck Creek in 2004 and found 137 pools/mile. This value far exceeds the supplemental indicator threshold of at least 39 pools/mile.

Suspended Solids Concentrations

No data have been collected.

Turbidity

No data have been collected.

Mountain IBI

Montana DEQ collected macroinvertebrate data in October 2002. Buck Creek received an index value of 68%, failing to meet the supplemental indicator threshold.

EPT Richness and Percent Clinger Taxa

Montana DEQ collected macroinvertebrate data in October 2002. The EPT richness was 19, failing to meet the proposed threshold of at least 22. The percent clinger taxa was 26.6; no numeric threshold has been set for this indicator.

Juvenile Trout Densities

Insufficient Data.

Human-caused Sediment Sources

As described in greater detail in Section 4.0, roads were identified as significant human caused sources of sediment in the Buck Creek watershed.

Fish Passage Barriers

There are no culverts in the Buck Creek watershed that impede or block fish passage. The only known culvert on the fish-bearing portion of Buck Creek is the culvert under the West Fork Highway. That highway culvert is suitable for fish passage. However, Buck Creek flows across residential properties on both sides of the highway, and there could be other culverts on private lands that have not been evaluated. Buck Creek is a small stream that goes intermittent near the West Fork Highway during the summer and autumn, and dewatering occurs on the private lands near the West Fork Highway. It appears that having an adequate supply of water in the creek is the limiting factor for fish passage in Buck Creek, not culverts.

3.8.2.4 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

Sediment & Habitat

Buck Creek was unaffected by the fires of 2000.

As part of the Little Boulder Timber Sale EIS analysis, the Bitterroot National Forest (BNF) conducted WATSED modeling of water and sediment yields to estimate the impacts of timber harvest and road construction in the watershed. As of 1991 (the last year analyzed in the report), water yields in Buck Creek were estimated to be 16% above natural and peak flows were estimated to be 10% above natural. Sediment yields were modeled for a range of years, and reached a high of 2700% above undisturbed conditions in 1980, but had declined to 202% over undisturbed conditions by 1986 and remained steady at this level through 1991, the last year of the analysis. The BNF estimated that sediment yields of 170% over natural could result in geomorphic instability in the stream; conditions in Buck Creek in 1991 were well beyond this threshold. Although no quantitative field data from Buck Creek were included in the EIS, comments from the project hydrologist indicated that the entire substrate of Buck Creek showed sediment deposition, pools were almost non-existent, and the stream was “at high risk of a complete loss of biological integrity” (USFS, 1993).

Decker 1991 determined that in the Buck Creek Watershed there were approximately 13.0 miles of forest roads and 28 stream crossings, resulting in a road density of approximately 6.5

miles/mile^2 and a crossing density of 14.0 per square mile[2] at the time of his analysis. At the time, 70% of the watershed appeared from air photos to have been impacted by timber harvest; although substantial recovery has occurred since the analysis. Soils in the watershed were determined to be predominately highly erodible weathered granitics. For these reasons, Decker classified the Buck Creek Watershed as having a high risk of increased sediment and/or water yield from further timber harvest or road construction and indicated that watershed rehabilitation was a high priority.

The Little Boulder EIS and the 1991 study by Decker appear to have been the primary sources of information upon which the 1996 listing of Buck Creek was based, and thus a review of these documents has been included here. However the data are more than a decade old and may no longer accurately reflect conditions in the watershed.

Periphyton

Periphyton was sampled by MDEQ in October 2002 as part of its reassessment of Buck Creek. The sampling site was located on lower Buck Creek, immediately upstream of the USFS boundary. Periphyton was evaluated based on 7 standard MDEQ metrics, all of which indicated full support of beneficial uses.

Chemistry

Water chemistry and metals in sediment data collected by MDEQ in October 2002 indicated no violations of state water quality standards.

3.8.2.5 Current WQ Impairment Summary

Table 3-17 below compares existing sediment data with the proposed target and indicator values in Buck Creek. Target and indicator development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

2 Estimates of road miles, road density, and watershed size differ slightly from those in the Watershed Characterization Report due to differences in GIS data layers.

Table 3-17. Existing Conditions and Water Quality Targets and Supplemental Indicators for Buck Creek.

Rosgen Stream Type	Parameter	Existing Condition	Proposed Thresholds
Targets			
B 4	% Fines < 2 mm (data collected in riffles)	32%	Mean: 19%; Range: 11-27%
	% Fines < 6 mm (data collected in riffles)	32%	Mean: 27%; Range 16-38%
	D_{50} (data collected in riffles)	12 mm	7-64 mm
	Clinger Richness	11	≥14
Supplemental Indicators			
B4	Mountain IBI	68%	> 75%
	% Clinger Taxa	26.6	High
	EPT Richness	19	≥ 22
	Pools/mile	137	39
	LWD/mile	5	50
	Residual Pool Depth	5 inches	1.5 feet
	Suspended Solids Concentration	Unknown	Comparable to reference
	Turbidity	Unknown	High flow – ≤ 50 NTU instantaneous maximum Summer base flow – ≤ 10 NTU
	Juvenile bull trout & westslope cutthroat trout densities	See Appendix I refers to P&A table – all streams	Documented increasing or stable trend.
	Human Caused Sediment Sources	Roads	No Preventable Sources
	Fish Passage Barriers	None identified.	No Barriers except to protect native salmonid genetics.

See Section 3.3 for an explanation of target development.

The 1993 EIS and Decker's 1991 assessment (reviewed above) provide strong evidence that the 1996 listing of Buck Creek was justified. Forest Service personnel who were interviewed for this report concurred that Buck Creek has been heavily roaded and harvested and agreed that the stream was a likely candidate for TMDL development (Wildey pers. com., 2002). Three of the four sediment targets are currently not being met, and macroinvertebrate data suggest impairment to aquatic life in the stream. In response, a sediment[3] TMDL and restoration plan will be developed for Buck Creek as part of this WQRP.

3.8.3 Ditch Creek

Ditch Creek is small third order tributary of the West Fork of the Bitterroot River. Stream flow is intermittent in the lower mile of Ditch Creek, and thus the stream is typically connected to the West Fork only during the spring runoff. The Ditch Creek Watershed is approximately 1.7 square miles in size, and lands within the watershed are managed entirely by the Bitterroot National Forest. The Ditch Creek watershed has been heavily roaded, with approximately 8.3 miles of roads and a road density of 4.8. The Ditch Creek watershed did not burn in the fires of 2000.

[3] Sediment is used in this document to refer collectively to a group of related pollutants including sediment, siltation, suspended solids, and/or habitat alteration.

3.8.3.1 Summary of 303(d) List

The primary source of information for the listing of Ditch Creek appears to have been the Buck–Little Boulder Timber Sale EIS, dated August 1993. Further evidence of impairment was provided in the BNF Sensitive Watershed Analysis (Decker et al., 1991). The conclusions from these two documents appear to be the primary reasons for listing Ditch Creek.

The 1996 Montana 303(d) list reported that Ditch Creek partially supported its aquatic life and cold-water fishery beneficial uses as a result of habitat alterations, siltation, and suspended solids. The source of these impairments was listed as silviculture. In the 2000 and 2002 303(d) lists, Montana DEQ revised these conclusions to indicate that the available data did not meet the requirements for sufficient and credible data, and thus no beneficial use support determinations could be made. Ditch Creek was subsequently scheduled for reassessment in order to gather the needed data. The 303(d) status of Ditch Creek is summarized in Table 3-18.

Table 3-18. 303(d) Status of Ditch Creek: MT76H003_060.

Year	Use Support Status	Probable Impaired Uses	Probable Causes	Probable Sources
1996	Partial support	Aquatic life Cold water fishery	Habitat alterations Siltation Suspended solids	Silviculture
2000/02	Needs reassessment	No Sufficient Credible Data (SCD)	No SCD	No SCD

A review of the available and relevant sediment data in Ditch Creek is provided in the sections below. This review includes all currently available target and indicator data, and Table 3-19 compares current data for target and indicator variables to proposed reference thresholds.

3.8.3.2 Sediment Target Data

As described in Section 3.3.1, sediment targets were developed to account for variability in stream response. It was determined that Ditch Creek's natural evolutionary classification stage is a Rosgen B4 stream channel. Therefore, the target data summarized below is for a B4 channel type.

% Fines--Wolman Pebble Counts < 2mm in Riffles

The Bitterroot National Forest collected pebble count data in Ditch Creek in July of 2003. The average percent fines values for less than 2 mm was 45%, which exceeded the target of 27%, the upper limit of the reference range.

% Fines--Wolman Pebble Counts < 6mm in Riffles

The Bitterroot National Forest collected pebble count data in Ditch Creek in July of 2003. The average percent fines values for less than 6 mm was 45%, which exceeded the target of 38%, the upper limit of the reference range.

D_{50}

The Bitterroot National Forest collected pebble count data in Ditch Creek in July of 2003. The average size class values for the D_{50} was 7 mm, within the target range.

Clinger Richness

Montana DEQ collected macroinvertebrate data in October 2002 and found a clinger richness of 8, which does not meet the proposed target threshold of greater than 14.

3.8.3.3 Sediment Supplemental Indicator Data

Residual Pool Depth

The BNF collected residual pool depth data in September 2002 and found an average value of 6 inches, well below the indicator threshold of at least 1.5 feet.

LWD

The BNF conducted large woody debris inventories in Ditch Creek in September 2002 and found 48 pieces/mile, slightly below the indicator threshold of at least 50/mile.

Pool/Mile

The BNF found 137 pools/mile in Ditch Creek in September 2002, well above the indicator threshold of at least 39/mile.

Suspended Solids Concentrations

No data have been collected.

Turbidity

No data have been collected.

Mountain IBI

Montana DEQ collected macroinvertebrate data in October 2002. Ditch Creek received an index value of 71%, failing to meet the supplemental indicator threshold.

EPT Richness and Percent Clinger Taxa

Montana DEQ collected macroinvertebrate data in October 2002 and found an EPT richness of 15, which does not meet the proposed supplemental indicator threshold of at least 22. The percent clinger taxa was 74.7; no numeric threshold has been set for this indicator.

Juvenile Trout Densities

Insufficient Data.

Human-Caused Sediment Sources

As described in greater detail in Section 4.0, roads were identified as significant human caused sources of sediment in the Ditch Creek watershed.

Fish Passage Barriers

There are two culverts in the Ditch Creek watershed that are known to impede or block fish passage. One is the culvert on Ditch Creek under the West Fork Highway, the other is the culvert on Ditch Creek on Road 91-E about 0.7 miles upstream of the highway. In both locations, Ditch Creek is intermittent and often dry during late summer. Some overland flow intermittently occurs in the section of stream between the two culverts. The rest of the culverts in the Ditch Creek watershed do not affect fish. BNF recommends that the West Fork Highway and Road 91-E culverts be replaced when the opportunity and funding allows. As with the Buck Creek culvert, replacement of the culvert on the highway will be more difficult due to the expense. It is most likely to occur whenever the highway is reconstructed in the future.

3.8.3.4 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

Sediment & Habitat

Ditch Creek was unaffected by the fires of 2000.

The BNF Sensitive Watershed Analysis (Decker et al., 1991) indicated that the Ditch Creek Watershed had been heavily roaded, and 90% of the watershed appeared from air photos to have been impacted by timber harvest; although substantial recovery has since occurred. Soils in the watershed were determined to be predominately highly erodible volcanics. For these reasons, Decker classified the Ditch Creek watershed as having a high risk of increased sediment and/or water yield from further timber harvest or road construction and indicated that watershed rehabilitation was a high priority.

The August 1993 Boulder-Little Buck EIS supported the results of Decker's assessment. WATSED modeling revealed that water yield in the Ditch Creek watershed was an estimated 14% above natural and that peak flow was 9% above natural. Sediment yield was estimated to have reached a peak of 708% above undisturbed levels as a result of road building and timber harvest, declining to 236% over undisturbed levels by 1987 and remaining steady at this level through 1991, the last year of the analysis in the EIS. The BNF estimated that sediment yields of 170% above natural background levels could result in geomorphic instability in the stream;

conditions in Ditch Creek in 1991 were well beyond this threshold. Additionally, the Tarzwell Substrate Ratio, a measure of the potential productivity of stream substrate, had declined by about 62% in Ditch Creek when compared to reference conditions in Little Boulder Creek. Pools in Ditch Creek were reported to be completely filled with sand, and logging slash had caused debris jams that were also filled with sand. According to the EIS, Ditch Creek was "in poor health and at high risk of a complete loss of biological integrity."

The Little Boulder EIS and the 1991 study by Decker appear to have been the primary sources of information upon which the 1996 listing of Ditch Creek was based, and thus a review of these documents has been included here. However the data are more than a decade old and may no longer accurately reflect conditions in the watershed.

Periphyton

Periphyton was sampled by MDEQ in October 2002 as part of its reassessment of Ditch Creek. The sampling site was located on lower Ditch Creek, approximately 0.3 miles upstream of its confluence with the West Fork of the Bitterroot River. Periphyton was evaluated based on 7 standard MDEQ metrics, all of which indicated full support of beneficial uses.

Chemistry

Water chemistry and metals in sediment data collected by MDEQ in October 2002 indicated no violations of state water quality standards.

3.8.3.5 Current WQ Impairment Summary

Table 3-19 below compares existing sediment data with the proposed target and indicator values in Ditch Creek. Target and indicator development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

Table 3-19. Existing Conditions and Water Quality Targets and Indicators for Ditch Creek.

Targets			
Rosgen Stream Type	**Parameter**	**Existing Condition**	**Proposed Thresholds**
B4	% Fines < 2 mm (data collected in riffles)	45%	Mean: 19%; Range: 11-27%
	% Fines < 6 mm (data collected in riffles)	45%	Mean: 27%; Range 16-38%
	D_{50}	7mm	7-64 mm
	Clinger Richness	8	> 14
Supplemental Indicators			
B4	Mountain IBI	71%	> 75%
	% Clinger Taxa	74.7	High
	EPT Richness	15	≥ 22
	Pools/mile	137	39
	LWD/mile	48	50
	Residual Pool Depth	6 inches	1.5 feet
	Suspended Solids Concentration	Unknown	Comparable to reference
	Turbidity	Unknown	High flow – ≤ 50 NTU instantaneous maximum Summer base flow – ≤ 10 NTU
	Juvenile bull trout & westslope cutthroat trout densities.	See Appendix I	Documented increasing or stable trend.
	Human Caused Sources	Roads	No preventable sources.
	Fish Passage Barriers	2 culvert barriers identified.	No barriers except to protect native salmonid genetics.

See Section 3.3 for an explanation of target development.

The 1993 EIS and Decker's 1991 assessment (reviewed above) provide strong evidence that the 1996 listing of Ditch Creek was justified. Forest Service personnel who were interviewed for this report concurred that Ditch Creek has been heavily roaded and harvested and agreed that the stream was a likely candidate for TMDL development (Wildey pers. com., 2002). Three of the four sediment targets are currently not being met, and macroinvertebrate data suggest impairment to aquatic life in the stream. In response, a sediment[4] TMDL and restoration plan will be developed for Ditch Creek as part of this WQRP.

3.8.4 Meadow Creek

Meadow Creek is a fourth order stream that originates at an elevation of 2317m and flows north for 16km before joining the East Fork of the Bitterroot River. It drains an area of 32 square miles. All of the lands within the watershed are managed by the Bitterroot National Forest. Geology in the area is a mix of weathered and hard granitics. The stream is bordered by mixed stands of Lodgepole pine, Engleman spruce, and willow. Meadow Creek has a snow-dominated hydrograph typical of streams in the central Rocky Mountains.

[4] Sediment is used in this document to refer collectively to a group of related pollutants including sediment, siltation, suspended solids, and/or habitat alteration.

3.8.4.1 Summary of 303(d) List

The listing of Meadow Creek appears to have been based primarily on a 1980 FWP habitat survey that noted trampled banks and road encroachment along Meadow Creek. Complete results of the survey and sampling locations were not located.

The 1996 Montana 303(d) list reported that Meadow Creek was threatened for support of its cold-water fishery beneficial use due to habitat alterations stemming from agriculture, rangeland, and highway/road/bridge construction. In the 2000 and 2002 303(d) lists, Montana DEQ revised these conclusions to indicate that the available for Meadow Creek did not meet the requirements for sufficient and credible data, and thus no beneficial use support determinations could be made. Meadow Creek was subsequently scheduled for reassessment in order to gather the needed data. The 303(d) status of Meadow Creek is summarized in Table 3-20.

Table 3-20. 303(d) Status of Meadow Creek: MT76H002_030.

Year	Use Support Status	Probable Impaired Uses	Probable Causes	Probable Sources
1996	Threatened	Cold water fishery	Habitat alterations	Agriculture, Range Land, Highway/road/bridge construction
2000/02	Needs reassessment	No Sufficient Credible Data (SCD)	No SCD	No SCD

A review of the available and relevant sediment data in Meadow Creek is provided in the sections below. This review includes all currently available target and indicator data, and Table 3-22 compares current data for target and indicator variable to proposed reference thresholds.

3.8.4.2 Sediment Target Data

As described in Section 3.3.1, sediment targets were developed to account for variability in stream response. It was determined that Meadow Creek's natural evolutionary classification stage contains both a Rosgen B4 stream channel in the upper reach and a C4 channel in the lower reach. Therefore, the target data summarized below is for B4 & C4 channel types.

% Fines--Wolman Pebble Counts < 2mm in Riffles

The Bitterroot National Forest collected pebble count data in Meadow Creek in July of 2003. The average percent fines values for less than 2 mm in the B4 channel reach was 22%, within the target range. The average percent fines values for less than 2 mm in the C4 channel reach was 10%, which was below the lower end of the target range, suggesting that fine sediment levels were not elevated in this reach of Meadow Creek.

% Fines--Wolman Pebble Counts < 6mm in Riffles

The Bitterroot National Forest collected pebble count data in Meadow Creek in July of 2003. The average percent fines values for less than 6 mm in the B4 channel reach was 22%, within the target range. The average percent fines values for less than 6 mm in the C4 channel reach was 12%, which was below the lower end of the target range, suggesting that fine sediment levels were not elevated in this reach of Meadow Creek.

D_{50}

The Bitterroot National Forest collected pebble count data in Meadow Creek in July of 2003. The average size class values for the D_{50} in the B4 channel reach was 57 mm and in the C4 reach it was 46 mm, meeting the target in both instances.

Clinger Richness

Montana DEQ collected macroinvertebrate data in October 2002 at two locations, one in the upper watershed near the confluence with Spruce Creek and another near the mouth of Meadow Creek. Clinger richness was 21 at the upper site and 17 at the lower, meeting the proposed indicator value at both locations.

3.8.4.3 Sediment Supplemental Indicator Data

Residual Pool Depth

The USFS conducted stream inventories in Meadow Creek in July of 2003. The average residual pool depth value was 1.5 feet, indicating that the supplemental indicator threshold has been met.

LWD

The USFS conducted large woody debris inventories in Meadow Creek in August 1995. The total number of pieces inventoried was 343 pieces per mile. This value far exceeds the supplemental indicator value of at least 50 pieces per mile.

Pool/Mile

The USFS conducted habitat inventories in Meadow Creek in August 1995. Pool/mile values for Meadow Creek were recorded as 52, meeting the threshold of 48 pool/mile.

Suspended Solids Concentrations

No data have been collected.

Turbidity

No data have been collected.

Mountain IBI

Montana DEQ collected macroinvertebrate data in October 2002 at two locations, one in the upper watershed near the confluence with Spruce Creek and another near the mouth of Meadow Creek. The IBI was 96% at the upper site and 76% at the lower, meeting the proposed threshold at both locations.

EPT Richness and Percent Clinger Taxa

EPT richness was 28 at the upper site and 23 at the lower, meeting the proposed threshold at both locations. The percent clinger taxa was 84% at the upper site and 74.5% at the lower; no numeric threshold has been set for this indicator.

Juvenile Trout Densities

Insufficient Data.

Human-Caused Sediment Sources

As described in greater detail in Section 4.0, roads and unstable stream banks were identified as potentially significant human caused sources of sediment in the Meadow Creek watershed.

Fish Passage Barriers

There are two culverts on Meadow Creek that BNF believes impede fish passage: FDR 5758 and FDR 725. BNF is aware from a decade of fish population monitoring surveys that some adult migratory bull trout and westslope cutthroat trout can get upstream through these two culverts. However, at higher flows, water velocities through these culverts are probably barriers or impediments to smaller juveniles of both species. Both culverts pinch the bankfull and baseflow wetted channel of Meadow Creek by more than half, and there is no substrate in the bottom of the culvert barrels. The FishXing model predicts that both culverts are barriers for juvenile and adult bull trout. Two other culverts in the Meadow Creek watershed were identified in the Burned Area Recovery FEIS as fish barriers: the Road 725 and 73609 culverts on Bugle Creek. Bugle Creek is a tributary to Meadow Creek. The Road 725 culvert on Bugle Creek was replaced with a new stream simulation culvert in November, 2003. The plan to replace the Road 73609 culvert was dropped because electrofishing surveys conducted in summer, 2003 indicated that fish are not present above or below the culvert, and habitat is unsuitable due to steep gradients. BNF recommends replacement of the FDR 5758 and 725 culverts on Meadow Creek, pending funding.

3.8.4.4 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

Sediment & Habitat

The BNF Sensitive Watershed Analysis (Decker et al., 1991) determined that in the Meadow Creek Watershed there were 74.0 miles of forest roads and 84 stream crossings, resulting in a road density of approximately 2.2 mi/mi^2 and a crossing density of 2.5 mi/mi^2. At the time, 15% of the watershed appeared from air photos to have been impacted by timber harvest. Soils in the watershed were determined to be predominately a mix of highly erodible weathered granitics and low erosion hard granitics. For these reasons, Decker classified the Meadow Creek as a sensitive watershed, suggesting that Meadow Creek was nearing impact thresholds at which additional harvest or road construction could produce damaging increases in sediment and/or water yield. Decker also noted that there were 9 miles of road in the riparian zones of Meadow Creek. This information is more than a decade old and thus may no longer accurately reflect conditions in the watershed.

The Meadow Creek Watershed is at the heart of the Meadow Tolan Allotment and is utilized by livestock for several months each season. There is a road in the riparian area that restricts stream channel and floodplain function for approximately six miles. Along with grazing, the watershed has historically been used for timber harvest and recreation (USFS, 2001a).

The Meadow/Tolan Bunch Gulch and Shirley Mountain Grazing Allotments Environmental Assessment, October 1997, reported that in 1992, 4 stream reaches were surveyed on Meadow Creek to evaluate grazing impacts. The surveys found that livestock were generally confined to the lower gradient reaches in the middle of the Meadow Creek Watershed by the natural topography of the drainage. In this area, which is located approximately between milepost 4 and milepost 7, between 30 and 75% of the stream banks at the survey sites showed evidence of impact by livestock. The Tarswell substrate ration, a measure of productivity based on aquatic insect diversity and substrate composition, was lower than reference condition due primarily to a high percentage of sand in the substrate. During the summer of 2004, 1700 feet of this reach was fenced and a ford was hardened to reduce impacts to the stream.

The fires of 2000 affected a large portion of the Meadow Creek Watershed. Forty-six percent of the watershed burned at high or moderate severity; an additional 19 percent was burned at a low severity level. In its post-burn EIS, the Bitterroot National Forest identified 5 primary factors that may impact support of aquatic life and cold-water fishery beneficial uses in the Meadow Creek Watershed (USFS, 2001a). These data may no longer reflect current conditions, as many of post fire impacts have since been addressed:

1. Elevated sediment inputs from the encroached segments of Road 725.
2. Channel widening and elevated sediment inputs in localized spots where riparian livestock grazing occurs; the areas of highest concern have been addressed by the construction of several riparian fences in recent years; other lesser used areas are being monitored.
3. Riparian timber harvest (partial canopy removal) along portions of the headwater tributaries. However, this has not been a practice since the mid 1990's when INFISH was amended to the Forest Plan requiring buffers along streams.

4. The culvert on Road 725 (Bugle Creek) was a complete fish barrier, but was replaced in November 2003.
5. The culvert on Road 73609 (Bugle Creek) was thought to be a fish barrier, but it was later determined that the stream is not a fishery at this point in the watershed (Jakober pers. com., 2004).

Macroinvertebrates

In addition to the macroinvertebrate sampling discussed in the target review, macroinvertebrate samples were collected and analyzed as part of the USFS Aquatic Ecosystem Inventory throughout the late-1970s and 1980s. The analysis was based on multiple factors including 1) the Diversity Index (DAT), which “combines a measure of dominance and number of taxa; 2) the Standing Crop (SC) expressed in gm/m^2; and 3) the Biotic Condition Index (BCI) “which indicates as a percentage how close an aquatic ecosystem is to its own potential”. In general, the macroinvertebrates in Meadow Creek were indicative of good water quality, but the presence of sediment and organic tolerant organisms provided a “warning sign” that some degradation had occurred. Average metric values were rated in the good to excellent range (Mangum, 1989). Macroinvertebrate samples were also collected in 1994, 1995, and 1996, but little interpretation of the results was provided in the reports, except that the macroinvertebrate communities were indicative of slight to moderate organic enrichment (Vinson, 1996). Results of the macroinvertebrate analysis from years in which some level of interpretation was provided are presented in Table 3-21. The exact locations of sampling sites were not provided in the reports from which these data were taken.

Table 3-21. Macroinvertebrate Analysis in Meadow Creek

Date	Location	DAT	Rating	SC	Rating	BCI	Rating
9/21/88	2A	20.0	Excellent	2.8	Good	94	Excellent
9/01/87	2A	20.4	Excellent	1.0	Fair	92	Excellent
9/23/86	2	20.3	Excellent	0.9	Fair	100	Excellent
10/03/85	1	24.2	Excellent	7.0	Excellent	98	Excellent
9/27/84	5	22.4	Excellent	2.2	Good	94	Excellent
9/08/80	5	17.9	Good	1.8	Good	88	Good
9/22/79	5	17.7	Good	2.2	Good	94	Excellent
10/30/79	5	17.7	Good	1.0	Fair	89	Good
9/12/78	5	15.3	Good	2.1	Good	NC	NA
11/03/78	5	18.1	Excellent	3.3	Good	NC	NA
Average	**All**	**18.4**	**Excellent**	**2.4**	**Good**	**93.6**	**Excellent**

Periphyton

Periphyton (attached algae) was sampled by MDEQ in October 2002 as part of its reassessment of Meadow Creek. Two sampling sites were established, one in the lower stream near its confluence with the East Fork of the Bitterroot and one in the upper stream above the confluence on Spruce Creek. Periphyton was evaluated based on seven standard MDEQ metrics, all of which indicated full support of beneficial uses at both sites.

Chemistry

Water chemistry and metals in sediment data collected by MDEQ in October 2002 indicated no violations of state water quality standards.

3.8.4.5 Current WQ Impairment Summary

Table 3-22 below compares existing sediment data with the proposed target and indicator values in Meadow Creek. Target and indicator development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

Table 3-22. Existing Conditions and Water Quality Indicators for Meadow Creek.

Targets			
Rosgen Stream Type	**Parameter**	**Existing Condition**	**Proposed Thresholds**
C 4	% Fines < 2 mm (data collected in riffles)	10%[1]	Mean: 23%; Range: 14-32%
	% Fines < 6 mm (data collected in riffles)	12%[1]	Mean: 33%; Range: 17-49%
	D_{50} (data collected in riffles)	46 mm[1]	3-47 mm
B4	% Fines < 2 mm (data collected in riffles)	22%	Mean: 19%; Range: 11-27%
	% Fines < 6 mm (data collected in riffles)	22%	Mean: 27%; Range: 16-38%
	D_{50} (data collected in riffles)	57mm	7-64 mm
All	Clinger Richness	21 upper 17 lower	≥ 14
Supplemental Indicators			
All	Mountain IBI	96 upper 76 lower	> 75%
	% Clinger Taxa	84 upper 74.5 lower	High
	EPT Richness	28 upper 23 lower	≥ 22
	Pools/mile	52	48
	LWD/mile	343	50
	Residual Pool Depth	1.5 feet[2]	1.5 feet
	Suspended Solids Concentration	Unknown	Comparable to reference
	Turbidity	Unknown	High flow – ≤ 50 NTU instantaneous maximum Summer base flow – ≤ 10 NTU
	Juvenile bull trout & westslope cutthroat trout densities.	See Appendix I	Documented increasing or stable trend.
	Human Caused Sediment Sources	Roads and Unstable stream banks.	No preventable sources.
	Fish Passage Barriers	None identified.	No barriers except to protect native salmonid genetics.

[1] Based on an average of two sites for ease of display.
[2] Data available at one site only (mile 7.3).
See Section 3.3 for an explanation of target development.

The available data indicate that as recently as 1996, significant grazing impacts were detectable in the lower gradient reaches of Meadow Creek, and the watershed was severely impacted by the fires of 2000. However, many of the impacts responsible for the listing of Meadow Creek have been mitigated by restoration activities in the watershed, and all of the targets and supplemental indicators for which current data are available are within expected reference ranges. In 1996 0.5 miles of riparian fencing were installed around the area of the most severe livestock impacts on Meadow Creek and additional fencing was installed in 2000 on Bugle Creek in the Meadow Creek Watershed. An additional 1700 feet of fencing installed during 2004. According to USFS personnel who were interviewed for this report, many of the problem grazing areas have now been fenced or are scheduled for fencing, but the stream has not yet had time to recover and grazing-related bank instability remains a problem in some reaches of Meadow Creek (Wildey, pers. com., 2002). In 1995, the Meadow Creek Road was graveled to decrease erosion, and disturbed soils associated with road improvements were seeded. Additional BMP upgrades on 7.1 near-stream miles of road 725 occurred in fall 2004.

Target and indicator variables appear to be within reference ranges and thus no TMDL has been developed for Meadow Creek. However, preventable human-caused sediment sources still exist in the watershed, and much of the sediment delivery mitigation that has occurred in the watershed is very recent, and the efficacy of this mitigation has not yet been determined. Additionally, the fires of 2000 burned a substantial portion of the watershed and have introduced a level of uncertainty regarding near-future conditions drainage. In response, a restoration and monitoring plan will be developed for Meadow Creek as part of this WQRP. It is recognized, however, that most of necessary restoration work has already occurred and that fish and aquatic life beneficial uses do not appear impaired by sediment in Meadow Creek.

3.8.5 Reimel Creek

The Reimel Creek watershed is a fourth order drainage of about eight square miles including two main tributaries, Wallace Creek and Diggins Creek. Characterized by a Douglas fir and mix subalpine forest, the watershed is at an average elevation of 6,100 feet and is managed predominately by the Bitterroot National Forest, which manages 96% of the lands within the watershed. An additional 4% of the watershed is in private hands, and these private lands are concentrated on or near the stream channel. Past management activities within the Reimel Creek watershed include minimal timber harvesting, a few roads, dispersed recreation, and grazing (USFS, 1997).

3.8.5.1 Summary of 303(d) List

The rationale for the listing of Reimel Creek appears to have been based primarily on two documents: the 1991 BNF Sensitive Watershed Analysis and the 1991 Camp Reimel Environmental Assessment, which are discussed in more detail below.

The 1996 Montana 303(d) list reported that Reimel Creek only partially supported its cold-water fishery beneficial use. The impairment to Reimel Creek was thought to be caused by habitat alterations, siltation and suspended solids resulting from agriculture and rangeland. In reviewing the 303(d) list in 2000 and 2002, however, Montana DEQ determined that the existing data did not meet the requirements for sufficient and credible data, and thus no beneficial use support determination could be made, and Reimel Creek was scheduled for reassessment. The 303(d) status of Reimel Creek is summarized in Table 3-23.

Table 3-23. 303(d) Status of Reimel Creek: MT76H002_020.

Year	Use Support Status	Probable Impaired Uses	Probable Causes	Probable Sources
1996	Partial support	Aquatic life Cold water fishery	Habitat alterations Siltation Suspended solids	Agriculture Range land
2000/02	Needs reassessment	No Sufficient Credible Data (SCD)	No SCD	No SCD

A review of the available and relevant sediment data in Reimel Creek is provided in the sections below. This review includes all currently available target and indicator data, and Table 3-26 compares current data for target and indicator variables to proposed reference thresholds.

3.8.5.2 Sediment Target Data

As described in Section 3.3.1, sediment targets were developed to account for variability in stream response. It was determined that Reimel Creek's natural evolutionary classification stage contains both a Rosgen B4 stream channel in the upper reach and a C4 channel in the lower reach. Therefore, the target data summarized below is for B4 & C4 channel types.

% Fines--Wolman Pebble Counts < 2mm in Riffles

The Bitterroot National Forest collected pebble count data in Reimel Creek in July of 2003. The average percent fines values for less than 2 mm in the B4 channel reach was 30%, which exceeded the target of 27%, the upper limit of the reference range. The average percent fines values for less than 2 mm in the C4 channel reach was 24%, which was within the target range.

% Fines--Wolman Pebble Counts < 6mm in Riffles

The Bitterroot National Forest collected pebble count data in Reimel Creek in July of 2003. The average percent fines values for less than 6 mm in the B4 channel reach was 31%, and the average percent fines values for less than 6 mm in the C4 channel reach was 25%. Both were within the target range.

D_{50}

The Bitterroot National Forest collected pebble count data in Reimel Creek in July of 2003. The average size class values for the D_{50} in the B4 channel reach was 24 mm, and in the C reach it was 25 mm, both within the target range.

Clinger Richness

Montana DEQ collected macroinvertebrate data in October of 2002 at two locations in Reimel Creek, one in the upper watershed near the Wallace Creek confluence and one near the mouth of Reimel Creek. Clinger Richness was 21 at the upper site and 19 at the lower, meeting the proposed target at both locations.

3.8.5.3 Sediment Supplemental Indicator Data

Residual Pool Depth

The USFS conducted stream inventories in Reimel Creek in July of 2003. Average residual pool depth values are 0.75 feet in the B4 channel and 1.2 feet in the C4 channel reach, indicating that the supplemental indicator threshold has not been met.

LWD

The USFS conducted large woody debris inventories in Reimel Creek, in September 2004 and found 62 pieces/mile, meeting the target threshold of at least 50 pieces/mile.

Pool/Mile

The USFS conducted pool counts in Reimel Creek in September 2004 and found 42 pools/mile, falling short of the threshold indicator of at least 60/mile.

Suspended Solids Concentrations

No data have been collected.

Turbidity

No data have been collected.

Mountain IBI

Montana DEQ collected macroinvertebrate data in October of 2002 at two locations in Reimel Creek, one in the upper watershed near the Wallace Creek confluence and one near the mouth of Reimel Creek. The IBI was 88 at the upper site and 76 at the lower, meeting the proposed supplemental indicator at both locations.

EPT Richness and Percent Clinger Taxa

EPT richness was 27 at the upper site and 23 at the lower, meeting the proposed supplemental indicator at both locations. The percent clinger taxa was 38 at the upper site and 76 at the lower; no numeric threshold has been set for this indicator.

Juvenile Trout Densities

Insufficient Data.

Human-Caused Sediment Sources

As described in greater detail in Section 4.0, roads were identified as significant human caused sources of sediment in the Reimel Creek watershed.

Fish Passage Barriers

There is one known culvert in the Reimel Creek watershed that blocks or impedes fish passage, and that culvert occurs on private land near the mouth of Reimel Creek. On the forest, the two culverts that affected fish (the Road 727 crossings of Reimel Creek and Diggins Creek) were replaced with new stream simulation culverts in 2000 and 2003, respectively. Both are adequately maintaining fish passage. There are no other culverts on the forest in the Reimel Creek watershed that affect fish. The BNF recommends pursuing replacement of the culvert on private land, and monitoring the two culverts on the forest to ensure that fish passage is being adequately maintained.

3.8.5.4 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

Sediment & Habitat

The Reimel Creek Watershed was heavily affected by the fires of 2000. Sixty-three percent of the fish bearing stream miles in the watershed burned at a moderate to high intensity, and the watershed is considered by the USFS to be a high risk of mass wasting as a result of the fires (USFS, 2000). Several mudslides and debris flows have occurred in the watershed since the fires.

The BNF Sensitive Watershed Analysis (Decker et al., 1991) determined that in the Reimel Creek Watershed there were 5 miles of forest roads and 10 stream crossings resulting in a road density of approximately 0.6 miles/mile^2 and a crossing density of 1.3 per square mile. At the time, 5% of the watershed appeared from air photos to have been impacted by timber harvest. Soils in the watershed were determined to be predominately a mix of highly erodible weathered granitics and relatively stable hard granitics. For these reasons, Decker classified the Reimel Creek watershed as a sensitive watershed, suggesting that management activities could produce damaging increases in sediment and/or water yield. At the time, however, most of the significant impacts in the watershed were from grazing not silviculture.

The 1991 Camp Reimel Environmental Assessment examined physical stream parameters at five sites on Reimel Creek to evaluate grazing impacts to the stream. These parameters are summarized in Table 3-24.

Table 3-24. Reimel Creek Grazing Evaluation Summary

Location	Condition	Gradient (%)	Particle Size Distribution (mm)			Width/ Depth Ratio	Sinuosity	Erodibility
			D_{15}	D_{50}	D_{84}			
R1 In the exclosure	Reference	1.0	7	28	125	8	1.4	Moderate
R2 Above the exclosure	Impacted	0.2	13	25	105	22	1.1	Very High
R3 In the upper meadow	Impacted	1.1	0.1	4.5	25	23	1.2	High
R4 ½ mile above Wallace Creek	Reference	>5	NC	NC	NC	NC	NC	Low
R5 Reimel and Wallace Creek at the confluence	Impacted	>4	NC	NC	NC	NC	NC	Very High

Reach R1 was an exclosure from which livestock have been excluded since the late 1950's. This site was used to infer reference conditions for reach R2, a grazed section of Reimel Creek that was immediately upstream of the exclosure. The EA described R2 as straighter, wider, and shallower with greater water velocity than the minimally impacted reach R1. Bank trampling and vegetation removal by livestock were reported to have destabilized the stream and pushed it out of equilibrium, a fact reflected in R2's higher channel stability rating (a higher rating indicates greater instability).

Reach R3, near the meadow below the Wallace Creek confluence, had no reference reach, but was compared by the EA author to similar conditions in C3 streams in the area. The EA stated that R3 suffered from impairments similar to R2: "almost the entire length of the channel is experiencing bank erosion because of trampling, increased velocities and reduced root structure from shrubs." The EA also noted that similar conditions were found near the USFS boundary lower in the creek, but no data were collected.

Limited data were collected on reach R5 and its reference reach R4. The EA noted that grazing had impacted the channel in reach R4 and that accelerated erosion from this site could be compounding instability in the lower reaches.

The Camp Reimel EA also included a summary of biological data collected at 3 sites on Reimel Creek. These data are summarized in Table 3-25.

Livestock have been excluded from site R1 since the late 1950's and the location was thus considered a reference reach for site R2, which was located immediately upstream of the R1 exclosure and was heavily grazed. As can been seen in Table 3-25, R2 was below reference conditions in all categories. Woody debris was absent, pools were shallower, the number of insects collected was less than half of that in the reference reach, and the substrate productivity ratio, a measure of the potential macroinvertebrate productivity that is reduced by the deposition of fine materials, was approximately 30% less than in the exclosure. Although no reference reach was located for R3, the EA states that conditions are considerably diminished compared to typical values in reference reaches.

The Camp Reimel EA and the 1991 study by Decker appear to have been the primary sources of information upon which the 1996 listing of Reimel Creek was based, and thus a review of these documents has been included here. However the data are more than a decade old and may no longer accurately reflect conditions in the watershed.

Table 3-25. Physical Stream Parameters of Reimel Creek.

Location	Condition	Substrate Productivity Ratio	Number of insects	Percent pools >1 ft deep	Woody Debris	
					Single #/100 ft	Jams #/100 ft
R1 In the exclosure	Reference	49	215	<33	1	1
R2 Above the exclosure	Impacted	31	93	<15	None	None
R3 In the upper meadow	Impacted	18	82	<15	None	None

In its post-burn EIS (USFS, 2001a), the Bitterroot National Forest identified 4 factors that may have impacted support of aquatic life and cold-water fishery beneficial uses in the Reimel Creek Watershed immediately following the fires These may no longer reflect current conditions, as many of these impacts have since been addressed:

1. Sediment levels were “functioning at unacceptable risk” because of past riparian livestock grazing, the 2000 fires, and the July 2001 mudslides. Another mudslide occurred in 2003.
2. Turbidity caused by the 2000 fires and the subsequent mudslides. However, the post-fire pulse of sediment that caused this turbidity was probably short-lived.
3. Potentially elevated water temperatures caused by losses of shade and channel widening along grazed areas scattered throughout the lower five miles.
4. Frequent isolation from the East Fork of the Bitterroot River caused by an irrigation pond on private land at the mouth of the Reimel Creek canyon.

To address grazing impacts, the Bitterroot National Forest constructed approximately a dozen fish habitat structures in Reimel Creek in September 1999 and planted over 1000 willows in early 2000. In 2001, a five-mile long livestock exclosure fence was constructed around lower Reimel Creek (downstream of Wallace Creek), and 4000 willow seedlings were planted inside of the fence to enhance post-fire recovery of riparian shrubs (USFS, 2001b). In June 2001, the BNF monitored the condition and effectiveness of the restorations project and reported the following conclusions: *The area surrounding the structures was burned with moderate and high severity in*

August 2000, but the structures themselves were unburned. The structures were working effectively, and are providing some of the best complex pool habitat and cover available in the lower four miles of Reimel Creek, particularly in the meadow section at milepost 3.8. The constructed pools were providing good depth and overhead cover, with improved beds of spawning gravels forming in the tailouts. Good undercut bank cover has formed under the logs in the meanders, and the V-log plunge pools have superior depth and cover. With the cessation of riparian grazing along the lower five miles of Reimel Creek, (a livestock exclosure fence was constructed in 2001) grasses, forbs, and stream banks are on a good recovery trend (USFS, 2001b).

However, in 2003, cattle breached the riparian fence and cattle grazed the creek for an unknown period of time, resulting in bank instability and sediment loading to Reimel Creek. The problem with the fence has since been corrected, and recovery of the creek has resumed.

Periphyton

Periphyton were sampled by MDEQ in October 2002 as part of its reassessment of Reimel Creek. Two sampling locations were established, one in lower Reimel Creek and one in the in the upper watershed approximately 0.25 miles upstream of the confluence with Wallace Creek. Periphyton was evaluated based on seven standard MDEQ metrics, all of which indicated full support of beneficial uses at the upper site. However at the lower site, one of the seven metrics, the siltation index, indicated only partial support of beneficial uses; the other six metrics all indicated full support.

Chemistry

Water chemistry and metals in sediment data collected by MDEQ in October 2002 indicated no violations of state water quality standards.

3.8.5.5 Current WQ Impairment Summary

Table 3-26 below compares existing sediment data with the proposed target and indicator values in Reimel Creek. Target and indicator development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

Table 3-26. Existing Sediment Conditions and Water Quality Indicators for Reimel Creek.

Rosgen Stream Type	Parameter	Existing Condition	Proposed Thresholds
Targets			
B4	% Fines < 2 mm (data collected in riffles)	30%[1]	Mean: 19%; Range: 11-27%
	% Fines < 6 mm (data collected in riffles)	31%[1]	Mean: 27%; Range: 16-38%
	D_{50} (data collected in riffles)	24mm[1]	7-64 mm
C4	% Fines < 2 mm (data collected in riffles)	24%	Mean: 23%; Range: 14-32%
	% Fines < 6 mm (data collected in riffles)	25%	Mean: 33%; Range: 17-49%
	D_{50} (data collected in riffles)	25mm	3-47 mm
All	Clinger Richness	21 upper 19 lower	≥14
Supplemental Indicators			
All	Mountain IBI	88 upper 76 lower	> 75%
	% Clinger Taxa	38 upper 75 lower	High
	EPT Richness	27 upper 23 lower	≥ 22
	Pools/mile	42	60
	LWD/mile	62	50
	Residual Pool Depth	0.75[1] feet in B4 reaches 1.2 feet in C4 reach	1.5 feet
	Suspended Solids Concentration	Unknown	Comparable to reference
	Turbidity	Unknown	High flow – ≤ 50 NTU instantaneous maximum Summer base flow – ≤ 10 NTU
	Juvenile bull trout & westslope cutthroat trout densities	See Appendix I	Documented increasing or stable trend.
	Human Caused Sediment Sources	Roads	No preventable sources
	Fish Passage Barriers	One culvert barrier identified.	No barrier except to protect native salmonid genetics.

[1] Based on the average value of three sites for ease of display.
[2] Based on the average value of two sites for ease of display.
See Section 3.3 for an explanation of target development.

The data reviewed above provide strong evidence that the 1996 listing of Reimel Creek was justified. However, watershed restoration activities that have been conducted in the Reimel Creek Watershed since the completion of the Camp Reimel EA in 1991 have addressed many of the grazing-related impacts, and most targets and indicators are within reference ranges. According to BNF personnel interviewed for this report, all of the major grazing impacts to Reimel Creek have since been treated with a combination of riparian fencing and stream bank stabilization techniques, and three portions of road have been relocated. In their opinion, most if not all of the significant grazing impacts have been mitigated for, assuming that the riparian fences remain in tact. (Wildey pers. com., 2003). The fires of 2000 burned much of the watershed potentially resulting in elevated sediment loads that may negatively impact aquatic life in Reimel Creek. Although impacts from the fire are mostly natural and will decline in significance each year, continued monitoring seems necessary. While most of the target and indicator parameters may point towards no impairment, several suggest the possibility of legacy impacts; therefore a sediment[5] TMDL and restoration plan will be developed for Reimel Creek as part of this WQRP**.**

3.8.6 East Fork

The East Fork of the Bitterroot River originates high in glaciated basins of the Sapphire Range. Some basins are underlain with meta-sedimentary rocks of the Belt Series and others with granitic bedrock. Many tributary streams flow through moderate- to low-relief landforms dominated by decomposed granitic parent material and then into broad, low-gradient meadows prior to reaching the East Fork. The BNF divides the East Fork Watershed into three sub-watersheds for management purposes, the Upper, Middle, and Lower East Fork. The upper east fork is an approximately 57.9 square mile watershed that is largely wilderness. The geology of the area is mostly glaciated and weathered granitics, and in this area the watershed and stream are considered healthy by the BNF because of the roadless and unmanaged conditions of the area. The Middle East Fork, which extends approximately from the wilderness boundary downstream to Sula, is dominated by granitic geology and the main stem of the East Fork is considered by the BNF to be in “moderate to good health” (USFS, 2001a) except for the inputs from the tributary watersheds and channelization on private land (USFS, 2001a). In the Lower East Fork, from Sula to the confluence with the West Fork, highway 93 restricts floodplain access and has straightened the river for much of the length resulting in higher current velocities and instances of downstream bank erosion. The parent geology of the Lower East Fork analysis area consists of granitic rocks in the forested uplands and alluvial sedimentary deposits in the flat valley bottom along the East Fork of the Bitterroot River. Private lands are concentrated along the stream and floodplain lands in the valley bottom. The Bitterroot National Forest System lands are generally found along the tributaries and along scattered parcels on the East Fork Bitterroot River.

3.8.6.1 Summary of 303(d) List

The 1996 listing of the East Fork of the Bitterroot River appears to have resulted from a brief FWP habitat survey that noted “excessive siltation, domestic stock, channel alteration (agriculture), bank encroachment (agriculture, stock trampling) overuse by stock and irrigation withdrawals” as factors affecting the fishery.

The 1996 Montana 303(d) list reported that East Fork of the Bitterroot River was threatened for support of its cold-water fishery beneficial use. The threats to the East Fork were thought to be caused by flow alterations, habitat alterations, and siltation resulting from agriculture, irrigated crop production, and rangeland. In reviewing the 303(d) list in 2000 and 2002, however, Montana DEQ determined that the existing data were sufficient and credible for making a beneficial use determination and that the data indicated that the East Fork was fully supporting its beneficial uses. The 303(d) status of the East Fork is summarized in Table 3-27.

[5] Sediment is used in this document to refer collectively to a group of related pollutants including sediment, siltation, suspended solids, and/or habitat alteration.

However, the Bitterroot Headwaters TMDL Technical Advisory Committee (TAC) requested that a pollution source assessment be conducted on the East Fork regardless of its 303(d) status. The TAC decided that because of the relatively large size of the East Fork and its watershed, land uses in the valley, the potential for future growth, and the impacts of the fires of 2000, the East Fork should be assessed as part of the ongoing TMDL efforts. For the purposes of this document, the East Fork was considered to be threatened for flow alteration, habitat alteration, and siltation as appeared on the 1996 303(d) list, as well as thermal modification, which several members of the TAC thought might be a problem in the East Fork.

Table 3-27. 303(d) Status of East Fork Bitterroot River: MT76H002_010.

Year	Use Support Status	Probable Impaired Uses	Probable Causes	Probable Sources
1996	Threatened	Cold water fishery	Flow Alterations, Habitat Alterations, Siltation	Agriculture, Irrigated crop production, Range land
2000/02	Full support	None	None	None

A review of the available and relevant sediment data in the East Fork is provided in the sections below. This review includes all currently available target and indicator data, and Table 3-30 compares current data for target and indicator variable to proposed reference thresholds.

3.8.6.2 Sediment Target Data

As described in Section 3.3.1, sediment targets were developed to account for variability in stream response. It was determined that the East Fork Bitterroot River's natural evolutionary classification stage contains Rosgen B3, C3, and C4 stream channels. Therefore, the target data summarized below is for B3, C3, and C4 channel types.

% Fines--Wolman Pebble Counts < 2mm in Riffles

The Bitterroot National Forest collected pebble count data in the East Fork Bitterroot River in October of 2003. The average percent fines values for less than 2 mm in the B3 channel reach was 7.6% and in the C3 channel reach it was 11.5%, both meeting the target threshold. The average percent fines values for less than 2 mm in the C4 channel reach was 35%, exceeding the target of 32%, the upper end of the reference range.

% Fines--Wolman Pebble Counts < 6mm in Riffles

The Bitterroot National Forest collected pebble count data in the East Fork Bitterroot River in October of 2003. The average percent fines values for less than 6 mm in the B3 channel reach was 9%; in the C3 reach it 14%; and in the C4 channel reach it was 45%. All three values are within target ranges.

D_{50}

The Bitterroot National Forest collected pebble count data in the East Fork Bitterroot River in October of 2003. The average size class values for the D_{50} in the B3 channel reach was 112 mm, The average size class values for the D_{50} in the C3 channel reach was 89mm, and in the C4 reach it was 17 mm; all were within the target ranges.

Clinger Richness

The Montana Department of Environmental Quality collected macroinvertebrate data in 2003. Clinger richness was 16, meeting the proposed target.

3.8.6.3 Sediment Supplemental Indicator Data

The supplemental indicator data was in two reaches of the East Fork, one above and one below Martin Creek. The data are summarized by reach below.

Residual Pool Depth

Above Martin Creek, the BNF found a mean residual pool depth of 1.7 feet in September 2001. Below Martin Creek a BNF survey in July 2003 found an average residual pool depth of 2.2 feet. Both met the indicator threshold of at least 1.5 feet.

LWD

The BNF conducted woody debris surveys on the upper East Fork between Martin Creek and Star Falls in September 2001 and found 109 pieces/mile, meeting the indicator threshold of at least 20/mile. In the lower East Fork between Martin Creek and Warm Springs Creek, BNF found 15 pieces/mile in July 2003, which does not meet the indicator threshold.

Pool/Mile

The BNF conducted pool counts on the upper East Fork between Martin Creek and Star Falls in September 2001 and found 42 pools/mile, meeting the indicator threshold of at least 23/mile at the average stream width in this reach. In the lower East Fork between Martin Creek and Warm Springs Creek, BNF found 8 pools/mile in July 2003, which meets the indicator threshold of 4-9 pools/mile for a stream of the width found in this reach.

Suspended Solids Concentrations

No data have been collected.

Turbidity

No data have been collected.

Mountain IBI

The Montana Department of Environmental Quality collected macroinvertebrate data in 2003. The Mountain IBI score was 76%, failing to meet the proposed indicator value.

EPT Richness and Percent Clinger Taxa

The Montana Department of Environmental Quality collected macroinvertebrate data in 2003. The EPT richness was 18, failing to meet the proposed indicator. The percent clinger taxa was 77 percent, meeting the proposed indicator.

Juvenile Trout Densities

Insufficient Data.

Human-Caused Sediment Sources

As described in greater detail in Section 4.0, roads and unstable stream banks were identified as potentially significant human caused sources of sediment in the East Fork Bitterroot River watershed.

Fish Passage Barriers

There are no known culverts on the East Fork of the Bitterroot River that block or impede fish passage. There are several culverts on small tributaries to the East Fork that block or impede fish passage (e.g. Guide, Jennings Camp, Bertie Lord Creek and its tributaries, Tepee Creek, Springer Creek, Mink Creek, the West Fork of Camp Creek and its tributaries, Crazy Creek, Medicine Tree Creek, Laird Creek). A few of these culverts either have, or will be, proposed for replacement in current forest NEPA projects such as the Burned Area Recovery FEIS. Five of the culverts proposed in the Burned Area Recovery FEIS were replaced with new stream simulation culverts in November 2003 (Bugle Creek, Road 725; Crazy Creek, Road 370-A; West Fork of Camp Creek, Road 729; two unnamed tributaries to the West Fork of Camp Creek, Road 8112). The BNF has recommended that replacing as many of the remaining barrier culverts as possible, pending funding. The forest should also monitor the new replacements to ensure that fish passage is being adequately maintained.

3.8.6.4 Temperature Target Data

The East Fork of the Bitterroot has never been listed as impaired by thermal modification. However, data from FWP suggest that temperatures may be high enough to impair aquatic life and/or cold-water fisheries beneficial uses, particularly in the lower reaches. Table 3-28 displays 7-day average maximum temperatures during the seasonal period of July 18- October 1 for select years from 1996 to 2003. Additionally, in an interview for this report, USFS biologist Mike Jakober suggested the encroachment of US 93, grazing practices in the Sula basin, and the removal of streamside trees (due to highway encroachment and riverfront development) could be responsible for elevated temperatures in the lower river.

Table 3-28. East Fork Bitterroot River Temperatures, 1996-2003.

Mile Marker	Year	7-day average Max in Degrees Celsius and Fahrenheit
0.5 (Primarily Private land)	1996	19.6 C / 67.2 F
	1997	19.1 C / 66.3 F
	1998	20.6 C / 69.0 F
	1999	20.2 C / 68.4 F
	2000	22.9 C / 73.3 F
	2001	21.8 C / 71.3 F
	2003	22.3 C / 72.2 F
	2004	21.6 C/ 70.9 F
17.8 (Primarily Private Land)	1996	17.7 C / 63.8 F
	1997	16.8 C / 62.3 F
	1998	18.5 C / 65.3 F
	1999	18.8 C / 65.9 F
	2000	20.3 C / 68.5 F
	2001	18.7 C / 65.7 F
	2003	Not Collected
	2004	Not collected
31.4 (Wilderness boundary)	1996	Not Collected
	1997	Not Collected
	1998	Not Collected
	1999	14.6 C / 58.3 F
	2000	Not Collected
	2001	Not Collected
	2003	17.7 C / 64.0 F
	2004	16.7 C/ 62.1F

3.8.6.5 Temperature Supplemental Indicator Data

MDEQ and Land and Water Consulting conducted a potential stream shade analysis in 2003. This analysis is further described in Section 5.0. The existing potential shade in the East Fork is 31%, indicating that it does not currently meet its potential.

3.8.6.6 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

Sediment & Habitat

Approximately half of the East Fork watershed burned in 2000, including 25% that burned at moderate to high severity. In the East Fork below Martin Creek, 20% of the fish-bearing stream miles burned with moderate to high severity. Above Martin Creek, 34% burned at moderate to high severity.

Physical habitat assessments were conducted throughout the East Fork downstream of Sula, Montana in the late summer of 1997 as part of a sediment and nutrient assessment of streams of the Bitterroot Valley by the Ravalli County Sanitarian's office. The assessment was performed on eight stream reaches between Sula and the confluence with the West Fork of the Bitterroot. Reach descriptions were not provided. Results are summarized in Table 3-29. The assessment found that the most reaches were on the border of partially and fully supporting beneficial uses – a score of 80 or higher indicates full support according to MDEQ, with the lowest scores found on reaches running through private land in the lower watershed. The average score was 79, indicating only partial support, but very close to full support. Despite the partial support indicated by the average score, the surveyor commented that, overall, habitat on the East Fork appeared to be healthy with no areas of major erosion (WCI, 1998).

Table 3-29. Physical Habitat Assessment Results, East Fork Bitterroot River, 1997.

Reach	Score	Use Support	Comments
1	74	Partial	Moderate riparian habitat; side channels forming in lower section
2	78	Partial	High width/depth ratio; minimal riparian habitat; moderate to minimum fish cover
3	76	Partial	Lower end had raw, steep banks; good fish cover; upper end has rip-rapped banks; entrenched
4	79	Partial	Minimal riparian veg at lower end due to US 93; marginal fish cover; upper end had high width/depth ratio and marginal fish cover.
5	79	Partial	The lower end had very low sinuosity and was riffle dominated. The upper end had good riparian habitat and fish cover.
6	83	Full	Lower end had marginal riparian zone and fish habitat. The upper end had good riparian habitat and fish cover
7	83	Full	The lower end had narrow riparian zone and moderate fish habitat and some erosion. The upper end had good, dense riparian zone and good fish habitat.
8	79	Partial	Thin but productive riparian zone; moderate fish habitat.
Mean	**79**	**Partial**	US 93 inhibits lateral migration and limits the riparian zone. Rock rip-rap is present especially at crossings. However, there are no areas of major erosion and the stream seems healthy.

In its post-burn EIS, the Bitterroot National Forest identified 4 factors that may impact support of aquatic life and cold-water fishery beneficial uses in the East Fork Watershed (USFS, 2001a). These factors may no longer reflect current conditions, as many of them have since been addressed:

1. Reductions in channel length, woody debris recruitment, and habitat complexity caused by encroachment of U.S. highway 93 and the East Fork highway.
2. Elevated water temperatures caused by losses of considerable lengths of riparian over story cover and stream shade on the river (caused by highways, livestock grazing in certain spots, and home construction).
3. Turbidity caused by the 2000 fires and the Laird, Dick and Reimel Creek Mudslides.
4. The culvert on Road 726 (Moose Creek) was a partial fish barrier but has been replaced.

Periphyton

Periphyton samples were collected upstream of the Conner cutoff bridge in the late summer of 1997 as part of a sediment and nutrient assessment of streams of the Bitterroot Valley. Results were summarized as follows: “Biological integrity was rated as excellent … with no impairment of aquatic life indicated. The rich assemblage of non-diatom taxa and a diverse, pollution-intolerant diatom flora suggest high quality, moderately nutrient-rich water with a very low sediment load” (Weber, 1998).

MDEQ’s 303(d) files for the East Fork refer to a 1990 periphyton study by Bahls that revealed no impairment. However, the report was not located and no further information is provided in MDEQ’s files.

Nutrients

Nitrogen and phosphorous sampling was conducted upstream of the Conner cutoff bridge in the late summer of 1997 as part of sediment and nutrient assessment of streams of the Bitterroot Valley. The raw data are not included in the report, but are described as providing no indication of elevated nutrient levels in the East Fork (Hooten, 1999).

Flow

While flow alteration is not a current listed impairment in the East Fork Bitterroot River, it was felt that existing temperature data may suggest a thermal impairment and consequently that the impairment may be attributed to dewatering. Therefore, some preliminary data was analyzed.

Flow alteration in the East Fork Bitterroot River is suspected to be primarily associated with the diversion of water for irrigation. At this time insufficient data exists to adequately define the flow patterns and irrigation withdrawals in the East Fork Bitterroot River. However, given the number of irrigation diversions and land use practices in the lower East Fork (as well as expected temperature impairments), it is suspected that a flow alteration impairment does exist. Consequently, a phased approach is presented in Section 9.9 to help define any flow impairment issues.

3.8.6.7 Current WQ Impairment Summary

Tables 3-30, 3-31 and 3-32 below compares existing sediment data with the proposed target values in E.F. Bitterroot River. Target and supplemental indicator development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

Table 3-30. Existing Conditions and Water Quality Targets and Supplemental Indicators for E.F. Bitterroot River.

Targets					
Rosgen Stream Type	**Parameter**	**Existing Condition**		**Proposed Thresholds**	
C4	% Fines < 2 mm (data collected in riffles)	35		Mean: 23%; Range: 14-32%	
	% Fines < 6 mm (data collected in riffles)	45		Mean: 33%; Range: 17-49%	
	D_{50} (data collected in riffles)	17mm		3-47mm	
C3	% Fines < 2 mm (data collected in riffles)	11.5[1]		Mean: 13%; Range: 6-20%	
	% Fines < 6 mm (data collected in riffles)	14[1]		Mean: 16%; Range: 8-24%	
	D_{50} (data collected in riffles)	89mm[1]		71-89 mm	
B3	% Fines < 2 mm (data collected in riffles)	7.6[2]		Mean: 12%; Range: 5-19%	
	% Fines < 6 mm (data collected in riffles)	9[2]		Mean: 16%; Range: 7-25%	
	D_{50} (data collected in riffles)	112mm[2]		64-256 mm	
All	Clinger Richness	16		≥ 14	
Supplemental Indicators					
All		Above Martin Creek	Below Martin Creek	Above Martin Creek	Below Martin Creek
	Mountain IBI	Unknown	67%	≥ 75%	≥ 75%
	% Clinger Taxa	Unknown	77%	High	High
	EPT Richness	Unknown	18	≤22	≤22
	Pools/mile	42	8	23	4-9
	LWD/mile	109	15	20	20
	Residual Pool Depth	1.7	2.2	1.5 feet	1.5 feet
	Suspended Solids Concentration	Unknown	Unknown	Comparable to reference conditions	
	Turbidity	Unknown	Unknown	High flow – ≤ 50 NTU instantaneous maximum Summer base flow – ≤ 10 NTU	
	Juvenile bull trout & westslope cutthroat trout densities.	See Appendix I	See Appendix I	Documented increasing or stable trend.	
	Human Caused Sediment Sources	Roads, Unstable stream banks.		No preventable sources	
	Fish Passage Barriers	No barriers identified on the East Fork; several identified in the watershed		No barriers except to protect native salmonid genetics.	

[1] Based on an average of two sites over 3 years.
[2] Based on an average of four sites over 3 years.
See Section 3.3 for an explanation of target development.

Table 3-31. Number of Days Temperature Target was Exceeded in the E.F. Bitterroot River.

Mile Marker	Year	Days > 15 ^{0} C and 59 ^{0} F
0.5 Primarily Private Land	1996	69
	1997	61
	1998	78
	1999	71
	2000	82
	2001	99
	2003	82
	2004	78
17.8 Primarily Private Land	1996	42
	1997	35
	1998	61
	1999	45
	2000	48
	2001	62
	2003	NC
	2004	NC
31.4 (Wilderness boundary)	1996	0
	1997	NC
	1998	NC
	1999	0
	2000	NC
	2001	NC
	2003	29 (thermograph removed from stream on Aug 15, 2003)
	2004	35

[1] NC = Not collected.

Table 3-32. Comparison Between Existing Conditions and Supplemental Indicator Values for the East Fork Bitterroot River.

Parameter	Existing Condition	Target	
% Shade	31%	33	Year 5
		34	Year 10
		44	Year 15
		55	Late Seral

Habitat Alteration & Sediment

The 1997 stream assessments indicated that, in general, the physical habitat of the East Fork was slightly impaired; although periphyton communities did not appear to be significantly impacted by siltation resulting from these habitat impairments Recent macroinvertebrate data meet the proposed targets. However, the %<2 mm sediment target are not currently being met at all locations. Therefore a sediment[6] TMDL and restoration plan will be developed for the East Fork Bitterroot River as part of this WQRP.

[6] Sediment is used in this document to refer collectively to a group of related pollutants including sediment, siltation, suspended solids, and/or habitat alteration.

Thermal Modification

While the East Fork has never been listed for thermal modifications, the available temperature data suggest that at the lower two monitoring locations the East Fork typically warms to levels thought to impair to a cold-water fishery. The data also indicates that the proposed targets in this WQRP were surpassed on multiple occasions. Therefore a temperature TMDL and restoration plan will be developed for the East Fork Bitterroot River as part of this WQRP. However, at this time additional data is needed to adequately describe the temperature regime in the East Fork. Section 9.10 later in this document, outlines a proposed temperature monitoring strategy in the East Fork.

Flow Alteration

While flow alteration is not considered a pollutant, and not a required element of TMDL development, flow alterations are suspected to be the primary influence on temperature impairments in the East Fork Bitterroot River, particularly in the lower watershed where water is removed from the East Fork for irrigation on private land. Therefore a phased approach study is proposed in Section 9.9 that outlines a flow/hydrologic study in the East Fork drainage.

3.8.7 Gilbert and Laird Creeks

Laird Creek is a third order tributary of the East Fork of the Bitterroot River, and Gilbert Creek is a small tributary to Laird Creek. The Gilbert/Laird Creek Watershed is approximately 9.4 square miles is size, and 98% of lands within the watershed are controlled by the Bitterroot National Forest. The small amount of private land in the watershed is located along the lower mile of Laird Creek. The watershed contains nearly 50 miles of forest roads, and approximately 84% of the watershed burned in the fires of 2000.

3.8.7.1 Summary of 303(d) List

Gilbert Creek is a small tributary to Laird Creek, and the streams were on the Montana 303(d) list for the same reasons in all years. For these reasons, their impairment status is discussed jointly below.

The decision to list Gilbert and Laird Creeks appears to have been based primarily on information contained in the 1991 BNF Sensitive Watershed Analysis and the 1992 Moon Creek Environmental Assessment.

The 1996 Montana 303(d) list reported that Gilbert and Laird Creeks were only partially supporting their cold-water fishery and aquatic life beneficial uses. The impairments to Gilbert and Laird Creeks were thought to be caused by habitat alterations, suspended sediment, and siltation resulting from silviculture. In reviewing the 303(d) list in 2000 and 2002, Montana DEQ determined that the existing data were sufficient and credible for making a beneficial use determination and that the data indicated that the creeks were still only partially supporting their beneficial uses. Suspended solids was removed as a cause of impairment, and logging road construction/maintenance was added as a source. The 303(d) status of Gilbert and Laird Creeks is summarized in Table 3-33.

Table 3-33. 303(d) Status of Gilbert Creek: MT76H002_080 & Laird Creek: MT76H002_070.

Year	Use Support Status	Probable Impaired Uses	Probable Causes	Probable Sources
1996	Partial support	Aquatic life Cold water fishery Agriculture	Habitat alterations Siltation Suspended solids	Silviculture
2000/02	Partial support	Aquatic life Cold water fishery	Habitat alterations Siltation	Silviculture Logging road construction/ maintenance

A review of the available and relevant sediment data in Gilbert and Laird Creeks is provided in the sections below. This review includes all currently available target and indicator data, and Table 3-34 compares current data for target and indicator variable to proposed reference thresholds.

3.8.7.2 Sediment Target Data

As described in Section 3.3.1, sediment targets were developed to account for variability in stream response. It was determined that both Gilbert and Laird Creek's natural evolutionary classification stage contains a Rosgen B4 stream channel. Therefore, the target data summarized below is for a B4 channel type. Additionally, since Gilbert and laird Creeks closely resemble each other and one is a tributary to the other, thresholds were set the same for both streams by calculating an average of values.

% Fines--Wolman Pebble Counts < 2mm in Riffles

The Bitterroot National Forest collected pebble count data in Gilbert and Laird Creeks in July of 2003. The average percent fines values for less than 2 mm was 18%, within the target range.

% Fines--Wolman Pebble Counts < 6mm in Riffles

The Bitterroot National Forest collected pebble count data in Gilbert and Laird Creeks in July of 2003. The average percent fines values for less than 6 mm was 26%, within the target range.

D_{50}

The Bitterroot National Forest collected pebble count data in Gilbert and Laird Creeks in July of 2003. The average size class values for the D_{50} was 26 mm, falling within the target range.

Clinger Richness

No data have been collected.

3.8.7.3 Sediment Supplemental Indicator Data

Residual Pool Depth

The USFS conducted stream inventories in Gilbert and Laird Creeks in July of 2003 and again in Sept 2004. Average residual pool depth value was 0.7 feet, failing to meet the supplemental indicator threshold of at least 1.5 feet.

LWD

The BNF conducted large woody debris inventories in Gilbert and Laird Creeks in September 2004 and found 78 pieces/mile, meeting the indicator threshold of at least 50/mile.

Pool/Mile

The BNF conducted habitat inventories in Gilbert and Laird Creeks in September 2004 and found 69 pools/mile, meeting the indicator threshold of at least 60/mile.

Suspended Solids Concentrations

No data have been collected.

Turbidity

No data have been collected.

Mountain IBI

No data have been collected.

EPT Richness and Percent Clinger Taxa

No data have been collected.

Juvenile Trout Densities

Insufficient Data.

Human-Caused Sediment Sources

As described in greater detail in Section 4.0, roads and unstable stream banks were identified as potentially significant human caused sources of sediment in the Gilbert and Laird Ditch Creek watersheds.

Fish Passage Barriers

There is one culvert in the Laird/Gilbert Creek watershed that is thought to potentially impede fish passage, and that culvert is located on private land under Highway 93. It is scheduled for replacement with a fish passable structure when the Conner North/South reconstruction phase of Highway 93 is implemented. Another culvert on private land near first house just below the forest boundary was replaced by a private contractor in November 2002. Since then, some of the substrate has been flushed from the barrel, but the culvert is believed to still provide adequate fish passage. On the forest, there are four culverts on Laird Creek that could potentially affect fish movement (in order from the bottom of the stream to the top, they are Road 13325, Road 13323, Road 370, and Road 5715), and one culvert on Gilbert Creek (Road 370). All but the Road 13325 and 13323 culverts were replaced with new stream simulation culverts following the 2000 fires. The Road 13325 and 13323 culverts were not replaced following the fires of 2000 because they were fish passable. Monitoring of the five fish culverts on Forest Service land in the Laird/Gilbert Creek watershed indicates that fish passage is being adequately maintained at all sites. BNF recommended that the fish culverts on the forest continue to be monitored in the future to ensure that adequate fish passage is maintained.

3.8.7.4 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

Sediment & Habitat

The Laird/Gilbert Creek Watersheds were heavily impacted by the fires of 2000. Fifty percent of the fish-bearing stream miles of the Laird Creek watershed were burned at a moderate to high severity level, and the watershed is considered by the USFS to be at a high risk of mass wasting (USFS, 2000). As mentioned above, several post fire mudslides have occurred in the watershed.

The Laird Creek watershed was evaluated in the 1991 BNF Sensitive Watershed Analysis (Decker et al., 1991). Although not stated so explicitly in the analysis, it is assumed here that Gilbert Creek was included in the analysis as part of the greater Laird Creek Watershed. Decker determined that in the Laird Creek Watershed there were 49.0 miles of forest roads and 65 stream crossings, resulting in a road density of approximately 5.2 and a crossing density of 6.9. At the time, 28% of the watershed appeared from air photos to have been impacted by timber harvest. Soils in the watershed were determined to be predominately a mix of highly erodible weathered granitics and relatively stable hard granitics. For these reasons, Decker classified the Laird Creek watershed as having a high risk of increased sediment and/or water yield from further timber harvest or road construction and indicated that watershed rehabilitation is a high priority.

As part of the 1992 Moon Creek Environmental Assessment, the Bitterroot NF conducted WATSED modeling to estimate the impacts of timber harvest and road construction on water and sediment yields in Gilbert and Laird Creeks. The modeling estimated that at the time of the

EA, water yields in the Gilbert Creek Watershed were elevated 10% over natural. In the larger Laird Creek watershed, water yield was estimated to be 13% over natural, with peak flows 8% higher than the pre-disturbance condition and runoff accelerated by 1 to 2 weeks. Sediment yield in Gilbert Creek was estimated to be 153% over the natural rate of 20 tons/year. In Laird Creek the sediment yield was estimated to be 122% over the natural rate of 58 tons/year.

In general, the effects of the increased water and sediment yield appeared at the time to have been significant; as summarized in the EA:

1. All of Gilbert Creek except the south tributary is experiencing channel adjustments in response to increased sediment supply and water yields from the past activities within the watershed. These channel adjustments appear to be ongoing and the affected stream reaches are considered to be out of balance or in a state of disequilibrium. This means that if a high frequency flood event would occur, there is a high probability that the stream would experience major channel changes that would be unusual for an otherwise stable A2 stream.

2. Laird Creek and its tributaries above 6000 feet in elevation appear to be stable and healthy even though limited timber harvest and road construction have occurred. These A2 and A2a streams appear to have recovered completely from any effects the activities might have had. Below 6000 feet, the effects of past management are more visible. Upstream of the Moon Creek confluence, Laird Creek has heavy sediment deposition and many debris jams that have adversely affected the channel stability and configuration (width/depth ratio). The reach of Laird Creek from about 5200 feet down to about 4800 feet is considered out of equilibrium and is extremely sensitive to increases in sediment supply or stream flow. Like Gilbert Creek, this stream reach would be at high risk of experiencing an equilibrium shift if the event of a flood.

The Moon Creek EA and the 1991 study by Decker appear to have been the primary sources of information upon which the 1996 listing of Gilbert and Laird Creeks was based, and thus a review of these documents has been included here. However the data are more than a decade old and may no longer accurately reflect conditions in the watershed.

The fires of 2000 had a significant effect on sediment loads in Gilbert and Laird Creeks. According to the Bitterroot National Forest:

> *On July 20-21, 2001, several intense thunderstorms triggered flash floods and a dozen large mudslides along the lower 2.5 miles of Laird Creek…. Eleven large mudslides occurred on the north slopes of Laird Creek; one small mudslide occurred on the south slope. These mudslides deposited large fans of ash, silt, sand and assorted debris in Laird Creek. Post-mudslide electro shocking surveys indicate that the majority of the bull trout, brook trout, and westslope cutthroat trout in the lower 2.5 miles of Laird Creek were killed by the mudslides and flashfloods. …. Westslope cutthroat trout were … found in good numbers in Gilbert Creek and upper Laird Creek above the affected area … Fish habitat in Laird Creek was simplified by the mudslides. Areas of abundant woody debris and pools prior to the mudslides are now shallow, unstable, aggraded riffles with most of the woody debris pushed high up onto the banks. Since the mudslides, Laird Creek has*

been actively down cutting through the gravel deposits and forming a new channel. Gilbert Creek had visible san deposition in its stream bottom, but vegetation was intact along its banks, and woody debris was stable in its channel (USFS, 2001a).

The Bitterroot National Forest monitored Gilbert and Laird Creeks extensively in 2001- 2004, and monitoring has revealed a quick recovery of the fishery in these streams. The forest plans to continue monitoring in 2005 (Jakober pers. com., 2004).

In its post-burn EIS (USFS, 2001a), the Bitterroot National Forest identified 4 factors that may impact support of aquatic life and cold-water fishery beneficial uses in the Gilbert/Laird Creek Watershed (USFS, 2001a). These data may no longer reflect current conditions, as many of post fire impacts have since been addressed:

1. Sediment levels are "functioning at unacceptable risk" because of roads, past harvest, the 2000 fires, and the July 2001 mudslides.
2. Channel aggradation, instability, turbidity, and poor habitat complexity throughout the lower 2.5 miles of Laird Creek as a result of the July 2001 mudslides.
3. Riparian timber harvest (partial canopy removal) along portions of the headwaters tributaries.
4. Subdivision in the riparian area on private land.

3.8.7.5 Current WQ Impairment Summary

Table 3-34 below compares existing sediment data with the proposed target and indicator values in Laird & Gilbert Creeks. Target and indicator development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

Table 3-34. Existing Conditions and Water Quality Indicators for Laird and Gilbert Creeks.

Targets			
Rosgen Stream Type	**Parameter**	**Existing Condition**	**Proposed Thresholds**
B4	% Fines < 2 mm (data collected in riffles)	18%[1]	Mean: 19%; Range: 11-27%
	% Fines < 6 mm (data collected in riffles)	26%[1]	Mean: 27%; Range: 16-38%
	D_{50} (data collected in riffles)	26mm[1]	7-64 mm
All	Clinger Richness	Unknown	$\geq$14
Supplemental Indicators			
All	Mountain IBI	Unknown	>75%
	% Clinger Taxa	Unknown	High
	EPT Richness	Unknown	$\geq$22
	Pools/mile	69	60
	LWD/mile	78	50
	Residual Pool Depth	0.7 feet[2]	1.5 feet
	Suspended Solids Concentration	Unknown	Comparable to reference
	Turbidity	Unknown	High flow – $\leq$ 50 NTU instantaneous maximum Summer base flow – $\leq$ 10 NTU

Table 3-34. Existing Conditions and Water Quality Indicators for Laird and Gilbert Creeks.

Targets			
Rosgen Stream Type	**Parameter**	**Existing Condition**	**Proposed Thresholds**
	Juvenile bull trout & westslope cutthroat trout densities.	See Appendix I	Documented increasing or stable trend.
	Human Caused Sediment Sources	Roads, Unstable stream banks	No preventable sources
	Fish Passage Barriers	1 barrier identified.	No barriers except to protect native salmonid genetics.

[1] Based on the average of three sites.
[2] Based on the average of two sites.
See Section 3.3 for an explanation of target development.

Habitat Alterations & Sediment

Although most of the target and indicator variables for which current data exist are within expected reference ranges, no macroinvertebrate data are available with which to evaluate aquatic life beneficial use support and some human-caused sediment sources exist in the watershed. Therefore a sediment[7] TMDL and restoration plan will be developed for Laird and Gilbert Creeks as part of this WQRP.

3.8.8 Hughes Creek

Hughes Creek is a 59.5 square mile watershed that is developed in the lower portions of the watershed yet contains a large percentage of undeveloped lands higher in the drainage. According to the BNF's post fire EIS, much of the main stem, valley bottom lands along the stream channel are under private ownership, and historic placer mining and dredge mining along the stream have been major direct sources of sediment and have altered channel conditions. Currently, most of the mined areas are on a recovering trend on both private and National Forest lands. Above Mine Creek, a major tributary to Hughes Creek, some mining is currently ongoing on private land. Irrigation withdrawals occur in the lower main stem, which may affect the streams ability to carry sediment during low flow and result in more sediment deposition that would be present if sufficient stream energy were available.

With the exception of a few scattered mines that are still active on private land, the majority of the area affected by mining has stabilized and does not appear to be an active source of sediment. Mining on private land still occurs upstream of Mine Creek. This mining activity has dramatically altered the Hughes Creek stream channel, reduced bull trout and westslope cutthroat trout habitat and carrying capacity, and increased sediment inputs to downstream Bitterroot NF reaches. In 1998, the Bitterroot NF restored a 0.25 mile-long reach of the Hughes Creek stream channel upstream of Mine Creek. Prior to reclamation, this reach looked similar to the mined areas that occur on private land. Recovery is still ongoing, particularly the riparian vegetation,

[7] Sediment is used in this document to refer collectively to a group of related pollutants including sediment, siltation, suspended solids, and/or habitat alteration.

but bull trout and westslope cutthroat trout numbers and habitat have responded favorably to the reclamation (USFS, 2001a).

3.8.8.1 Summary of 303(d) List

The decision to list Hughes Creek appears to have been based primarily on qualitative evidence of localized mining impacts.

The 1996 Montana 303(d) list reported that Hughes Creek only partially supported its cold-water fishery, aquatic life, and agriculture beneficial uses. The impairments to Hughes Creek were thought to be caused by habitat alterations, siltation, suspended solids, and thermal modifications resulting from dredge mining and resource extraction. In reviewing the 303(d) list in 2000 and 2002, Montana DEQ determined that the existing data were sufficient and credible for making a beneficial use determination and that the data indicated that Hughes Creek was still not supporting its cold water fishery and aquatic life beneficial uses, but that the agricultural beneficial uses were now fully supported. The list of impairment causes was reduced to habitat alterations, and the sources of impairment were changed to abandoned mining, channelization, and placer mining. The 303(d) status of Hughes Creek is summarized in Table 3-35.

Table 3-35. 303(d) Status of Hughes Creek: MT76H003_040.

Year	Use Support Status	Probable Impaired Uses	Probable Causes	Probable Sources
1996	Partial support	Aquatic life Cold water fishery Agriculture	Habitat alterations, Siltation, Suspended solids, Thermal modification	Dredge mining Resource extraction
2000/02	Non support	Aquatic life Cold water fishery	Habitat alterations	Abandoned mining Channelization Placer mining

A review of the available and relevant sediment data in Hughes Creek is provided in the sections below. This review includes all currently available target and indicator data, and Table 3-37 compares current data for target and indicator variable to proposed reference thresholds.

3.8.8.2 Sediment Target Data

As described in Section 3.3.1, sediment targets were developed to account for variability in stream response. It was determined that Hughes Creek's natural evolutionary classification stage contains both Rosgen B4 (in the upper reach) and C4 (in the lower reach) stream channels. Therefore, the core indicator data summarized below is for B4 and C4 channel types.

% Fines--Wolman Pebble Counts < 2mm in Riffles

The Bitterroot National Forest collected pebble count data in Hughes Creek in July of 2003. The average percent fines values for less than 2 mm in the B4 channel reach was 10% and in the C4 channel reach it was 7.5%. Both are slightly below the expected reference range, indicating that excessive fine sediment in probably not a problem in these reaches of Hughes Creek. The extent to which placer mining is responsible for the apparent reduction in fine sediment is unknown.

% Fines--Wolman Pebble Counts < 6mm in Riffles

The Bitterroot National Forest collected pebble count data in Hughes Creek in July of 2003. The average percent fines values for less than 6 mm in the B4 channel reach was s 10% and in the C4 channel reach it was 8%, which also met the threshold. Both are slightly below the expected reference range, indicating that excessive fine sediment in probably not a problem in these reaches of Hughes Creek. The extent to which placer mining is responsible for the apparent reduction in fine sediment is unknown.

D_{50}

The Bitterroot National Forest collected pebble count data in Hughes Creek in July of 2003. The average size class values for the D_{50} in the B4 channel reach was 63 mm, which was outside of the target range. The average size class values for the D_{50} in the C4 channel reach was 55 mm, which was also outside of the target range. The higher than expected D_{50}s resulted, at least in part, from unusually low levels of fine sediment, which may represent, in part, a coarsening of the substrate as a result of mining.

Clinger Richness

No data have been collected.

3.8.8.3 Sediment Supplemental Indicator Data

Residual Pool Depth

The USFS conducted stream inventories in Hughes Creek in July of 2003. Average residual pool depth value in the B4 channel reach was 1.8 feet and in the C4 channel reach it was 1.5 feet, meeting the indicator threshold in both cases.

LWD

The USFS conducted large woody debris inventories in Hughes Creek in July 1999. The total number of pieces inventoried in Hughes Creek was 25 pieces per mile. This value does not meet the supplemental indicator value of at least 50 pieces per mile.

Pool/Mile

The USFS conducted habitat inventories in Hughes Creek in July 1999 and 2004. Pool/mile values for Hughes Creek were recorded as 29 in both inventories, which meets the supplemental indicator threshold of 23 pools/mile.

Suspended Solids Concentrations

No data have been collected.

Turbidity

No data have been collected.

Mountain IBI

No data have been collected.

EPT Richness and Percent Clinger Taxa

No data have been collected.

Juvenile Trout Densities

Insufficient Data.

Human-Caused Sediment Sources

As described in greater detail in Section 4.0, forest roads and unstable stream banks (mostly from mining) were identified as potentially significant human caused sources of sediment in the Hughes Creek watershed, and historic place mining has altered the morphology of the channel is several reaches.

Fish Passage Barriers

There are five culverts in the Hughes Creek watershed that are known to block or impede fish passage. Four are located on the Bitterroot National Forest; one is located on private land in lower Taylor Creek. From lowest to highest in the watershed, they are: (1) Malloy Gulch, Road 104-D; (2) Mill Gulch, Road 104-D; (3) Taylor Creek, private road near mouth; (4) Taylor Creek, Road 104-D, and (5) Mine Creek, Road 5688 (only USFS culvert). The one barrier culvert on the Bitterroot National Forest will be replaced as funding allows. Replacement of the Road 104-D culverts will require cooperation with the county, as 104-D is a county road. BNF also recommended that efforts be made to work with the private landowner to replace the barrier culvert on private land in lower Taylor Creek. The rest of the culverts in the Hughes Creek watershed do not affect fish.

3.8.8.4 Temperature Target Data

In Stream Temperature

Montana Fish, Wildlife and Parks (FWP) have been collecting in-stream temperature data in the BHTPA for several years. There are two sites in Hughes Creek. The summary of data below suggests that temperature values in Hughes Creek exceed the proposed target values (Table 3-36).

Table 3-36. Hughes Creek Temperatures, 1998-2003.

Mile Marker	Year	7-Day Average Maximum in Degrees Celsius & Fahrenheit
1.4	1998	18.5 C / 65.3 F
	2003	15.8 C / 60.4 F
9.0	1998	NC[1]
	2003	16.2 C / 61.1 F

[1] NC = Not Collected

3.8.8.5 Temperature Supplemental Indicator Data

MDEQ and Land and Water Consulting conducted a potential stream shade analysis in 2003. This analysis is further described in Section 5.0. The existing potential shade in Hughes Creek is 55%, indicating that it does not currently meet its potential.

3.8.8.6 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

Habitat & Sediment

Approximately 4% of the watershed burned at a high severity level and another 8% burned at a low severity level. As a result, water yields are expected in increase by less than 1% (USFS, 2001a).

The BNF Sensitive Watershed Analysis (Decker et al., 1991) determined that in Hughes Creek Watershed there were 65 miles of forest roads and 137 stream crossings, resulting in a road density of 1.1 mi/mi^2 and a crossing density of 2.3 mi/mi^2. At the time, 12% of the watershed appeared from air photos to have been impacted by timber harvest. Soils in the watershed were determined to be a mix of highly erodible weathered granitics and volcanics and low erosion quartzites and hard granitics. For these reasons, Decker classified the Hughes Creek watershed as "apparently healthy with low road densities, a small percentage of timber harvest and few other impacts such as roads in riparian areas.

In its post-burn EIS, the Bitterroot National Forest identified 6 factors that may impact support of aquatic life and cold-water fishery beneficial uses in the Hughes Creek Watershed (USFS, 2001a). These data may no longer reflect current conditions, as many of post fire impacts have since been addressed:

1. Road 104-D encroaches on the lower ten miles of Hughes Creek's floodplain; this increases the potential for road sediment inputs.
2. A substantial reduction in fish habitat complexity along several miles of Hughes Creek that has been dredge mined for several decades (on private land upstream of Mine

Creek). However, in 1998, 0.25 miles on channel on FS system lands was re-structured to add features and sinuosity and trees were planted.

3. Riparian timber harvest (partial canopy removal) along portions of the headwaters tributaries.
4. The road 104-d culvert on Taylor Creek is a complete fish barrier.
5. The road 104-d culverts on Mill Gulch and Malloy Gulch are partial fish barriers.
6. The lower mile of the Taylor Creek stream channel has been straightened and simplified (lacks woody debris) because of past mining activity.

3.8.8.7 Current WQ Impairment Summary

Tables 3-37, 3-38 and 3-39 below compare existing sediment, temperature and shade data with the proposed target and supplemental indicator values in Hughes Creek. Target and indicator development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

Table 3-37. Existing Conditions and Water Quality Targets and Indicators for Hughes Creek.

Targets			
Rosgen Stream Type	**Parameter**	**Existing Condition**	**Proposed Thresholds**
C4	% Fines < 2 mm (data collected in riffles)	7.5%[1]	Mean: 23%; Range: 14-32%
	% Fines < 6 mm (data collected in riffles)	8%[1]	Mean: 33%; Range: 17-49%
	D_{50} (data collected in riffles)	55 mm[1]	3-47 mm
B4	% Fines < 2 mm (data collected in riffles)	10	Mean: 19%; Range: 11-27%
	% Fines < 6 mm (data collected in riffles)	10	Mean: 27%; Range: 16-38%
	D_{50} (data collected in riffles)	63mm	7-64 mm
All	Clinger Richness	Unknown	≥14
Supplemental Indicators			
All	Mountain IBI	Unknown	>75%
	% Clinger Taxa	Unknown	High
	EPT Richness	Unknown	≥ 22
	Pools/mile	29	23
	LWD/mile	25	50
	Residual Pool Depth	1.5 feet in C4 reaches[1] 1.8 feet in B4 reach	1.5 feet
	Suspended Solids Concentration	Unknown	Comparable to reference
	Turbidity	Unknown	High flow – ≤ 50 NTU instantaneous maximum Summer base flow – ≤ 10 NTU
	Juvenile bull trout & westslope cutthroat trout densities.	See Appendix I	Documented increasing or stable trend.
	Human Caused Sediment Sources	Roads and Unstable stream banks	No preventable sources
	Fish Passage Barriers	5 identified barriers.	No barriers except to protect native salmonid genetics.

[1] Based on the average of two sites.
See Section 3.3 for an explanation of target development.

Table 3-38. Number of Days Temperature Target was Exceeded in Hughes Creek.

Mile Marker	Year	Days > 15 degrees C and 59 degrees F
1.4	1998	85
	2003	NC[1]
9.0	1998	76
	2003	37

[1] NC = Not Collected

Table 3-39. Comparison Between Existing Shade Conditions and Supplemental Indicator Values for Hughes Creek.

Parameter	Existing Condition	Threshold	
% Shade	55%	56%	Year 5
		58%	Year 10
		65%	Year 15
		78%	Late Seral

[1] Number shown is the max 7-day average for 2003.

Habitat Alteration & Sediment

The data reviewed above provide evidence that mining impacts have significantly impacted the physical habitat of Hughes Creek, and that these impacts have altered sediment loading to the creek. However, sediment targets (%<2, %<6, and D_{50}) all indicate an apparent coarsening of the stream substrate and a potentially depressed level of fine sediments, probably as a result of mining in the channel. Active mining continues to occur on private land in the middle reaches of Hughes Creek, but impacts from this mining appear to be localized.

Nevertheless, no current macroinvertebrate data are available with which to evaluate aquatic life beneficial use support, and the road network remains a potentially significant source of sediment to the streams. Therefore a sediment[8] TMDL and restoration plan will be developed for Hughes Creek as part of this WQRP.

Thermal Modification

Based on the review off all available data, there is strong evidence to support temperature impairment in Hughes Creek. Therefore a temperature TMDL and restoration plan will be developed for Hughes Creek as part of this WQRP.

3.8.9 Moose Creek

Moose Creek is a third order tributary to the East Fork of the Bitterroot River. The Moose Creek Watershed is approximately 25 square miles in size, and the Bitterroot National Forest manages 98% of lands within the watershed. A small amount of private land associated with a mining claim is located in the headwaters. Few significant impacts are known to exist, and the Bitterroot National Forest considers Moose Creek a reference watershed. The fires of 2000 affected approximately 8% of the watershed.

[8] Sediment is used in this document to refer collectively to a group of related pollutants including sediment, siltation, suspended solids, and/or habitat alteration.

3.8.9.1 Summary of 303(d) List

The decision to list Moose Creek in 1996 as threatened by agricultural sources appears to have resulted from a 1977 FWP assessment in MDEQ's files that noted irrigation runoff and domestic stock as sources of "man-caused pollution"; although no irrigation or livestock uses are known to exist in the watershed, and no additional details were provided in the report. The listing status of the stream was changed in 2000 based primarily on USFS nutrient data from the 1970s that indicated potentially elevated levels of nitrogen and phosphorous. The siltation listing in 2000 appears to be based on macroinvertebrate community analysis that revealed a potentially elevated number of sediment-tolerant organisms.

The 1996 Montana 303(d) list reported that Moose Creek was threatened for support of its cold-water fishery beneficial use. The threat to Moose Creek was thought to result from siltation caused by agriculture, irrigated crop production, and rangeland. In reviewing the 303(d) list in 2000 and 2002, Montana DEQ determined the existing data were sufficient and credible for making a beneficial use determination, and that these data indicated that Moose Creek only partially supported both its cold water fishery and its aquatic life beneficial uses. Impairment of Moose Creek was thought to result from nutrients and siltation from unknown sources. The 303(d) status of Moose Creek is summarized in Table 3-40.

Table 3-40. 303(d) Status of Moose Creek: MT76H002_040.

Year	Use Support Status	Probable Impaired Uses	Probable Causes	Probable Sources
1996	Threatened	Cold water fishery	Siltation	Agriculture, Irrigated crop production, Range land
2000/02	Partial support	Aquatic life Cold water fishery	Nutrients Siltation	Unknown

A review of the available and relevant sediment data in Moose Creek is provided in the sections below. This review includes all currently available target and indicator data, and Table 3-43 compares current data for target and indicator variable to proposed reference thresholds.

3.8.9.2 Sediment Target Data

As described in Section 3.3.1, sediment targets were developed to account for variability in stream response. It was determined that Moose Creek's natural evolutionary classification stage contains a Rosgen B3 stream channel. Therefore, the target data summarized below is for B3 channel types.

% Fines--Wolman Pebble Counts < 2mm in Riffles

The Bitterroot National Forest collected pebble count data in Moose Creek in September of 2003. The average percent fines values for less than 2 mm was 10.5%, within the target range.

% Fines--Wolman Pebble Counts < 6mm in Riffles

The Bitterroot National Forest collected pebble count data in Moose Creek in September of 2003. The average percent fines values for less than 6 mm was 10.5%, within the target range.

D_{50}

The Bitterroot National Forest collected pebble count data in Moose Creek in September of 2003. The average size class values for the D_{50} in the B3 channel reach was 96.5 mm, within the target range.

Clinger Richness

Macroinvertebrate samples were collected in 2001 and 1995. The clinger richness was 14 and 18, respectively, meeting the target of at least 14.

3.8.9.3 Sediment Supplemental Indicator Data

Residual Pool Depth

The USFS conducted stream inventories in Moose Creek in September of 2003 and 2004. Average residual pool depth value was 1.8 feet in both years, indicating that the supplemental indicator threshold of at least 1.5 feet has been met.

LWD

The BNF conducted a LWD count in Moose Creek in September 2004 and found 60 pieces/mile, meeting the indicator threshold of at least 50/mile.

Pool/Mile

The BNF conducted a pool count in Moose Creek in September 2004 and found 16 pools/mile, falling below the indicator threshold of at least 23/mile.

Suspended Solids Concentrations

No date has been collected.

Suspended Solids Concentrations

No date has been collected.

Turbidity

No date has been collected.

Mountain IBI

Montana DEQ collected macroinvertebrate samples in Moose Creek near the forest boundary in 2001. The Mountain IBI score was 33%, failing to meet the supplemental indicator threshold of greater than 75%. However conclusions about the low IBI score suggest a potential metals problem due to a specific midge bloom that skewed the taxa results.

EPT Richness and Percent Clinger Taxa

EPT richness was 16 in 200l, failing to meet the supplemental indicator threshold of at least 22. No recent data were available for percent clinger taxa, but in 1995 it was 65%.

Juvenile Trout Densities

Insufficient Data.

Human-Caused Sediment Sources

As described in greater detail in Section 4.0, forest roads and unstable stream banks were identified as potentially significant human caused sources of sediment in the Moose Creek watershed.

Fish Passage Barriers

There are five culverts in the Moose Creek watershed that are known to block or impede fish passage. From lowest to highest in the watershed, they are: (1) Moose Creek, Road 726; (2) Lick Creek, Road 432; (3) Lick Creek, Road 5771; (4) Reynolds Creek, Road 432 is a bridge project scheduled for 2005; and (5) Sign Creek, Road 432. The Road 726 culvert on Moose Creek was proposed for replacement as a bridge in the Burned Area Recovery FEIS, and survey and design has been completed. When funding becomes available, the Forest plans on removing the FDR 726 culvert on Moose Creek and replacing it with a new bridge. This is likely to occur in the next couple of years. BNF recommended that the forest replace the other four barrier culverts on Lick, Reynolds, and Sign creeks (tributaries to Moose Creek), pending funding.

3.8.9.4 Nutrient Target Data

Total phosphorous, total nitrogen, and nitrate/nitrite nitrogen samples were collected by the USGS periodically from 2001 to 2003. The median TP concentration in this period was 0.016 mg/L. The median TN concentration was 0.17 mg/L. The median $NO_{2/3}$ is difficult to determine because of the preponderance of samples that were below the analytical detection limit; an approximate median of 0.013 mg/L is assumed based on the available data, which is probably an overestimate (Table 3-41 and 3-44).

The median total nitrogen and $NO_{2/3}$ concentrations were below target thresholds. The median total phosphorous concentration was below the VNRP target, but was slightly above USEPA guidelines (Table 3-41and 3-44).

Table 3-41. USGS Nutrient Data from Moose Creek (Station 455550113432001).

Date	Total Nitrogen Ammonia + Organic (mg/L as N)	Dissolved $NO_2 + NO_3$ (mg/L as N)	Dissolved Nitrogen, Nitrite (mg/L as N)	Dissolved Ortho-phosphorous (mg/L as P)	Total Phosphorous (mg/L as P)	Discharge (cfs)
3/22/01	E0.07	0.006	<0.001	E0.005	0.017	7.3
4/27/01	0.27	0.008	0.002	<0.007	0.021	24
5/16/01	0.19	<0.005	<0.001	<0.007	0.019	123
10/30/01	E0.06	<0.013	<0.002	E0.005	0.011	7.7
4/17/02	0.17	0.027	<0.002	E0.004	0.011	14
6/3/02	0.17	<0.013	<0.002	<0.007	0.016	136
6/25/02	0.11	<0.013	<0.002	E0.004	0.012	72
9/4/02	0.13	<0.013	<0.002	E0.006	0.012	8
4/24/03	0.26	0.053	E0.002	0.004	0.021	43

E = Estimated

No current benthic chlorophyll a data were available.

3.8.9.5 Nutrient Supplemental Indicator Data

The Mountain IBI was 33% in 2001, failing to meet the supplemental indicator threshold of at least 75%. No data were available for the remaining nutrient supplemental indicators.

3.8.9.6 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

Sediment

The BNF Sensitive Watershed Analysis (Decker et al., 1991) determined that in the Moose Creek Watershed there were 17 miles of forest roads and 20 stream crossings, resulting in a road density of 0.7 miles/mile^2 and a crossing density of 0.8 per square mile. At the time, 5% of the watershed appeared from air photos to have been impacted by timber harvest. Soils in the watershed were determined to be a mix of highly erodible weathered granitics and low erosion hard granitics. For these reasons, Decker classified the Moose Creek watershed as “apparently healthy with low road densities, a small percentage of timber harvest and few other impacts such as roads in riparian areas.”

Macroinvertebrates

In addition to the samples discussed in the target review, macroinvertebrate samples were collected and analyzed as part of the USFS Aquatic Ecosystem Inventory in the mid to late-1980s. The analysis was based on multiple factors including 1) the Diversity Index (DAT), which "combines a measure of dominance and number of taxa"; 2) the Standing Crop (SC) expressed in gm/m^2; and the Biotic Condition Index (BCI) "which indicates as a percentage how close an aquatic ecosystem is to its own potential." In general, the macroinvertebrates in Moose Creek were indicative of good water quality, but the presence of sediment and organic tolerant organisms provided a warning sign that some degradation had occurred Although there was considerable variability in metric scores over the four years, the average scores were rated as good for SC and excellent for DAT and BCI. The 3 years of 100 BCI indicated that the biotic community of Moose Creek was at its potential (Mangum, 1989). Results of the macroinvertebrate analysis in the 1980s are presented in Table 3-42. The exact locations of sampling sites were not provided in the reports from which these data were taken.

Table 3-42. Macroinvertebrate Results from Moose Creek in the 1980s.

Date	Location	DAT	Rating	SC	Rating	BCI	Rating
9/21/88	1E	16.5	Good	1.9	Good	93	Excellent
9/01/87	1E	15.2	Good	1.7	Good	100	Excellent
9/23/86	1E	19.0	Excellent	0.9	Fair	100	Excellent
10/02/85	1	22.2	Excellent	4.7	Excellent	100	Excellent
Average	**All**	**18.2**	**Excellent**	**2.3**	**Good**	**98.2**	**Excellent**

3.8.9.7 Current WQ Impairment Summary

Tables 3-43 and 3-44 below compare existing sediment and nutrient data with the proposed target and indicator values in Moose Creek. Target and Indicator development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

Table 3-43. Existing Conditions and Sediment Water Quality Target and Supplemental Indicators for Moose Creek.

Targets			
Rosgen Stream Type	**Parameter**	**Existing Condition**	**Proposed Thresholds**
B3	% Fines < 2 mm (data collected in riffles)	10.5%[1]	Mean: 12%; Range: 5-19%
	% Fines < 6 mm (data collected in riffles)	10.5%[1]	Mean: 16%; Range 7-25%
	D_{50} (data collected in riffles)	96.5mm[1]	64-256 mm
	Clinger Richness	18	≥14
Supplemental Indicators			
B3	Mountain IBI	33%	>75%
	% Clinger Taxa	65%	High
	EPT Richness	15	≥ 22
	Pools/mile	16	23
	LWD/mile	60	50
	Residual Pool Depth	1.8[2]	1.5 feet
	Suspended Solids Concentration	Unknown	Comparable to reference
	Turbidity	Unknown	High flow – ≤ 50 NTU instantaneous maximum Summer base flow – ≤ 10 NTU
	Juvenile bull trout & westslope cutthroat trout densities.	See Appendix I	Documented increasing or stable trend.
	Human Caused Sediment Sources	Roads, Unstable Stream Banks	No preventable sources
	Fish Passage Barriers	5 barriers identified.	No barriers except to protect native salmonid genetics.

[1] Based on the average value from two locations.
[2] Data available from only one of two locations (mile 4.1)
See Section 3.3 for an explanation of target development.

Table 3-44. Existing Conditions and Nutrient Water Quality Targets and Supplemental Indicators for the Bitterroot Headwaters TPA.

Targets	Threshold	Existing Condition
Benthic Chlorophyll-*a* (P25)	< 33 mg/m^2	NA
USEPA Ecoregion II, Total Phosphorus (P25)	< 0.01 mg/L	0.016 mg/L
USEPA Ecoregion II, Nitrate+Nitrite (NO_2/NO_3) (P25)	< 0.014 mg/L	0.013 mg/L
Clark Fork Total Phosphorous Guidelines	< 0.04 mg/L	0.016 mg/L
Clark Fork Total Nitrogen	< 0.3 mg/L	0.17 mg/L
Supplemental Indicators	**Threshold**	
Montana Mountain Macroinvertebrate Index of Biological Integrity	> 75%	33%
Dissolved Oxygen, 7-Day Mean	> 9.5 mg/L	NA
Dissolved Oxygen, 1-Day Minimum	> 8.0 mg/L	NA
USEPA Ecoregion II, Chlorophyll-*a*, Water Column (P25)	< 1.08 µg/L	NA

Sediment

In a memo to MDEQ in which he commented on the 2000 303(d) list, BNF supervisor Rodd Richardson stated, “[Moose Creek] is in the headwaters of the East Fork Bitterroot River. This stream lies primarily in an inventoried roadless area. With the exception of the lower 3 miles, from the mouth to the end of road #432, and a small defunct mine of the extreme watershed divide, the watershed is completely natural and undisturbed. In fact, we have a long term monitoring station at the trailhead (end of road) that we use as reference stream for an undisturbed watershed with its particular geologic characteristics. Our studies, assessments and data from Forest Service hydrologists as well as Forest Service and FWP fisheries biologists indicate that this stream is a healthy, functioning stream that is fully supporting cold water aquatic life down to its mouth” (R. Richardson memo, June 2000).

In an interview for this report, Marilyn Wildey and Mike Jakober from the USFS expressed their surprise that Moose Creek would be considered impaired. They were aware of no agricultural impacts along Moose Creek and stated that Moose Creek supported a reference condition fishery, even in its lower-most reaches. Furthermore, Moose Creek is minimally impacted by human activities with low road densities and little recent timber harvest, and is considered a reference watershed by the Bitterroot National Forest.

All proposed sediment targets were met in Moose Creek. Additionally, there are very few, if any, anthropogenic sources of impacts in Moose Creek. Therefore, no TMDL has been developed for this drainage. However, the mountain IBI score of 33% in 2001 is unusually low for a stream with few anthropogenic impacts. In response, additional monitoring is proposed to ensure water quality standards are maintained.

Nutrients

Recent USGS nutrient data (reviewed above) suggest that nutrient levels in Moose Creek do not impair or threaten beneficial uses. Although the median total phosphorous concentration exceeded the USEPA guidelines slightly, it was well below the VNRP target. With few if any plausible anthropogenic nutrient sources in Moose Creek, nutrient concentrations are most likely the result of natural processes. For these reasons, no TMDL has been developed for Moose Creek. As a margin of safety, nutrient monitoring has been included in the monitoring plan described in Section 9.0.

3.8.10 West Fork

The West Fork watershed is approximately 360,000 acres in size, and nearly 97 percent of lands within the watershed are managed by the Bitterroot National Forest. Most of the remaining lands are in private ownership, with private lands concentrations in the floodplain of the river. The West Fork of the Bitterroot River begins at an elevation of approximately 6,500 feet along the Montana/Idaho divide in the Bitterroot Mountains, and flows generally north to Conner, Montana, near which it joins the East Fork of the Bitterroot River to form the mainstem of the Bitterroot. The watershed was heavily impacted by the fires of 2000, with over 13 percent of lands in the watershed burned to some degree.

3.8.10.1 Summary of 303(d) List

There is a reference in MDEQ's files to a 1988 non-point source assessment that listed the West Fork as moderately impaired by sediment from silviculture and placer mining. A 1985 Montana Interagency Stream Fishery Data report noted temperature, turbidity, excessive siltation, logging practices, overuse by stock, and irrigation withdrawals as factors affecting the fishery. Above Painted Rocks the interagency report attributed excess sediment to mining and logging practices. The report stated explicitly that dewatering is the cause of the temperature problems; however no data were provided in support of this conclusion. The report also noted that the habitat trend was deteriorating. These two reports appear to have been the basis for the decision to list the West Fork in 1996.

The 1996 Montana 303(d) list reported that the West Fork of the Bitterroot River only partially supported its cold-water fishery and aquatic life beneficial use. The impairments to the West Fork were thought to be caused by flow alterations, noxious aquatic plants, habitat alterations, and thermal modifications resulting from dredge mining and resource extraction. In reviewing the 303(d) list in 2000 and 2002, Montana DEQ determined that the existing data were sufficient and credible for making a beneficial use determination and that the data indicated that the West Fork was still only partially supporting its aquatic life and cold water fishery beneficial uses. Causes of impairment were revised to habitat alterations and siltation, and the sources of impairment were changed to bridge construction, bank or shoreline modification/destabilization, and highway/road/bridge runoff. The 303(d) status of the West Fork is summarized in Table 3-45.

Table 3-45. 303(d) Status of West Fork Bitterroot River: MT76H003_010.

Year	Use Support Status	Probable Impaired Uses	Probable Causes	Probable Sources
1996	Partial support	Aquatic life Cold water fishery	Flow alteration Noxious aquatic plants Habitat alterations Thermal modifications	Dredge mining Resource extraction
2000/02	Partial support	Aquatic life Cold water fishery	Habitat alterations Siltation	Bridge construction Bank or shoreline modification/ Destabilization Highway/road/ Bridge runoff

A review of the available and relevant sediment data in the West Fork is provided in the sections below. This review includes all currently available target and indicator data, and Table 3-49 compares current data for target and indicator variables to proposed reference thresholds.

3.8.10.2 Sediment Target Data

As described in Section 3.3.1, sediment targets were developed to account for variability in stream response. It was determined that the West Fork Bitterroot River's natural evolutionary classification stage contains a Rosgen C4 stream channel. Therefore, the target data summarized below is for C4 channel types. Additionally, data was collected when possible, above and below the painted Rock reservoir.

% Fines--Wolman Pebble Counts < 2mm in Riffles

The Bitterroot National Forest collected pebble count data in the West Fork Bitterroot River in July of 2003. The average percent fines values for less than 2 mm in the C4 channel reach above Painted Rock was 13%, meeting the target threshold. No data was collected below Painted Rock reservoir.

% Fines--Wolman Pebble Counts < 6mm in Riffles

The Bitterroot National Forest collected pebble count data in the West Fork Bitterroot River in July of 2003. The average percent fines values for less than 6 mm in the C4 channel reach above Painted Rock was 15%, slightly below the lower end of the target range, suggesting that fine sediment deposition may not be a problem in this reach of the West Fork. No data was collected below Painted Rock reservoir.

D_{50}

The Bitterroot National Forest collected pebble count data in the West Fork Bitterroot River in July of 2003. The average size class values for the D_{50} in the C4 channel reach above Painted Rocks was 57 mm, outside of the target range. No data was collected below Painted Rock reservoir.

Clinger Richness

No current data available.

3.8.10.3 Sediment Supplemental Indicator Data

Residual Pool Depth

The USFS conducted stream inventories in the West Fork Bitterroot River in July of 2003. Average residual pool depth value in the C4 channel reach above Painted Rocks is 1.6 feet, indicating that the supplemental indicator threshold has been met. No data was collected below Painted Rock reservoir.

LWD

The USFS conducted large woody debris inventories in the West Fork Bitterroot River. The total number of pieces inventoried in the West Fork Bitterroot River above Painted Rocks was 42 pieces per mile and the number below Painted Rocks was 26 pieces/mile. Both values meet the supplemental indicator value of at least 20 pieces per mile.

Pool/Mile

The USFS conducted habitat inventories in the West Fork Bitterroot River. Pool/mile values for the West Fork Bitterroot River were recorded as 29 above Painted Rock and 5 below, meeting the stream width-dependent indicator threshold in both cases.

Suspended Solids Concentrations

No data have been collected.

Turbidity

No data have been collected.

Mountain IBI

No current data.

EPT Richness and Percent Clinger Taxa

No current data.

Human-Caused Sediment Sources

As described in greater detail in Section 4.0, roads and unstable stream banks were identified as potentially significant human caused sources of sediment in the West Fork Bitterroot River watershed.

Juvenile Trout Densities

Insufficient data.

Fish Passage Barriers

There are no culverts on the West Fork of the Bitterroot River that block or impede fish passage. There are numerous culverts on tributaries to the West Fork that block or impede fish passage (e.g. Pierce, Baker, Lavene, Boulder, Ward, East Piquett, Castle, Britts, Beavertail, Ditch, Little Boulder, Elk, Coal, Johnson, and Sheep Creeks). About a third of these culverts have been proposed for replacement in current forest NEPA projects such as the Burned Area Recovery FEIS and Frazier Interface EA. Four of the culverts proposed in the Burned Area Recovery FEIS were replaced with new stream simulation culverts in July 2003 (Took Creek, Road 1303; Took Creek, Road 362; Magpie Creek, Road 362; Sand Creek, Road 362). BNF recommended that the forest replace as many of the remaining barrier culverts as possible, pending funding. The forest should also monitor the new replacements to ensure that fish passage is being adequately maintained.

3.8.10.4 Nutrient Target Data

Total phosphorous, total nitrogen, and nitrate/nitrite nitrogen samples were collected by the USGS periodically from 2001 to 2003. The median TP concentration in this period was 0.018 mg/L. The median TN concentration was 0.18 mg/L. The median $NO_{2/3}$ was 0.019 (Table 3-46 and 3-50).

The median total nitrogen concentration was below target thresholds. The median total phosphorous concentration was below the VNRP target, but was slightly above USEPA guidelines. The median $NO_{2/3}$ concentration was slightly above the USEPA target (Table 3-50).

No current benthic chlorophyll a data were available.

Table 3-46. USGS Nutrient Data from Station 455550113432001 near Conner Bridge.

Date	Total Nitrogen Ammonia + Organic (mg/L as N)	Dissolved $NO_2 + NO_3$ (mg/L as N)	Dissolved Nitrogen, Nitrite (mg/L as N)	Dissolved Ortho-phosphorous (mg/L as P)	Total Phosphorous (mg/L as P)	Discharge (cfs)
3/22/01	<0.08	0.013	<0.001	<0.007	0.01	50
4/27/01	0.1	0.008	0.001	<0.007	0.011	93
5/16/01	0.18	0.006	<0.001	<0.007	0.019	1010
10/29/01	0.24	0.037	E.002	<0.007	0.019	52
4/16/02	0.21	0.187	<0.002	<0.007	0.022	148
6/4/02	0.18	0.019	<0.002	<0.007	0.02	1410
6/25/02	0.14	0.014	<0.002	<0.007	0.018	402
9/3/02	0.16	0.023	E.002	<0.007	0.011	329
4/23/03	0.23	0.135	E.002	<0.007	0.024	324

E=estimated

3.8.10.5 Nutrient Supplemental Indicator Data

No nutrient supplemental indicator data were available.

3.8.10.6 Temperature Target Data

In Stream Temperature

Table 3-47 below displays 7-day average maximum temperatures during the seasonal period of July 18- October 1 of each year. Temperature data from FWP monitoring sites at West Fork mile markers 1.2, 22.2, and 34.0 are collected seasonally from July 18th - October 1 of each year. Data from mile marker 40.0 were available, but only for 2 years. The summary of data below suggests that temperature values in the West Fork exceed the proposed target values.

Table 3-47. Temperature Data for the W.F. Bitterroot River, 1996-2003.

Mile Marker	Year	7-Day Average Max in Degrees Celsius and Degrees Fahrenheit
1.2	1996	17.5 C / 63.5 F
	1997	17.9 C / 64.2 F
	1998	18.9 C / 66.1 F
	1999	17.9 C / 64.2 F
	2000	18.6 C / 65.4 F
	2001	19.1 C / 66.4 F
	2003	19.3 C / 66.7 F
22.2	1996	14.2 C / 57.6 F
	1997	15.4 C / 59.8 F
	1998	16.4 C / 61.6 F
	1999	NC
	2000	NC
	2001	NC
	2003	NC
40.1	1996	10.8 C / 51.4 F
	1997	10.7 C / 51.2 F
	1998	NC[1]
	1999	NC
	2000	NC
	2001	NC
	2003	NC

[1] NC = Not collected.

3.8.10.7 Temperature Supplemental Indicator Data

MDEQ and Land and Water Consulting conducted a potential stream shade analysis in 2003. This analysis is further described in Section 5.0. The existing potential shade in the West Fork Bitterroot River is 25%, indicating that it does not currently meet its potential.

3.8.10.8 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

Sediment

Approximately 13 percent of the West Fork watershed was affected by the fires of 2000. Although the West Fork watershed was less affected by the fires than the East Fork, several of its tributary watersheds were heavily impacted by the fires. In particular, upper Slate Creek, upper Overwhich Creek, Chicken Creek, Piquett Creek, and the west-facing slopes of the lower West Fork are considered to be at high risk of accelerated erosion and mass wasting.

Physical Habitat Assessments were conducted throughout the West Fork in the late summer of 1997 as part of sediment and nutrient assessment of streams of the Bitterroot Valley by the

Ravalli County Sanitarian's office. The assessment was performed on eight stream reaches between Painted Rocks Reservoir and the confluence with the East Fork of the Bitterroot. The West Fork flows through primarily private ground in this section. Descriptions of reach locations were not provided. Results are summarized in Table 3-48. The assessment found that the most reaches were on the border of partially and fully supporting beneficial uses – a score of 80 of higher indicates full support according to MDEQ. Reaches 5 and 6 were the areas of greatest concern, with scores in the low 70s. The average score was 79, indicating only partial support, but very close to full support (WCI, 1998). The results of this assessment, combined with the 1997 macroinvertebrate data described below, appear to have been the main sources for the revisions to the West Fork's 303(d) status in 2000.

Table 3-48. Physical Habitat Assessment Results, West Fork Bitterroot River, 1997.

Reach	Score	Use Support	Comments of Observer
1	79	Partial	Riparian habitat and fish cover were considered reasonable for the stream. Some flow constrictions and riprap noted.
2	80	Full	Riparian vegetation was disturbed and/or removed in places; marginal fish cover; some channelization.
3	80	Full	Moderate riparian vegetation; moderate fish cover; low sinuosity; high width/depth ratio.
4	84	Full	Variable reach: lower portion impacted by road; upper portion not impacted.
5	74	Partial	Variable reach: lower portion not impacted; upper portion impacted by road, riprap, and grazing.
6	71	Partial	Impacted by Nez Perce Road (loss of riparian vegetation, channelization, riprap); active erosion.
7	83	Full	Good fish cover, impacted by roads, bridges, and diversion return flow; variable riparian vegetation.
8	80	Full	Reduced riparian vegetation; moderate fish cover; road constricts right side of river.
Mean	79	Partial	Factors causing impairment include development of the West Fork road (rip-rapping and entrenchment), the influence of small bridges, grazing and active erosion.

In its post-burn EIS, the Bitterroot National Forest identified 4 primary factors that may impact support of aquatic life and cold-water fishery beneficial uses in the West Fork Watershed (USFS, 2001a). These data may no longer reflect current conditions, as many of post fire impacts have since been addressed:

Below Painted Rocks Dam

1. Reductions in channel length, woody debris recruitment, and fish habitat complexity caused by the encroachment and channelization along the West Fork Highway.
2. Elevated water temperatures from losses of riparian overstory cover and stream shade on the river (mostly caused by highway encroachment, some from residential floodplain development), and altered river flows from the operation of Painted Rocks Dam.

Above Painted Rocks Dam

3. Elevated water temperatures caused by losses of riparian overstory cover and stream shade on the private reaches of the river below Deer Creek.

4. Reductions in woody debris recruitment and fish habitat complexity due to encroachment of the West Fork Highway.

According to the Bitterroot National Forest: *Overall, road encroachment is the main cause of shade and woody debris recruitment reductions … in the West Fork drainage – not riparian timber harvest. The largest losses of shade and woody debris recruitment occur along the West Fork as a result of highway encroachment and residential development. Elsewhere, riparian timber harvest is not concentrated on any stream on the Forest. Where it does occur, it is small and scattered and generally located along small, non-fish bearing headwater tributaries with minimal potential to route large woody debris downstream into occupied fish habitat, except during mudslides. Because of the scattered distribution across the landscape, low percentage of stream miles affected, and small quantities of water exposed to sunlight, the potential to warm stream temperatures is minimal … Above Painted Rocks Dam, the loss of riparian shade contributes to warmer summer water temperatures. In the West Fork below Painted Rocks Dam, the loss of riparian shade and temperature alterations caused by stored water releases from PRR cause elevated late summer water temperatures. In these reaches of the West Fork, elevated temperatures have increased the extent of habitat occupied by non-native trout, increased the competitive advantage of non-native trout over native trout, and cumulatively decreased the survival and production of bull trout and westslope cutthroat trout* (USFS, 2001a).

Macroinvertebrates

Macroinvertebrate samples and macroinvertebrate habitat assessments were collected upstream of the Conner cutoff bridge in the late summer of 1997 as part of a sediment and nutrient assessment of streams of the Bitterroot Valley. Based on the Montana Valleys and Foothill Prairies Eco-region criteria, the macroinvertebrate community at this site indicated non-impairment and full support of beneficial uses (92% of max).

Macroinvertebrate analysis results were summarized as follows: “Bank vegetation was perceived to be marginal at the site on the West Fork, and sub-optimal to marginal bank stability was noted. All other habitat parameters were rated optimal at this site … Excellent water quality at the West Fork of the Bitterroot River site was indicated by the low biotic index score (2.92). However, some habitat impairment was evident in the moderately low taxa richness (25) and EPT richness (16), and in the low density of organisms at the sample site. Only 201 organisms were collected in the entire sample, even though substrate was kicked for 6 minutes. The habitat assessment does not reveal what the source of impact might be, since marginal stream bank instability and vegetative cover were the only impairments to habitat quality noted. Neither sediment deposition nor embeddedness was associated with the stream bank findings at the site. Relatively high numbers of *Pteronarcys* sp. (12% of the sampled assemblage), a shredder, suggest that allochthonous riparian inputs of woody debris are substantial at this site, and the positive implications of an abundance of this stonefly for the fishery are well-known” (Bollman, 1998).

The existing macroinvertebrate data relied on metrics not entirely consistent with those chosen for this WQRP, and thus they were not used to make impairment determinations in this document.

Periphyton

Periphyton samples were also collected upstream of the Conner cutoff bridge in the late summer of 1997 as part of a sediment and nutrient assessment of streams of the Bitterroot Valley. Results were summarized as follows: "Biological integrity was rated as good, with only minor aquatic life impairment indicated, due primarily to a slightly elevated siltation index value. The non-diatom and diatom algal assemblages were very diverse, and consisted of taxa that indicated relatively clean water with moderate dissolved solids and ample, although not excessive, levels of algal nutrients" (Weber, 1998).

Nutrients

The 1996 listing for noxious aquatic plants appears to have been based primarily on the observation of localized algal growth immediately below Painted Rocks Dam during a September 1990 MDEQ stream survey. A return visit by MDEQ in September of 2003 found only moderate algal growth directly below painted rocks reservoir. At the time of the visit the algal growth was assessed to be: light microalgal growth with approximately 20% cover, moderate macroalgal growth covering approximately 40% of substrate, 10% of substrate was covered by light moss growth, a light growth of macrophytes covered approximately 15% of substrate, and 10% of substrate had no algal growth. It was concluded at this time that the algal growth below the dam was not excessive compared to the potential and was not hindering or impairing any beneficial uses. Furthermore, beyond the immediate vicinity of the dam, algal growth in the West Fork is reported generally to be light (Clancy pers com, 2003), and, as reported above, the periphyton (attached alage) community does not reflect elevated nutrient concentrations (Weber 1998).

Welch et al. (1988), in a study of streams from Washing ton and Montana, concluded that 20% streambed cover by algae may represent a nuisance threshold. The New Zealand Ministry for the Environment recommends no more than 30% cover by filamentous algae to protect recreational and aesthetic uses of its gravel bottom streams (Biggs, 2000).

Nitrogen and phosphorous sampling was conducted upstream of the Conner cutoff bridge in the late summer of 1997 as part the sediment and nutrient assessment of streams of the Bitterroot Valley. The raw data are not included in the report, but are described as providing no indication of elevated nutrient levels in the West Fork (Hooten, 1999).

Flow

It is suspected that the West Fork was originally listed as impaired for flow alterations based on the assumption that Painted Rocks Dam altered the discharge of the river in a manner that would impair beneficial used, and/or that substantial irrigation withdrawals from the river resulted in dewatering. In fact, however, the available data do not support these conclusions. Although the dam may have negatively impacted beneficial uses in the past, the current operations of the dam are not suspected of altering the flow of the river in a way that would harm fish or other aquatic life. Painted Rocks reservoir operating information is provided below:

Painted Rocks reservoir impounds 31,706 AF of water at the spillway crest, and covers 655 acres. The DNRC has contracts to deliver 15,000 acre-feet (AF) for in-stream fisheries flows and 10,000 AF for irrigation. The contract requires that delivery of the water between May 1st and September 30th.

The irrigation water released from Painted Rocks is delivered as far north as Florence (approximately 65 miles downstream), and in-stream fisheries flows are protected as far as Bell Crossing (approximately 48 miles downstream), which includes the entire length of the West Fork of the Bitterroot River.

The reservoir is filled on the rising limb of the spring runoff hydrograph. After the reservoir stops spilling the gates are adjusted weekly to insure that inflows equal outflows and the reservoir remains at full pool, until the water is called for.

The DFW&P has identified an optimum flow low rate of 400 cfs at the Bell Crossing bridge, which is located on the Bitterroot River downstream of the West Fork confluence. Prior to the FWP purchase of water, average late summer flows at Bell Crossing were in the 40-50 cfs range, and sometimes dropped as low as 25 cfs. Since that purchase of Painted Rocks water, the FWP has been able to consistently meet the targeted flow rate. USFS and FWP fisheries biologists revealed no dewatering concerns in the Bitterroot River at Bell Crossing during normal years. Even in the last two years of severe drought the flows at Bell Crossing have not fallen below 200 cfs. The DNRC water rights query data base (http://nris.state.mt.us/apps/dnrc2002/waterrightmain.asp) indicates that water rights diversions from the West Fork between Painted Rocks Dam and the confluence with the East Fork total 19.1 acre-feet per year, or less than one tenth of one percent of the DNRC delivery contract volume. Finally, personal communication with USFS and FWP fisheries biologists revealed no dewatering concerns in the West Fork. Releases from Painted Rocks Dam augment flows in the West Fork during summer low flow periods. It is reasonable to conclude that flow alteration impairment from dewatering does not occur in the West Fork.

3.8.10.9 Current WQ Impairment Summary

Tables 3-49 and 3-50, 3-51, and 3-52 below compare existing sediment, temperature, and nutrient data with the proposed target/indicator values in the West Fork Bitterroot River. Target and indicator development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

Table 3-49. Existing Conditions and Sediment Water Quality Indicators for W.F. Bitterroot River.

Targets					
Rosgen Stream Type	**Parameter**	**Existing Condition**		**Proposed Thresholds**	
C4		Above Painted Rocks	Below Painted Rocks	Above Painted Rocks	Below Painted Rocks
	% Fines < 2 mm (data collected in riffles)	13	Unknown	Mean: 23%; Range: 14-32%	Mean: 23%; Range: 14-32%
	% Fines < 6 mm (data collected in riffles)	15	Unknown	Mean: 33%; Range: 17-49%	Mean: 33%; Range: 17-49%
	D_{50} (data collected in riffles)	57	Unknown	3-47 mm	3-47 mm
	Clinger Richness	Unknown	Unknown	$\geq$ 14	$\geq$ 14
Supplemental Indicators					
C4	Mountain IBI	Unknown	Unknown	$\geq$ 75%	$\geq$ 75%
	% Clinger Taxa	Unknown	Unknown	High	High
	EPT Richness	Unknown		$\geq$ 22	$\geq$ 22
	Pools/mile	29	5	23	4
	LWD/mile	42	26	20	20
	Residual Pool Depth	1.6	Unknown	1.5 feet	1.5 feet
	Suspended Solids Concentration	Unknown	Unknown	Comparable to reference conditions	
	Turbidity	Unknown	Unknown	High flow – $\leq$ 50 NTU instantaneous maximum Summer base flow – $\leq$ 10 NTU	
	Juvenile bull trout & westslope cutthroat trout densities.	See Appendix I	See Appendix I	Documented increasing or stable trend	
	Human Caused Sediment Sources	Roads, Unstable stream banks		No preventable sources	
	Fish Passage Barriers	No barriers identified on the West Fork; several identified in the watershed		No barriers except to protect native salmonid genetics	

See Section 3.3 for an explanation of target development.

Table 3-50. Existing Conditions and Nutrient Water Quality Targets and Supplemental Indicators for the Bitterroot Headwaters TPA.

Targets	Threshold	Existing Condition
Benthic Chlorophyll-*a* (P25)	< 33 mg/m^2	NA
USEPA Ecoregion II, Total Phosphorus (P25)	< 0.01 mg/L	0.018 mg/L
USEPA Ecoregion II, Nitrate+Nitrite (NO_2/NO_3) (P25)	< 0.014 mg/L	0.019 mg/L
Clark Fork Total Phosphorous Guidelines	< 0.039 mg/L	0.018 mg/L
Clark Fork Total Nitrogen	< 0.3 mg/L	0.18 mg/L
Supplemental Indicators	**Threshold**	
Montana Mountain Macroinvertebrate Index of Biological Integrity	> 75%	NA
Dissolved Oxygen, 7-Day Mean	> 9.5 mg/L	NA
Dissolved Oxygen, 1-Day Minimum	> 8.0 mg/L	NA
USEPA Ecoregion II, Chlorophyll-*a*, Water Column (P25)	< 1.08 µg/L	NA

Table 3-51. Number of Days Temperature Target was Exceeded in the W.F. Bitterroot River.

Mile Marker	Year	# Of Days > 15 C and 59 F
1.2	1996	52
	1997	54
	1998	76
	1999	63
	2000	71
	2001	98
	2003	53
22.2	1996	0
	1997	18
	1998	29
	1999	NC
	2000	NC
	2001	NC
	2003	NC
40.1	1996	0
	1997	0
	1998	NC
	1999	NC
	2000	NC
	2001	NC
	2003	NC

[1] NC = Not collected.

Table 3-52. Comparison Between Existing Conditions and Supplemental Indicator Values for W.F. Bitterroot River.

Parameter	Existing Condition	Threshold	
% Shade	25%	26%	Year 5
		27%	Year 10
		33%	Year 15
		45%	Late Seral

Habitat Alteration & Sediment

In a memo to MDEQ in which he commented on the 2000 303(d) list, BNF Supervisor Rodd Richardson stated, "We have done extensive studies and analysis of the headwaters of this drainage over the last 10 years. Our evaluations indicate that this stream is fully supporting cold-water aquatic life from the Deer Creek confluence to the headwaters. FWP fisheries biologists support this determination. We have recently completed stream and watershed improvement projects in the headwaters that address all known sediment sources and bank stability problems. In fact, we recently relocated about ¾ mile of the upper West Fork in conjunction with Federal Highway Administration to move the stream away from the road" (R. Richardson memo, June 2000).

The Beaver-Woods Vegetation Management Project Final EIA (10/95) states that the main stem of the West Fork above Deer Creek "appears to be a healthy C4 stream type, with substrate composition, channel stability ratings and aquatic productivity being within normal ranges."

Based on these comments and the data reviewed above, it appears that habitat and sediment impairments to the West Fork are limited to the sections below the Deer Creek confluence. And even below Deer Creek, siltation does not appear to be a problem. To the contrary, sediment targets in the lower river suggest a possible coarsening of the stream substrate limited fine sediment deposition, probably as a result of the sediment capture by Painted Rocks Dam. However, no recent macroinvertebrate data are available with which to evaluate aquatic life beneficial use support and source assessment results (Section 4.0) indicate substantial human-caused sediment loading to the West Fork. In response, a sediment[9] TMDL and restoration plan will be developed for the West Fork as part of this WQRP.

Noxious aquatic plants

As explained above, the West Fork of the Bitterroot does not appear to be impaired by excessive algal growth. Although at times, nutrient concentrations were slightly above USEPA target guidelines, the suitability of these targets for streams in western Montana is still under review. Median nutrient concentrations were consistently below VNRP standards, which were developed specifically for western Montana. As a result, no TMDL will be developed for nutrient or noxious aquatic plants. However, as an additional margin of safety in the WQRP, nutrient monitoring has been included in the monitoring plan described in Section 9.0.

[9] Sediment is used in this document to refer collectively to a group of related pollutants including sediment, siltation, suspended solids, and/or habitat alteration.

Thermal Modification

Based on the review of all available data, there appears to be a temperature impairment in the West Fork Bitterroot River. Therefore, a temperature TMDL and restoration plan will be developed for the West Fork Bitterroot River as part of this WQRP. However, at this time additional data is needed to adequately describe the temperature and flow regimes in the West Fork. Section 9.9 later in this document, outlines a proposed temperature monitoring strategy in the West Fork.

Flow Alteration

As explained above, it is recommended that flow alteration be removed from the 303(d) list and no flow-related TMDL has been developed for the West Fork.

3.8.11 Overwhich Creek

Overwhich Creek is a fourth order tributary to the West Fork of the Bitterroot River. The Overwhich Creek watershed is approximately 50 square miles in size, and the Bitterroot National Forest manages 99% of lands within the watershed. The road network is relatively small, and 62% of the watershed is roadless. Approximately 57% of the watershed was affected by the fires of 2000.

3.8.11.1 Summary of 303(d) List

The 1996 listing of Overwhich Creek appears to have resulted from a brief 2/8/85 Montana Interagency Stream Fishery Data Report that listed temperature and excess flow fluctuations as “mostly natural” factors limiting the fishery. The report also mentions logging practices as a “watershed abuse.”

The 1996 Montana 303(d) list reported that Overwhich Creek was threatened for support of its cold-water fishery beneficial use. The threat to Overwhich Creek was thought to result from flow alterations and thermal modifications caused by silvicultural practices in the watershed. In reviewing the 303(d) list in 2000 and 2002, however, Montana DEQ determined that, except for drinking water, the existing data did not meet the requirements for sufficient and credible data, and thus no beneficial use support determination could be made, and Overwhich Creek was scheduled for reassessment. However, water chemistry data from the 1970s revealed several violations of the human health water quality standard for lead. As a result, Overwhich Creek was listed in 2000 as not supporting its drinking water beneficial use. The 303(d) status of Overwhich Creek is summarized in Table 3-53.

Table 3-53. 303(d) Status of Overwhich Creek: MT76H003_050.

Year	Use Support Status	Probable Impaired Uses	Probable Causes	Probable Sources
1996	Threatened	Cold water fishery	Flow Alteration and Thermal Modification	Silviculture
2000/02	Needs reassessment for aquatic life and cold water fishery	No Sufficient Credible Data (SCD)	No SCD	No SCD
	Non-support for drinking water	Drinking water	Lead	Abandoned mining

3.8.11.2 Temperature Target Data

Montana Fish, Wildlife and Parks (FWP) have been collecting in-stream temperature data in the BHTPA for several years. There are two sites in Overwhich Creek. The summary of data below suggests that temperature values in Overwhich Creek exceed the proposed target values (Table 3-54).

Table 3-54. Temperature Data for Overwhich Creek, 1996-2003.

Mile Marker	Year	7-day average Max in Degrees Celsius and degrees Fahrenheit
2.0	1998	15.5 C / 59.9 F
	1999	15.3 C / 59.5 F
7.0	1998	17.6 C / 63.6 F
	1999	NC

[1] NC = Not collected.

3.8.11.3 Temperature Supplemental Indicator Data

MDEQ and Land and Water Consulting conducted a potential stream shade analysis in 2003. This analysis is further described in Section 5.0. The existing potential shade in Overwhich Creek is 51%, indicating that it does not currently meet its potential.

3.8.11.4 Metals (Lead) Target and Indicator Data

MDEQ collected metal samples in Overwhich Creek during the 2002 and 2003 field season. The concentration of lead was below detection at both sites.

3.8.11.5 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

Approximately 18% of the watershed burned at high and moderate severity; another 21% burned at low severity. Thirteen percent of the fish-bearing stream miles in the watershed burned at high and moderate severity. Accelerated channel migration was predicted by the USFS as a result of fire related increased in sediment yield (USFS, 20001a).

The BNF Sensitive Watershed Analysis (Decker et al., 1991) determined that in the Overwhich Creek Watershed there were 59.0 miles of forest roads and 139 stream crossings, resulting in a road density of 1.2 and a crossing density of 2.7. At the time, 12% of the watershed appeared from air photos to have been impacted by timber harvest. Soils in the watershed were determined to be a mix of highly erodible weathered granitics and volcanics and low erosion quartzites and hard granitics. For these reasons, Decker classified the Overwhich Creek watershed as "apparently healthy with low road densities, a small percentage of timber harvest and few other impacts such as roads in riparian areas.

Mass Wasting

The Bitterroot National Forest has described a mass wasting event that occurred in the Overwhich Creek Watershed in 1992: *An overland flow event occurred in Overwhich Creek in 1992 following an escaped prescribed fire that burned 1,800 acres on steep slopes. The event resulted in the channel scour in four tributaries to Overwhich and deposition of sediment, rocks and logs in the main stem. Over the past eight years, the affected streams have been on an improving trend. Stream surveys conducted on the main stream indicate that the percentages of fine sediments have been decreasing each year. The channel has been migrating across the valley bottom during period of peak flows partially because of the event and partially because of natural instabilities …A significant portion of the fish community in the lower five miles of Overwhich Creek, including bull trout, western cutthroat trout, brook trout and mountain whitefish, were destroyed by the amount and force of the sediment [from the 1992 event].* (USFS, 2001b).

In its post-burn EIS, the Bitterroot National Forest identified 4 primary factors that may impact support of aquatic life and cold-water fishery beneficial uses in the Overwhich Creek Watershed (USFS, 2001a). These data may no longer reflect current conditions, as many of post fire impacts have since been addressed:

1. Natural geologic instability and high bed loads which cause considerable channel migration and natural slumping.
2. Road 5703 encroaches on the lower five miles of Overwhich Creek's floodplain, increasing potential for road sediment inputs.
3. Riparian timber harvest (partial canopy removal and clear cutting) in scattered spots along the lower five miles of Overwhich Creek, and along some headwaters tributaries.

Macroinvertebrates

Macroinvertebrates were sampled by the USFS in upper and lower Overwhich Creek (specific site locations are not provided in the report) on 9/30/93 (Vinson, 1995). Although little interpretation of the sampling results is provided in the report, two indices are included. The Modified Hilsenhoff Biotic Index (MHBI), which, according to Vinson, is best at detecting organic pollution, but has also been used to detect nutrient enrichment, high sediment loads, low dissolved oxygen, and thermal impacts was 5.06 at the lower sight and 4.94 at the upper sight, both indicative of “moderate organic enrichment”. The Biotic Condition Index (BCI), a measure, as a percentage, of how close a waterbody is to its potential, was also provided. The BCI for Overwhich Creek was 79 at the upper site indicating “fair” conditions, and 80 at the lower sight, indicating “good” conditions.

In October 2002, macroinvertebrates were again sampled in upper and lower Overwhich Creek, this time by MDEQ. Based on the mountain metric (Bukantis, 1998), the lower reach received a score of 85 and the upper reach 90, both indicating full support of beneficial uses.

Periphyton

In October 2002, MDEQ also sampled periphyton at two sites on Overwhich Creek. At the lower site, all seven metrics indicated full support of beneficial uses. However, at the upper site, one metric, the siltation index, indicated moderate impairment of beneficial uses; the other six metrics all indicated full support of beneficial uses.

A non-point source summary in MDEQ’s assessment files mentioned a study by Bahls (1990) that found the periphyton community in Overwhich Creek was “moderately stressed.” The report itself was not located, and no sampling locations were provided in the MDEQ summary.

Lead

The decision to list Overwhich Creek as impaired by lead was based on water chemistry data that were collected in 1980 or before. While some of these data did indeed reveal violations of the state’s drinking water standards, data collected more recently suggest that lead is no longer a problem in Overwhich Creek. As part of an October 2002 and 2003 reassessment of Overwhich Creek, MDEQ collected water chemistry and metals in sediment data at two locations on Overwhich Creek. The concentration of lead was below detection at both sites, and metals in sediment levels were near the median for the Northern Rockies. For these reasons, no TMDL has been developed for lead in Overwhich Creek at this time. The available lead data are summarized in Tables 3-55 and 3-56.

Table 3-55. Dissolved Lead in Overwhich Creek.

Date	Dissolved Lead Concentration (ug/L)	Hardness (mg/L)	Standards (ug/L)		
			Acute A.L.	Chronic A.L.	Human Health
7/3/2003	ND (<1) upper site*	36.0	22.2	0.9	15
7/3/2003	ND (<1) lower site*	36.4	22.6	0.9	15
10/9/2002	ND (<1) upper site*	50.3	34.0	1.3	15
10/9/2002	ND (<1) lower site*	49.2	33.1	1.3	15
5/28/1980	40***	25.9	14.7	0.6	15
5/12/1980	120***	21.8	14.0**	0.5**	15
4/29/1980	60***	22.5	14.0**	0.5**	15
9/25/1979	50***	46.6	30.9	1.2	15
5/27/1979	110***	17.0	14.0**	0.5**	15
5/24/1979	60***	17.5	14.0**	0.5**	15
6/15/1978	50***	17.9	14.0**	0.5**	15
5/2/1977	0	27.6	15.9	0.6	15
4/12/1977	0	43.9	28.6	1.1	15
7/8/1975	50***	19.2	14.0**	0.5**	15
9/17/1973	0.05	44.0	28.7	1.1	15

*Indicates sample method was analyzed as total recoverable
**Indicates a hardness of 25 mg/L was used to calculate aquatic life standards
***Indicates a violation of standards

Table 3-56. Lead Sediment Concentration in Overwhich Creek.

Date	Lead Sediment Concentration (ug/g)	Northern Rockies Intermontane Basins (USGS)		
		Median (ug/g)	Min (ug/g)	Max (ug/g)
10/9/2002 (Upper Site)	45.8	47	12	6600
10/9/2002 (Lower Site)	51.4	47	12	6600

Lead sampling in Overwhich Creek is included in the implementation and monitoring plan described in Sections 8.0 and 9.0. If this sampling continues to indicate that lead concentrations are below the state's water quality standards, then lead will formally be removed from the 303(d) list as a cause of impairment to Overwhich Creek. If at any time, however, the concentration of lead is found to exceed water quality standards, then Overwhich Creek will be rescheduled for TMDL development for lead.

Flow

Overwhich Creek was originally listed as impaired for flow alterations from silvicultural practices and subsequent water yield increases. However, there is no recent data to support these conclusions. Timber harvest occurred on only 258 acres in the basin, representing less than 1% of the total land area, well below levels of harvest thought to potentially impact in-stream flows. The DNRC water rights query database lists only two water rights in the Overwhich Creek watershed, with a combined total of 0.02 cfs (http://nris.state.mt.us/apps/dnrc2002/waterrightmain.asp). The available data suggest that flows in Overwhich Creek have not been significantly altered by human activities.

3.8.11.6 Current WQ Impairment Summary

Table 3-57, and 3-58 below compares existing sediment data with the proposed target values in Overwhich Creek. Target development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

Table 3-57. Number of Days Temperature Target was Exceeded in Overwhich Creek.

Mile Marker	Year	Days > 15 degrees C and 59 degrees F
2.0	1998	47
	1999	13
7.0	1998	12
	1999	NC

[1] Number shown is the maximum 7-day average for 1999.

Table 3-58. Comparison Between Existing Conditions and Supplemental Indicator Values for Overwhich Creek.

Parameter	Existing Condition	Threshold	
% Shade	51%	51%	Year 5
		52%	Year 10
		59%	Year 15
		73%	Late Seral

Thermal Modifications

Overwhich Creek was listed in 1996 as threatened, not impaired by thermal modifications. Although it is impossible to know for certain why the stream was listed in 1996, the listing appears to have been based on anecdotal evidence of temperature problems; no hard data appear in the 1985 interagency report. Based on the temperature data currently available from FWP, it appears that Overwhich Creek has a relatively natural temperature regime and that elevated temperatures do not threaten or impair beneficial uses in the creek. USFS fisheries biologist Mike Jakober, who was interviewed for this report, described the thermal regime in Overwhich Creek as mostly natural and said he had no reason to think that thermal modifications impair or threaten the fishery, particularly in light of limited harvest in the watershed, and a road system that was generally far from the stream. Jakober added that he considered Overwhich Creek surprisingly cool, especially in the lower reaches where there is a wide valley bottom and a Rosgen C channel, stream features that typically result in warmer temperatures. While the fires of 2000 burned a significant portion of the watershed, and have resulted in elevated stream temperatures, fire-related impacts are largely natural. As Table 3-57 above shows, the proposed in-stream temperature target was exceeded as many as 60 times in 2 years. Conversely, 2 year's worth of data may not be enough to explain a temperature problem in Overwhich Creek. Additionally, sufficient levels of reference stream data within the BHTPA are needed for comparison. Finally, the current level of shade is below its potential, shown in Table 3-58. Based on the information provided above, Overwhich Creek is still considered impaired for thermal modifications until additional data (as outlined in Section 9.10) can be collected. Therefore a temperature TMDL and restoration strategy have been developed as part of this WQRP.

Lead

Based on the information provided above, Overwhich Creek does not appear to be impaired for lead or metals. Therefore, no TMDL for lead has been developed, but continued lead sampling is included in the monitoring plan described in Section 9.8.

Flow Alteration

As discussed above, less than 1% of the basin area has been harvested, eliminating silviculture as a possible cause of flow alterations in Overwhich Creek. In the absence of any significant human sources of flow alterations, Overwhich Creek is not impaired. For this reason, no TMDL has been developed for flow alterations from silviculture in Overwhich Creek.

3.8.12 Nez Perce Fork

The Nez Perce Fork is a fourth order tributary to the West Fork of the Bitterroot River. The Nez Perce Fork Watershed is approximately 37 square miles in size, and the Bitterroot National Forest manages 97% of lands within the watershed. Private lands in the watershed are concentrated near the stream channel in the lower 3 miles of the watershed. With an average elevation of 6,100 feet, the watershed is predominately a forest of Lodgepole pine and Douglas fir. The Nez Perce Fork Watershed was unaffected by the fires of 2000.

3.8.12.1 Summary of 303(d) List

The 1996 listing appears to be the result of a brief 2/8/85 Montana Interagency Stream Fishery Data Report that listed temperature as a “mostly natural” factor limiting the fishery. No hard data were included. The report listed logging practices as a “watershed abuse.”

The 1996 Montana 303(d) list reported that Nez Perce Fork was threatened for support of its cold-water fishery beneficial use. The threat to Nez Perce Fork was thought to result from thermal modification caused by silvicultural practices in the watershed. In reviewing the 303(d) list in 2000 and 2002, however, Montana DEQ determined that the existing data did not meet the requirements for sufficient and credible data, and thus no beneficial use support determination could be made, and Nez Perce Fork was scheduled for reassessment. The 303(d) status of Nez Perce Fork is summarized in Table 3-59.

Table 3-59. 303(d) Status of Nez Perce Fork: MT76H003_020.

Year	Estimated Size	Use Support Status	Probable Impaired Uses	Probable Causes	Probable Sources
1996	14.7 miles	Threatened	Cold water fishery	Thermal Modification	Silviculture
2000/02	14.7 miles	Needs reassessment	No Sufficient Credible Data (SCD)	No SCD	No SCD

3.8.12.2 Temperature Target Data

Montana Fish, Wildlife and Parks (FWP) have been collecting in-stream temperature data in the BHTPA for several years. There are two sites in the Nez Perce Fork. The summary of data below suggests that temperature values in the Nez Perce Fork exceed the proposed target values (Table 3-60).

Table 3-60. Temperature Data for Nez Perce, 1996-2003.

Mile Marker	Year	7-day average Maximum in Degrees Celsius and Fahrenheit
1.0	1996	15.9 C / 60.6 F
	1999	17.6 C / 63.7 F
	2000	19.5 C / 67.1 F
	2001	19.5 C / 67.1 F
	2003	19.6 C / 67.3 F
11.0	1996	14.4 C / 57.9 F
	1999	13.9 C / 57.0 F
	2000	16.3 C / 61.3 F
	2001	15.4 C / 59.8 F
	2003	19.6 C / 67.3 F

3.8.12.3 Temperature Supplemental Indicator Data

MDEQ and Land and Water Consulting conducted a potential stream shade analysis in 2003. This analysis is further described in Section 5.0. The existing potential shade in the Nez Perce Fork Bitterroot River is 38%, indicating that it does not currently meet its potential.

3.8.12.4 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

The Nez Perce Fork was unaffected by the fires of 2000.

The BNF Sensitive Watershed Analysis (Decker et al., 1991) divided the Nez Perce Fork into two sub-watersheds: the upper Nez Perce and the South Fork of Nez Perce. Decker determined that in the upper Nez Perce Watershed there were 4.0 miles of forest roads and 15 stream crossings, resulting in a road density of 0.8 and a crossing density of 3.0. At the time, 0% of the watershed appeared from air photos to have been impacted by timber harvest. In the South Fork Watershed, Decker determined that there were 2.0 miles of roads and 2 crossings, resulting in a road and crossing density of 1.0. At the time, 20% of the watershed appeared from air photos to have been impacted by timber harvest. Soils in the both watersheds were determined to be predominately a mix of hard granitics and quartzites, both of which were classified as having a low rate of erosion. For these reasons, Decker classified the both Nez Perce watersheds as “apparently healthy with low road densities, a small percentage of timber harvest and few other impacts such as roads in riparian areas.”

USFS personnel interviewed for this report agreed that if temperatures were elevated in the Nez Perce Fork watershed, silviculture was probably not the cause, as little riparian harvest has taken place in the watershed. Instead, they identified road encroachment and an accompanying loss of over story shade as the probable reason for the temperature impacts (Jakober pers. com., 2002; Wildey pers.com., 2002).

Macroinvertebrates

In October 2002, MDEQ collected macroinvertebrate and periphyton (attached algae) samples at three locations on the Nez Perce Fork. The macroinvertebrate communities at the upper, middle, and lower Nez Perce Fork sites were 96, 88, and 88 percent of the maximum possible respectively according to standard MDEQ metrics, all indicating no impairment and full support of beneficial use. Similarly, periphyton results indicated no impairment and full support of beneficial uses at all three sites.

Periphyton

A note in the MDEQ assessment files mentions a periphyton report by Bahls 1990 that found no impairment. The report itself has not yet been located.

Chemistry

Water chemistry and metals in sediment data collected by MDEQ in October 2002 indicated no violations of state water quality standards.

3.8.12.5 Current WQ Impairment Status

Table 3-61 and 3-62 below compare existing sediment data with the proposed target values in the Nez Perce Fork. Target development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

Table 3-61. Number of Days Temperature Target was Exceeded in Nez Perce Fork.

Mile Marker	Year	Days > 15 C and 59 F
1.0	1996	30
	1999	35
	2000	48
	2001	60
	2002	55
11.0	1996	0
	1999	0
	2000	12
	2001	14
	2002	NC

NC = Not collected.

Table 3-62. Comparison Between Existing Conditions and Supplemental Indicator Values for Nez Perce Fork Creek.

Parameter	Existing Condition	Threshold	
% Shade	38%	38%	Year 5
		39%	Year 10
		42%	Year 15
		45%	Late Seral

[1] Number shown is the max 7-day average for 2003.

It appears from the temperature data that the Nez Perce Fork is potentially impaired by thermal modifications, at least in its lower reaches. However, it appears from Decker's 1991 analysis, and the opinions of agency personnel, that road encroachment, not silviculture, is the likely cause of the thermal modifications. Therefore, a temperature TMDL and restoration strategy have been developed as part of this WQRP.

3.8.13 Martin Creek

Martin Creek is a fourth order tributary to the East Fork of the Bitterroot River. The Martin Creek Watershed is approximately 32 square miles in size, and the Bitterroot National Forest manages 100% of the lands within the watershed. At an average elevation of 6,800 feet, the watershed is comprised predominately of a Lodgepole pine, Douglas fir and mixed subalpine forest. The watershed contains approximately 90 miles of roads and three percent of the watershed was affected by the fires of 2000.

3.8.13.1 Summary of 303(d) List

The 1996 listing appears to be based on a brief November 1977 FWP stream assessment that noted temperature and excess flow fluctuations as factors limiting the fishery in Martin Creek. FWP listed these factors under the heading "mostly natural"; the assessment applies only to an unspecified 1-mile reach of the 11.7 miles of Martin Creek.

The 1996 Montana 303(d) list reported that Martin Creek was threatened for support of its cold-water fishery beneficial use. Threats to Martin Creek were thought to result from flow alterations and thermal modification caused by silvicultural practices in the watershed. In reviewing the 303(d) list in 2000 and 2002, however, Montana DEQ determined that the existing data did not meet the requirements for sufficient and credible data, and thus no beneficial use support determination could be made and Martin Creek was scheduled for reassessment. The 303(d) status of Martin Creek is summarized in Table 3-63.

Table 3-63. 303(d) Status of Martin Creek: MT76H002_050.

Year	Use support status	Probable impaired uses	Probable causes	Probable sources
1996	Threatened	Cold water fishery	Flow Alteration Thermal modification	Silviculture
2000/02	Needs reassessment	No Sufficient Credible Data (SCD)	No SCD	No SCD

3.8.13.2 Temperature Target Data

Montana Fish, Wildlife and Parks (FWP) have been collecting in-stream temperature data in the BHTPA for several years. There is one site in Martin Creek. Additionally, Moose Creek was selected as a reference stream for temperature to use in comparison for Martin Creek. The summary of data below in Table 3-64 suggests that temperature values in Martin Creek meet the proposed target values.

Table 3-64. Comparison Between Martin Creek & Moose Creek.

Mile Marker	Year	7-Day Average Maximum for Martin Creek in Degrees Celsius	7-Day Average Maximum for Moose Creek in Degrees Celsius
1.3 (Martin Creek) 1.4 (Moose Creek)	1998	59.9	59.5
	1999	58.3	58.5
	2000	63.2	63
	2001	61.3	61.3
	2003	63.9	NC

3.8.13.3 Temperature Supplemental Indicator Data

MDEQ and Land and Water Consulting conducted a potential stream shade analysis in 2003. This analysis is further described in Section 5.0. The existing potential shade in Martin Creek is 67%, indicating that it does not currently meet its potential. However, in-stream temperature targets are currently being met, which suggests that the existing potential shade, while lower than expected potential, is not adversely affecting stream temperatures.

3.8.13.4 Sources and Other Relevant Data

This section provides a review of data that does not specifically match the target/indicator approach outlined in Section 3.3, but still provides information regarding the existing conditions and impairment status within the watershed.

Martin Creek was largely unaffected by the fires of 2000, with less than 3% of the watershed burned.

The BNF Sensitive Watershed Analysis (Decker et al., 1991) determined that in the Martin Creek Watershed there were 50.0 miles of forest roads and 72 stream crossings, for a road density of 2.2 and a crossing density of 3.1. At the time, 45% of the watershed appeared from air photos to have been impacted by timber harvest. Soils in the watershed were determined to be predominately a mix of highly erodible weathered granitics and low erosion hard granitics. For these reasons, Decker classified the Martin Creek as a sensitive watershed, suggesting that Martin Creek was nearing impact thresholds at which additional harvest or road construction could produce damaging increases in sediment and/or water yield. More recent analysis by the Bitterroot National Forest (2000) estimated the equivalent clearcut area at 2.5%, suggesting substantial recovery since Decker's analysis.

Macroinvertebrates and Periphyton

Macroinvertebrate samples were collected and analyzed as part of the USFS Aquatic Ecosystem Inventory, 1985 to 1988. The analysis was based on multiple factors including 1) the Diversity Index (DAT), which "combines a measure of dominance and number of taxa; 2) the Standing Crop (SC) expressed in gm/m^2; and 3) the Biotic Condition Index (BCI) "which indicates as a percentage how close an aquatic ecosystem is to its own potential" (Mangum, 1989). In general, the macroinvertebrates indicated that Martin Creek was in good condition, but the presence of sediment and organic tolerant organisms suggested that some impacts to water quality had occurred. The 3 indices presented had an average rating of good to fair. Results of the macroinvertebrate analysis are presented in Table 3-65. Details of sampling site locations were not provided in the report.

Table 3-65. Macroinvertebrate Analysis from Martin Creek.

Date	Location	DAT	Rating	SC	Rating	BCI	Rating
9/21/88	1A	17.2	Good	1.0	Good	89	Good
9/01/87	1A	12.1	Good	0.7	Fair	85	Good
9/23/86	1	18.0	Excellent	0.3	Poor	91	Excellent
10/2/85	1	17.9	Good	2.3	Good	89	Good
Average	**All**	**16.3**	**Good**	**1.1**	**Fair**	**88.5**	**Good**

More recently, MDEQ collected macroinvertebrate and periphyton samples at two locations in Martin Creek in October 2002. The macroinvertebrate community received a score that was 68% of maximum at the lower site indicating potential impacts from fine sediment deposition. At the upper site the score was 84%, indicating no impairment and full support of beneficial uses. The periphyton community at both sites indicated full support of beneficial uses.

Chemistry

Water chemistry and metals in sediment data collected by MDEQ in October 2002 indicated no violations state water quality standards.

Flow Alteration

Martin Creek was originally listed as impaired for flow alterations from silvicultural practices and subsequent water yield increases. However, there is no recent data to support these conclusions. Only 183 acres of the watershed have been harvested, representing less than 1% of the total basin area, well below levels of harvest thought to impact in-stream flows. The DNRC water rights query database indicated that there are no water rights or diversions in the Martin

Creek watershed (http://nris.state.mt.us/apps/dnrc2002/waterrightmain.asp). The available data suggest that flows in Martin Creek have not been significantly altered by human activities.

3.8.13.5 Current WQ Impairment Status

Table 3-66 and 3-67 below compare existing temperature and shade data with the proposed target values in Martin Creek. Target development is discussed in Section 3.3.1, and the source of the existing condition data is summarized in Table 3-13.

Table 3-66. Comparison Between Martin Creek & Moose Creek.

Mile Marker	Year	Days > 15 C and 59 F for Martin Creek	Days > 15 C and 59 F for Moose Creek
1.3 (Martin Creek0 1.4 (Moose Creek)	1998	23	17
	1999	0	0
	2000	18	19
	2001	28	29
	2003	39	NC[1]

Table 3-67. Comparison Between Existing Conditions and Supplemental Indicator Values for Martin Creek.

Parameter	Existing Condition	Target	
% Shade	67%	69%	Year 5
		71%	Year 10
		75%	Year 15
		85%	Late Seral

Thermal modification

Based on the temperature data currently available from FWP, it appears that Martin Creek has a relatively natural temperature regime and that elevated temperatures do not threaten or impair beneficial uses in the creek. When temperature data from Moose Creek (reference stream) is compared with Martin, there is very little difference. USFS fisheries biologist Mike Jakober, who was interviewed for this report, described the thermal regime in Martin Creek as mostly natural and said he had no reason to think that thermal modifications impair or threaten the fishery. Chris Clancy, fisheries biologist for FWP, expressed a similar opinion. Therefore, it is concluded that Martin Creek is not threatened for thermal modifications. No temperature TMDL has been developed. However, it is recommended that monitoring of the existing shade continue to help quantify Martin Creek's full potential in the event in-stream temperatures may decrease as shade increases.

Flow Alteration

As discussed above, less than 1% of the basin area has been harvested, eliminating silviculture as a possible cause of flow alterations in Martin Creek. Therefore, it is concluded that Martin Creek is not impaired for flow alterations and no TMDL has been developed.

3.9 Bitterroot Headwaters Water Quality Impairment Status Summary

The listed impairments for waterbodies in the Bitterroot Headwaters TPA were summarized in Tables 3-1 and 3-2. The available data suggest that in most cases the streams that appear on the 1996 and 2002 303(d) lists probably do not fully support their beneficial uses as a result of the pollutants that are included on the lists. However, in several cases, the data convincingly demonstrate that several pollutants are no longer limiting beneficial uses support. These pollutants include habitat alterations (sediment) in Deer Creek and Meadow Creek, lead and flow alterations in Overwhich Creek, nutrients and siltation in Moose Creek, noxious aquatic plants and flow alterations in the West Fork of the Bitterroot, and thermal modifications and flow alterations in Martin Creek. Consequently, no TMDLs have been developed for these pollutant/stream combinations.

TMDLs for all other impairment/stream combinations are presented later in this document. The primary pollutants of concern in these TMDLs are thermal modifications and sediment. For the purposes of this document, sediment is used to refer to a group of sediment-related pollutants including sediment, siltation, suspended solids and/or habitat alteration. Streams impaired by sediment included Buck Creek, Ditch Creek, Reimel Creek, East Fork of the Bitterroot River, Moose Creek, Gilbert/Laird Creek, West Fork of the Bitterroot River (the section below the dam is probably sediment limited), and Hughes Creek. Streams impaired by temperature (thermal modifications) include Overwhich Creek, Hughes Creek, Nez Perce Fork, and the East and West Forks of the Bitterroot River. Note that Hughes Creek and the West Fork of the Bitterroot River appear in both groups.

Additionally, the East Fork of the Bitterroot River will remain listed for flow alteration because insufficient data currently exist with which to make a beneficial use determination. However, no TMDL for flow alteration has been developed. Instead, flow alteration on the East Fork will be addressed in a phased approach as described in Sections 6.0.

The final impairment status of listed streams in the Bitterroot Headwaters TPA is summarized in Table 3-68.

Table 3-68. Final Impairment Status of the Listed Streams in the Bitterroot Headwaters TPA.

Waterbody	Listed Cause of Impairment[1]	1996 303(d) List	2002 303(d) List	Impaired Yes/No/Undetermined	TMDL Required	TMDL Developed
Buck Creek	Other Habitat Alterations	X		YES	NO	NO
	Siltation	X		YES	YES	YES
	Suspended Solids	X		YES	YES	YES
Ditch Creek	Other Habitat Alterations	X		YES	NO	NO
	Siltation	X		YES	YES	YES
	Suspended Solids	X		YES	YES	YES
Deer Creek	Other Habitat Alterations	X		NO	NO	NO
Hughes Creek	Other Habitat Alterations	X	X	YES	NO	NO
	Siltation	X		YES	YES	YES
	Suspended Solids	X		YES	YES	YES
	Thermal Modifications	X		YES	YES	YES
Overwhich Creek	Thermal Modifications	X		YES	YES	YES
	Flow Alterations	X		NO	NO	NO
	Lead		X	NO	NO	NO
	Metals		X	NO	NO	NO
Nez Perce Fork	Thermal Modifications	X		YES	YES	YES
West Fork Bitterroot River	Other Habitat Alterations	X	X	YES	NO	NO
	Siltation		X	YES	YES	YES
	Thermal Modifications	X		YES	YES	YES
	Noxious Aquatic Plants	X		NO	NO	NO
	Flow Alteration	X		NO	NO	NO
Moose Creek	Siltation	X	X	NO	NO	NO
	Nutrients		X	NO	NO	NO
Martin Creek	Thermal Modifications	X		NO	NO	NO
	Flow Alterations	X		NO	NO	NO
Meadow Creek	Other Habitat Alterations	X		NO	NO	NO
Reimel Creek	Other Habitat Alterations	X		YES	NO	NO
	Siltation	X		YES	YES	YES
	Suspended Solids	X		YES	YES	YES
Gilbert/Laird Creeks	Other Habitat Alterations	X	X	YES	NO	NO
	Siltation	X	X	YES	YES	YES
	Suspended Solids	X		YES	YES	YES
East Fork Bitterroot River	Other Habitat Alterations	X		YES	NO	NO
	Siltation	X		YES	YES	YES
	Flow Alterations	X		Undetermined	NO	NO
	Thermal Modifications			YES[3]	NO	YES

1 Other Habitat Alteration, Siltation, Suspended Solids are addressed collectively as Sediment throughout this document.
2 Insufficient data exists to confidently determine impairment status, however a conservative, more protective approach was taken by developing a TMDL and restoration strategy in these cases.
3 The East Fork Bitterroot River was not previously listed for thermal modifications, however it was determined that a thermal impairment exists and therefore a TMDL and restoration strategy was developed as part of this WQRP.

Water Quality Restoration Plan and Total Maximum Daily Loads for the Bitterroot Headwaters Planning Area

VOLUME II
TOTAL MAXIMUM DAILY LOAD ELEMENTS

Preface

Volume II, *Total Maximum Daily Load Elements*, contains Sections 4.0 through 7.0. These Sections include: Section 4.0: Sediment, Section 5.0: Temperature, Section 6.0: Flow, and Section 7.0: Endangered Species Considerations.

The format of this volume is designed to address pollutant sources, water quality goals, water quality targets, TMDLs, and load allocations for each impaired waterbody as defined in Section 3.0 of Volume I.

Sediment (discussed as siltation, TSS and habitat alterations in this document), temperature, and flow are the specific listed impairments in the BHPA. Given that these relatively small numbers of impairments are common among the listed streams, each "impairment" section then addresses that specific impairment in a waterbody-by-waterbody case. This enables the reader to focus on a particular waterbody of their interest while also concentrating on one impairment at a time.

It is important for the reader to understand terminology used in this section and how each term fits into the overall WQRP/TMDL. Four such terms are briefly described below:

- Source Assessment - A source assessment is a detailed inventory of all verified sources (to include natural sources) applicable to the impairment at question or any additional impairments that are believed to be affecting beneficial uses in the watershed being studied. Basically, a source assessment identifies all sources and estimates the load from each source. The source assessment allows for a linkage to water quality targets, to help determine impairment status; allows for the analysis to quantify loads from sources; and allows for analysis of mitigation measures that are expected to result in reductions of any human-cased sources.
- Allocations - Load allocations are best estimates of the loading of a particular source. For purposes of TMDL development, allocations consist of waste load allocation (point sources), and load allocations (non point sources and natural).
- Total Maximum Daily Load (TMDL) - The sum of the individual wasteload allocations (WLA), load allocations (LA) and natural background, plus a margin of safety. TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standard.
- Margin of Safety (MOS) - Accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving waterbody.

A detailed outline of each section within Volume II is provided below.

Section 4.0: The Sediment Section was developed to completely address all sediment related impairments in the BHPA. This section identifies all known sediment sources in the 303(d)-listed streams and provides a discussion on the assessment methods used to identify these sediment sources. The section then displays a waterbody-by-waterbody dialogue whereby source assessment results, load allocations, TMDLs, and MOS are developed in each waterbody.

Section 5.0: The Temperature Section was developed to completely address all temperature impairments in the BHPA. This section identifies all known temperature sources in the 303(d)-listed streams and provides a discussion on the assessment methods used to identify all temperature sources. The section then displays a waterbody-by-waterbody dialogue whereby source assessment results, load allocations, TMDLs, and MOS are developed in each waterbody.

Section 6.0: The Flow Section, while not a required TMDL element, was developed because flow is a driving mechanism that influences both sediment and temperature in the BHPA. Since the implementation portion of this Water Quality Restoration Plan (WQRP) and subsequent TMDL are voluntary, it is appropriate to analyze all parameters influencing water quality and beneficial uses. Therefore, flow was addressed as it relates to sediment and temperature in the BHPA. Since very little is currently understood about flow in the BHPA, no formal targets, load allocations or TMDLs were developed. Instead, a phased approach was presented by which flow issues in the BHPA could be addressed with future efforts.

Section 7.0: The Endangered Species Considerations Section, while also not a required element of the State for TMDL development, was developed to confine water quality goals and targets as they may relate to any known endangered species within the BHPA.

In addition to describing pollutant sources, developing TMDLs, and load allocations for all impairments of each waterbody, Volume II describes the technical analysis used to develop each element. Volume II also acknowledges all uncertainties associated with each element and links these uncertainties into the Monitoring Strategy as outlined in Volume III, Section 9.0. This “uncertainty analysis” is dovetailed with a Margin of Safety and Seasonality discussion at the end of Sections 4.0, 5.0 and 6.0.

SECTION 4.0
SEDIMENT

4.1 Introduction

This section provides:

- A description of the methodologies used to assess sediment sources in the Bitterroot Headwaters TPA.
- A summary of the results of the sediment source assessment for all sediment-listed streams.
- TMDLs for all of the sediment-listed streams.
- TMDL targets for all of the sediment-listed streams.

Streams within the Bitterroot Headwaters TPA that are listed for sediment and/or sediment related impairments and are therefore discussed in Section 4.0 include:

1) East Fork Bitterroot River
2) West Fork Bitterroot River
3) Ditch Creek
4) Buck Creek
5) Hughes Creek
6) Gilbert/Laird Creek
7) Reimel Creek

Deer Creek and Meadow Creek were listed for “other habitat alterations,” a sediment-related impairment, but were determined not to be impaired and therefore no TMDLs have been produced as discussed in Sections 3.8.1.5 and 3.8.4.5. Moose Creek was listed for siltation and nutrients, but recent data indicate no impairments due to these pollutant, as discussed in Section 3.8.9.7, and thus no TMDLs have been developed for this waterbody.

Section 5.0 presents a similar analysis and discussion for streams listed for temperature-related impairments. Section 6.0, discusses flow as it relates to dewatering. Section 7.0 provides a link between the sediment and temperature TMDLs presented in Sections 4.0 and 5.0 and the support of beneficial uses, particularly bull trout. Sections 8.0 and 9.0 present a restoration and monitoring strategy for all streams, regardless of why they were listed.

4.2 Source Characterization

This section provides a summary of all potentially significant point, non-point and natural sources of sediment. As discussed previously, the term sediment is used in this document to refer collectively to several closely-related pollutants, including sediment, siltation, suspended solids and/or habitat alteration that appear on the 303(d) list as summarized in Table 3-2.

4.2.1 Sediment Point Sources

There are no point sources of sediment in the project area.

4.2.2 Non-point Sediment Sources

Six potentially significant non-point sources of sediment were evaluated. These sources include natural background sediment loading, sediment from the fires of 2000, sediment from timber harvest activities, sediment from forest roads (BNF, county, and private ownership), sediment from stream bank instability, and sediment from road traction sanding. Due to comparatively small surface area of the waterbodies in this assessment, airborne sediment sources are not thought to be significant. The first three of these sediment sources – natural background, fires of 2000, and timber harvest – were quantified via computer modeling. The other three sources, forest roads, stream bank instability, and traction sanding, were evaluated with a combination of on-the-ground assessments and remote sensing techniques.

Grazing and conversion of floodplain to agriculture lands and housing development can result in changes in riparian vegetation and potentially large sediment loads in some cases. These sources were not assessed separately, but were included implicitly in the stream bank instability assessment. This document recommends a phased approach to partitioning sediment from stream bank instability to specific sources on the ground.

Because of the logistical difficulties in gaining access to private lands, assessment of sediment sources on private land was conducted primarily with air photo analysis. Although private lands account for only a small fraction of the total watershed area, they are concentrated near streams and in the floodplain, and thus may contribute a disproportionately large amount of the sediment loading in the watershed.

The source assessment conducted for this WQRP focused primarily on lands managed by the Bitterroot National Forest, which provided unlimited access to forest lands. In 1995 the forest amended the forest plan to include INFISH guidelines for all forest management activities. The INFISH guidelines include a buffer along all waterbodies, springs and wetlands. In addition, BNF applies all appropriate BMP’s to its forest management activities. As a result, much of the sediment loading from forestlands identified in this assessment appears to be the result of legacy issues from management that predates the 1995 amendments.

4.3 Source Assessment Methods

4.3.1 Modeling: Sediment from Natural Background Delivery, Timber Harvest, and Fires of 2000

The Burned Area Recovery (BAR) model was originally created to assist in the evaluation of sediment related impacts on water resources caused by non-channelized erosion following the 2000 fire season (LWC, 2001). The model was constructed to calculate post-fire sediment yield (as of June 2001) and estimate future increased sediment yields related to post-fire salvage logging activities proposed by the Bitterroot National Forest. This model was a principal component used in the Bitterroot National Forest’s Burned Area Recovery Environmental Impact Statement (EIS).

The BAR Sediment Yield Model is based on, and is an extension of, the Disturbed Watershed Erosion Prediction Project (Disturbed WEPP) model. WEPP was used to provide erosion quantities in tons/acre/year for various hillslope and vegetative cover classes. The BAR model takes the WEPP generated erosion quantities and generates a sediment yield quantity that is delivered to a stream. The percentage of erosion that is modeled as being delivered is based on (1) distance from the stream course, (2) vegetative cover category, and (3) hillslope gradient. The BAR model estimates sediment yield from every acre within a 1,200-foot buffer around the stream. These acre-specific sediment yield quantities are summed to produce a watershed-wide sediment yield. Debris flows, landslides, and other catastrophic erosional events are stochastic in nature and are beyond the capabilities of existing science to predict these events. The BAR model does not address these types of events.

Modeled estimates of sediment from timber harvest relate only to sediment load to streams that would result from the overland flow of water and resultant erosion. Because the WEPP model predicts 100% cover of vegetation along skid trails within five years of timber harvest and assumes zero delivery of sediment from harvest activities conducted at a distance of more than 1,200 feet from a stream, estimates of harvest-related sediment tend to be low or zero unless there have been recent timber harvests conducted near to streams.

Because little such harvest has occurred in the 303(d)-listed watersheds of the Bitterroot Headwaters TMDL planning area, estimates of sediment load from timber harvest are generally low. Timber harvest may also cause sediment loading to streams via pathways other than overland flow, including forest roads and stream bank erosion. These potential sources have been addressed elsewhere in the source assessment (Sections 4.3.2 and 4.3.3).

Several years elapsed between the completion of the sediment modeling and the release of this WQRP, and thus modeling results may overestimate the current loads. Similar post-fire modeling conducted for the Ninemile Watershed TMDL by the Lolo National Forest estimated that fire related sediment loads declined by more than 50% between 2000 and 2004, and similar reductions could be expected in the Bitterroot Headwaters. Nevertheless, the 2001 estimates are presented to maintain temporal consistency with other source assessment data and as a margin of safety in sediment loading estimates.

A summary of modeling results for all listed streams in the Bitterroot Headwaters TPA is presented in Section 4.4, and results are discussed on a stream-by-stream basis in Section 4.7.

4.3.2 Roads[10]

Analysis of potential sediment inputs from roads at stream crossings was conducted using the FroSAM model, a modified version of what is commonly referred to as the "Washington Method" (Washington Forest Practices Manual, 1998). The road assessment focused on forest roads managed by the Bitterroot National Forest and Ravalli County because of ease of access;

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10 Throughout this document, the terms "roads" should not be construed as applying strictly to roads managed by the Bitterroot National Forest, but is instead used to refer to all unpaved roads in the watershed that might contribute sediment to streams in the basin. These roads have been constructed and are maintained by a variety of owners and land managers, including the Bitterroot National Forest, Ravalli County, and private landowners.

private road were assessed where access was granted. A description of the methodology is included as Appendix E. Because of the large watershed and often-extensive road network, it was not possible to evaluate the sediment load from every road in the basin. Instead, all of the roads in the sediment-listed tributaries to the East and West Forks of the Bitterroot River were evaluated, and results were extrapolated to the non-listed tributaries to derive a total basin-wide sediment load from forest roads.

Since the road sediment loading analysis was completed in 2002, the Bitterroot National Forest has conducted sediment delivery mitigation work on many of the road in the listed watersheds, and thus the loads presented in this analysis may be an overestimate of current loads. BNF restoration work is discussed in Section 8.0.

A summary of road assessment results is presented in Section 4.4.1 and the results are discussed on a stream-by-stream basin in Section 4.7.

4.3.2.1 Extrapolation to the East and West Forks

GIS data layers obtained from the Bitterroot National Forest show 1,962 potential stream crossings in the East Fork Watershed. Of these, 376 were visited on the ground (in Laird, Gilbert, Moose, and Meadow Creeks), and were estimated to contribute a total of 301 tons of sediment/year, for an average of 0.80 tons/year/crossing. This average was applied to the 1,586 crossings that were not visited, for a total road crossing sediment contribution in the East Fork Watershed of 1,570 tons/year [(1586*0.80) + 301].

GIS data layers show 1,787 potential stream crossings in the West Fork Watershed. Of these, 218 were visited on the ground (in Buck, Ditch, and Hughes Creeks), and were estimated to contribute a total of 374 tons of sediment/year, for an average of 1.7 tons/year/crossing. This average was applied to the 1569 crossings that were not visited, for a total road crossing sediment contribution in the West Fork Watershed of 3,041 tons/year [(1569*1.7) + 374].

4.3.3 Sediment from Stream Bank Instability

Due to the size of the Bitterroot Headwaters TPA and the large number of listed stream miles, the assessment of stream bank conditions and related sediment sources had to strike a balance between collecting highly detailed information at a limited number of locations and providing a coarser, less detailed assessment across the entire watershed. To achieve this, a multi-scale approach was employed in the assessment of stream bank instability and related sediment loading. While none of the steps is a completely comprehensive assessment of bank condition, in sum they provide a reasonable approximation of the magnitude off the potential bank instability impacts in the listed streams. A more detailed on the ground assessment will be required to identify the mechanisms of bank failure and to devise restoration strategies where they are needed. The four steps of the assessment are described below:

Step 1: Bank Stability Reconnaissance

Early in the project, qualitative site visits were conducted in each of the watersheds listed for sediment-related pollutants. The purpose of these site visits was to determine in which of the listed watersheds stream bank instability was a potential source of sediment worthy of more detailed quantification. It was determined that in three watersheds, Ditch Creek, Buck Creek, and Reimel Creek, stream bank instability was not a significant anthropogenic source of sediment. In general, Ditch, Buck, and Reimel Creeks are small, low energy streams with low, well-vegetated, stable banks. As a result, Ditch, Buck and Reimel Creeks were not included in the subsequent steps of the bank instability source assessment, leaving Hughes Creek, West Fork of the Bitterroot, East Fork of the Bitterroot, Meadow Creek, Laird/Gilbert Creeks, and Moose Creek as part of this assessment.

Step 2: Air Photo Analysis

In order to provide an assessment across the entire length of all of the listed streams, sediment from stream bank instability was evaluated via air photos. Streams were delineated into assessment reaches using the following criteria: 1) ownership boundaries as identified by the NRIS Stewardship map, 2) significant changes in channel slope and/or valley type, 3) functional change in riparian vegetation, 4) at the confluence of tributary streams, and 5) at changes in aspect class (i.e. North-South, East-West).

Within each reach, bank conditions were delineated on USGS quad maps and then digitized into GIS, where the total length of unstable banks was calculated and compared to the total bank length as a measure of the magnitude of the bank instability and potential sediment load. This air photo assessment was a subtask of a more comprehensive air photo assessment that was used in the temperature source assessment, and thus the methods are discussed in more detail in the temperature source assessment in Section 5.0.

Step 3: On-the-ground Assessment

In some cases, small stream size and dense riparian vegetation precluded the identification of bank condition from the air photos. Although it is unlikely that stream segments that are protected with riparian vegetation so dense that it obscures the stream from view in aerial photographs are also impacted by significant anthropogenic bank instability problems, an on-the-ground component was added to the stream bank assessment as a site-specific analysis to augment and help validate the aerial photo work.

In this step of the analysis, field crews assessed bank conditions on-the-ground by providing a qualitative classification of bank conditions as either stable or unstable and delineating unstable banks on USGS quad maps. Unstable banks were then digitized into GIS and the length of unstable banks was calculated.

To calculate a total length of unstable bank by reach, the results of the air photo (Step 2) and on-the-ground (Step 3) assessment were summed after subtracting the length of bank labeled as unstable in both assessments to avoid double counting these areas.

Step 4: Bank Erosion Hazard Index (BEHI) Assessment

The BEHI assessments utilized a slightly modified version of the Rosgen (1996) method to characterize stream bank conditions into numerical indices of bank erosion potential. A complete description of the method is provided in Appendix F.

The BEHI methodology evaluates a stream bank's inherent susceptibility to erosion as a function of six factors, including:

1. The ratio of stream bank height to bankfull stage.
2. The ratio of riparian vegetation rooting depth to stream bank height.
3. The degree of rooting density.
4. The composition of stream bank materials.
5. Stream bank angle (i.e., slope).
6. Bank surface protection afforded by debris and vegetation.

In the Bitterroot Headwaters TPA, the BEHI assessment was conducted on approximately 28,600 feet (5.4 miles) of stream bank. Assessment locations were concentrated in the East and West Forks of the Bitterroot as these streams appeared from Steps 2 and 3 of the stream bank assessment to have the most significant bank-related sediment load, but included a minimum of approximately 2,000 feet of banks in each of the targeted streams.

This portion of the assessment did not result in a sediment load estimate, but instead provided an estimate of erosion potential in the listed streams. The bank instability assessment that was conducted as part of the Bitterroot Headwaters TMDL did not differentiate between natural and anthropogenic causes of bank instability, nor did it identify the mechanisms of bank failure; these tasks will fall to the implementation phase of the TMDL.

4.3.3.1 Additional Stream Bank Condition Parameter

As part of the assessment of thermal impacts (discussed in Section 5.0), an air photo assessment of riparian vegetation was conducted for inclusion in a modeling exercise that, among other things, estimated the number of years until the riparian vegetation in each of the air photo assessment stream reaches reached a late seral (mature) stage. As a proxy measure of increased susceptibility to stream bank erosion, the years to late seral modeling estimates were incorporated into the assessment of stream-bank stability. Reaches that exceeded 20 years to seral condition were labeled as “at risk” and digitized into GIS for analysis with bank conditions as described in Steps 2 and 3. Shrub and graminoid species were not considered in this analysis.

A summary of stream bank instability results is presented in Section 4.4.2 and the results are discussed on a stream-by-stream basin in Section 4.7.

4.3.4 Road Traction Sand

Road traction sanding during winter months provides a potential source of sediment loading to streams. In the Bitterroot Headwaters TMDL Planning Area, this risk applies to stream segments adjacent to three road segments: US Highway 93 parallels the East Fork of the Bitterroot from its confluence with the West Fork near Conner Montana upstream to Sula, Montana, where US 93 leaves the East Fork and instead follows Camp Creek to the Idaho boarder at Lost Trail Pass. Upstream from Sula, the East Fork is paralleled by the East Fork Road, which is sanded until approximately mile 14.4. Both highway 93 and the East Fork road are maintained and sanded by the Montana Department of Transportation (MDT). The West Fork of the Bitterroot River is paralleled by Montana State Route 473, which is sanded for approximately the lower 32 miles of its length by the Ravalli County Roads Department. Analysis of these roads indicates that the sanded portions within the BHPA encroach within 200 feet of the East Fork, West Fork and Camp Creek for approximately 23 miles (Table 4-1). Although Camp Creek is not a listed waterbody, it was included in this analysis because it is a tributary of the East Fork and thus a potential source of road sand.

Table 4-1. Proximity of Sanded Roads to Streams in the Bitterroot Headwaters TPA.

Stream	Length of Road within 100 Feet of Waterbody	Length of Road between 100 and 200 Feet of Waterbody
East Fork Bitterroot River	4.92	7.08
Camp Creek	1.11	1.09
West Fork Bitterroot River	3.79	4.90

Montana Department of Transportation (MDT) personnel provided information of the amount of sand spread on the highways in question. MDT applies sand at an average rate of approximately 1 ton/mile/year on highway 93 and the East Fork Road (Moeller pers com, 2004). No sand application rates could be obtained from Ravalli County, so it is assumed that the county applies sand at the same rate as MDT. Using this applications rate, Table 4-2 lists the amount of road sand applied on roads close to the East and West Forks of the Bitterroot and Camp Creek.

Table 4-2. Tons of Traction Sand Applied to Near-Stream Road Segments in the BHTPA.

Stream	Traction Sand Applied to Roads within 100 Feet of Stream	Traction Sand Applied to Roads between 100 and 200 Feet of Stream
East Fork Bitterroot River	4.92	7.08
Camp Creek	1.11	1.09
West Fork Bitterroot River	3.79	4.90

Assuming a conservatively high estimate of 10% delivery of traction sand from roads within 100 feet of these waterbodies and 5% delivery for roads between 100 and 200 feet from the streams, total sediment loads from road sanding are 0.846 tons/year delivered to the East Fork, and 0.166 tons/year delivered to Camp Creek, for a total load to the East Fork of 1.012 tons/year. An estimated 0.624 tons/year are delivered to the West Fork. In light of the relatively minor contribution of this source to the total sediment load in the East and West Forks of the Bitterroot

River, road sand is not included in subsequent discussions of sediment loading or in the TMDLs that follow.

4.3.5 Other Sediment Sources

Several other potential sediment sources were evaluated, but not included in the Load Allocation because of their minor contribution or because of difficulties in quantification. These include mass wasting, erosion associated with livestock grazing, and erosion from agricultural land. Although these potential sediment sources are not addressed directly, the bank instability analysis presented above integrates numerous water quality concerns described here.

Grazing

Three streams, Reimel Creek, Meadow Creek and the East Fork of the Bitterroot are listed in full or in part due to sediment loading from cattle grazing. In all 3 streams, the impact of cattle grazing on sediment production was addressed indirectly thorough assessment of stream bank instability. Although localized impacts are present in Reimel and Meadow Creeks, improved range management practices and the construction of grazing enclosures have resulted in improved conditions since the 1996 decision to list the streams (USFS, 2001a), and USFS personnel interviewed for this report have indicated that most of the past grazing-related problems on Meadow and Reimel Creeks have been addressed. Because the existing management system appears to be addressing grazing impacts on these streams, they are not incorporated into the TMDL. On the East Fork, grazing impacts occur primarily on private land and are thought to contribute sediment to the East Fork largely through increased stream bank instability. These potential impacts were evaluated in the assessment of stream bank instability described above in Section 4.3.3. The TMDL and allocation for bank-related sediment, including grazing-induced sediment loading, is presented as a reduction in bank instability in Section 4.4.2. Grazing and riparian management on the East Fork are also addressed as part of the implementation plan in Section 8.0.

Mass-Wasting

The large size of the Bitterroot Headwaters TMDL planning area and large tracts of largely roadless areas precluded a detailed on the ground assessment of mass wasting. It is recognized, however, that mass wasting may at times be a significant source of sediment to streams in the TPA, and that the fires of 2000 precipitated numerous mass wasting events in the watershed. The stochastic nature of mass wasting events, however, makes meaningful prediction and quantification of their sediment load impossible. However, the Bitterroot NF post-burn EIS included the following description of mass wasting events that had occurred prior to the time of its publication. Where mass wasting events threaten streams in the Bitterroot Headwaters TPA, the Bitterroot National Forest has implemented sediment-reduction measures.

East Fork Watershed

Numerous mudslides have occurred in the East Fork Geographic Area (GA) since the end of the 2000 fires. Most of the mudslides occurred during several weeks of intense thunderstorms in mid

July 2001. Some of the mudslides have caused widespread sedimentation of fish habitat, channel instability, "black water" conditions for several days to weeks, and fish kills, including:

- The lower 2.5 miles of Laird Creek (July, 2001)
- The East Fork near the confluence of Laird Creek (July, 2001)
- Reimel Creek upstream and downstream of Wallace Creek (July, 2001)
- An unnamed tributary to Camp Creek (July, 2001)

Additionally, the upper East Fork of the Bitterroot in the wilderness and Meadow Creek above the end of Road 5761 has had highly turbid water periodically since 2001.

On July 20-21, 2001, several intense thunderstorms triggered flash floods and a dozen large mudslides along the lower 2.5 miles of Laird Creek. The water level in Laird Creek increased rapidly by six feet during the height of the flash floods. Eleven large mudslides occurred on the north slopes of Laird Creek; one small mudslide occurred on the south slope. These mudslides deposited large fans of ash, silt, sand, and assorted debris in Laird Creek. Post-mudslide electroshocking surveys indicate that the majority of the bull trout, brook trout, and westslope cutthroat trout in the lower 2.5 miles of Laird Creek were killed by the mudslides and flash floods. The electroshocking surveys found no surviving fish in the mudslide-affected sections of Laird Creek on the Forest, but did capture two 10-inch bull trout, and several small brook trout and rainbow trout in the lower 0.25 miles on private land. Westslope cutthroat trout were also found in good numbers in Gilbert Creek and upper Laird Creek above the affected area. During the floods, residents in the area reported seeing fish swept far up onto the floodplain. Areas of abundant wood debris and pools prior to the mudslides are now shallow, unstable, aggraded riffles with most of the woody debris pushed high up onto the banks. Since the mudslides, Laird Creek has been actively down cutting through the gravel deposits and forming a new channel. Gilbert Creek had visible sand deposition in its stream bottom, but vegetation was intact along its banks, and woody debris was stable in its channel.

Based on Forest monitoring of the recovery of the Overwhich Creek fish populations following the 1992 mudslides, it took about 6-7 years for bull trout and westslope cutthroat trout populations in the affected portions of Overwhich Creek to fully recover to pre-mudslide levels (USFS, 2000a). A similar timeframe would be a reasonable estimate for westslope cutthroat trout in the affected portions of Laird Creek. Westslope cutthroat trout are common in upper Laird Creek, Moon Creek, and Gilbert Creek, and good numbers of migratory fish are present in the East Fork. These surviving fish would be the most likely sources of recolonization. Bull trout recovery may take longer in Laird Creek because there are fewer sources of recolonization. There are very few, if any, bull trout in Laird Creek upstream of the mudslides, and migratory bull trout are uncommon in the East Fork. Ongoing post-fire fisheries research will monitor native versus non-native trout recovery in Laird Creek.

Post-mudslides electroshocking surveys in the East Fork downstream of Laird Creek failed to detect a fish kill. Walking surveys along the stream banks also did not find any dead fish. Turbidities were extremely high for several days following the Laird Creek mudslides, but if fish were killed, it was not evident in the electroshocking and stream bank surveys.

Large mudslides occurred in the non-fish-bearing intermittent tributaries to Camp Creek downstream of Dick Creek and the headwaters of Reimel Creek on July 16-17, 2001. A few dead westslope cutthroat trout were observed along the stream banks of Reimel Creek and Camp Creek following these mudslides. In both streams, some westslope cutthroat trout appeared to have been swept downstream and deposited high and dry on the floodplain as flood flows rapidly receded. Compared to Laird Creek, fish kills in these two streams were probably much lighter and more localized.

Smaller mudslides have also occurred in the headwaters of the West Fork of Camp Creek near Porcupine Saddle (July, 2001), scattered areas in the Cameron Creek drainage (July, 2001), several intermittent draws on the east side of Camp Creek south of the Sula Ranger Station (July, 2001), several intermittent draws on Sula Peak (September, 2000), and numerous intermittent draws along the lower East Fork between Conner and Sula (July, 2001). A larger mudslide occurred in Lord Draw at the same time as the Laird Creek mudslides. None of these mudslides contributed a large quantity of sediment to fish-bearing streams, nor are they likely to have killed fish. The majority of the sediment created by the Lord Draw mudslides was deposited in a large fan about 0.25 miles west of Highway 93 and the East Fork.

“Black water” periods during the July 2001 thunderstorms have been observed at intervals lasting for several days to weeks in the flowing streams: Camp, Praine, Reimel, Wallace, Laird, Gilbert, Cameron, upper Tolan Creeks, and the East Fork downstream of Reimel Creek.

West Fork Watershed

One mudslide is known to have occurred in the West Fork Geographic Area since the end of the 2000 fires. This mudslide occurred in an unnamed, headwaters tributary to Chicken Creek during July 2001. The mudslide caused “black water” conditions in Chicken Creek and the West Fork between Chicken Creek and Painted Rocks Reservoir for several days. Post-mudslide electroshocking surveys in Chicken Creek captured fewer bull trout and westslope cutthroat trout than October 2000 post-fire surveys, which suggests that the mudslide may have killed some fish. Based on the results of post-mudslide fish population monitoring in the East Fork downstream of Laird Creek, it is unlikely that a detectable fish kill occurred in the West Fork below Chicken Creek since the concentrations and duration of the turbidity in the East Fork far exceeded that in the West Fork. “Black water” also occurred in Little Blue Joint Creek for several days after the July 2001 thunderstorms.

4.4 Source Assessment Summary and Results

There are no point sources associated with sediment loads in the Bitterroot Headwaters TPA. Five non-point sources have been identified as contributing significant quantities of sediment to the listed streams. These sources include natural background, fires of 2000, recent timber harvest, forest roads, and stream bank instability. Airborne sediment sources are considered to be negligible. Table 4-3 below summarizes each source of sediment and the methodology used to calculate each load**.**

Table 4-3. Source Assessment Method Summary.

Potential Sediment Source	Source Assessment Methodology
Point Sources	No known point sources exist
Natural Background	Burned Area Recovery Model
Timber Harvest (overland flow)	Burned Area Recovery Model
Fires of 2000	Burned Area Recovery Model
Forest Roads	Washington Road Sediment Assessment Method (modified)
Stream Bank Instability	• Bank Stability Reconnaissance • Air Photo Assessment • Rapid on-the-ground Assessment • Bank Erosion Hazard Index • Years to late-Seral modeling
Grazing	Included in assessment of stream bank instability and thus not separately quantified
Mass Wasting	Stochastic and therefore not quantified. Bitterroot National Forest is conducting ongoing monitoring and mitigation

4.4.1 Modeling: Sediment from Natural Background Delivery, Timber Harvest, and Fires of 2000

Table 4-4 presents a summary of modeled estimates of sediment generated from three sources: Natural Background, Timber Harvest, and Fires of 2000. The results are also discussed on a stream-by-stream basis in Section 4.7.

Table 4-4. Modeled Estimates of Sediment Load from Natural Background Sources, Timber Harvest, and the Fires of 2000 as of June 2001 (Tons/Year).

Stream	Watershed Size (mi^2)	Background Sediment tons/year and ($tons/mi^2$)	Sediment from Timber Harvest[1]	Area Burned in 2000 (mi^2)	Sediment from Fires of 2000 tons/year and ($tons/mi^2$)
Buck	2.4	72 (30)	-	0	-
Ditch	1.7	40 (24)	-	0	-
Hughes	59.8	1,095 (18)	-	6.8	1,491 (219)
West Fork	559.4	9,473 (17)	8.5	75	19,220 (256)
Laird/Gilbert	11.8	178 (15)	-	10	3,718 (372)
Moose	24.9	413 (17)	-	2	26 (13)
Meadow	32.1	514 (16)	15	21	4,046 (193)
Reimel	9.2	150 (16)	-	5.2	1,686 (517)
East Fork	407.3	7,246 (18)	617.1	203	50,642 (249)

[1] Sediment from overland flow only. Does not include sediment from other harvest related sources.

Table 4-5 presents a summary of estimated road sediment loading for all of the targeted streams. The results are also discussed on a stream-by-stream basin in Section 4.7. Appendix G, presents the data that was collected at each crossing, as well as maps showing the crossing locations.

Table 4-5. Sediment Load from Forest Roads.

Stream[1]	Road Sediment (tons/year)	% Of Background Sediment	Watershed Size (mi^2)	Miles of Roads	Road Density (mi/mi^2)	# Of Potential Crossings[2]
Buck	192	266	2	15.0	6.2	49
Ditch	70	175	2	8.3	8.3	18
Hughes	112	10	60	87.1	1.5	151
West Fork[1]	3,041	32	560	1,272	2.3	1,787
Laird/Gilbert	90	51	12	52.0	4.4	119
Moose	35	8.5	25	37.7	1.5	67
Meadow	173	34	32	81.9	2.5	177
Reimel	3.4	2.3	9	6.4	0.7	13
East Fork[1]	1,570	22	560	1,482	3.6	1,962

[1] Results for the East and West Fork watersheds were estimated by extrapolating from a sample of the total sites.
[2] Based on GIS road and stream layers. Some crossings that appear on GIS layers do not actually exist on the ground.

Nearly 600 potential forest road sediment delivery sites were analyzed on-the-ground as part of this TMDL effort, and 206 sediment contributing stream crossings and near-stream road segments were located and quantified. As can be seen in Figure 4-1, approximately 70% of the total estimated sediment load from contributing crossings can be attributed to only the 60 worst road sediment sources.

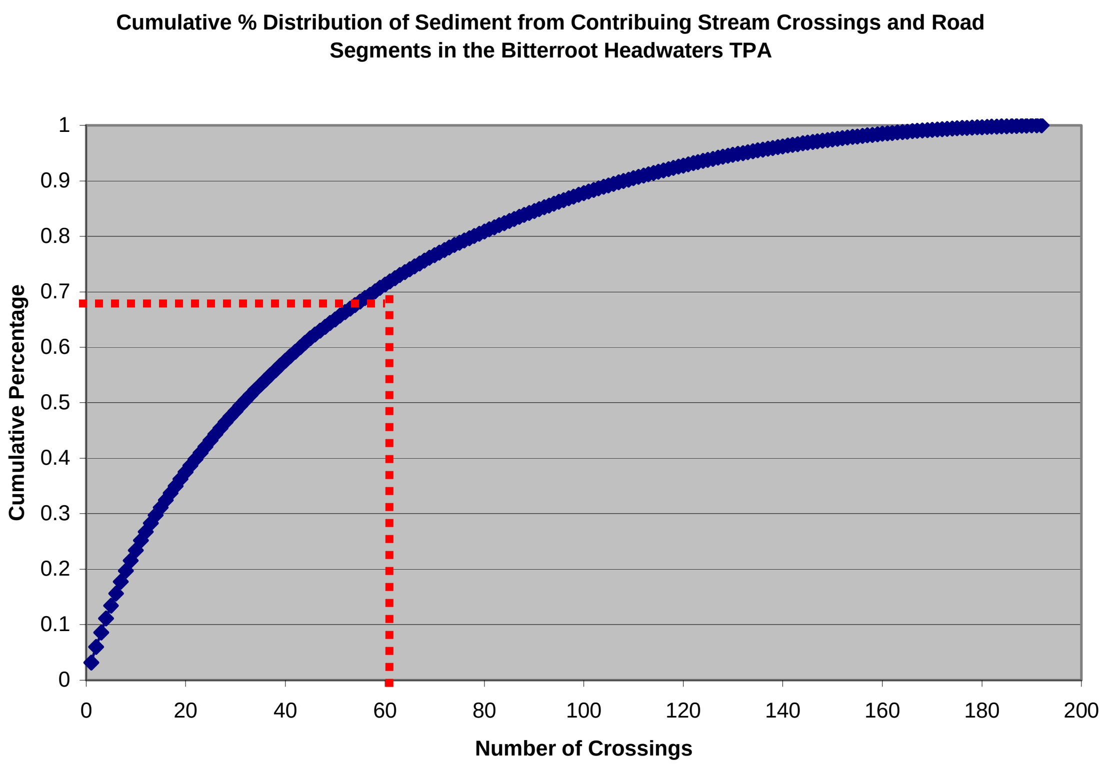


Figure 4-1. Cumulative % Distribution of Sediment from Contributing Stream Crossings and Road Segments in the Bitterroot Headwaters TPA.

4.4.2 Stream Bank Instability

Table 4-6 presents the combined results of the stream bank instability assessments in all of the listed streams, and the results are presented on a stream-by-stream basis in Section 4.7 below. Appendix H presents the assessment results by reach.

Table 4-6. Bank Instability Assessment Results.

Stream	Total Bank Length (miles)	% Unstable (air photo assessment)	% Unstable (on-the-ground assessment)	Total % Unstable (overlap removed)	% 20+ Years To Late Seral Veg. Condition	BEHI Results	
						BEHI Erosion Risk Category	% Of Banks Sampled
East Fork	87.0	1.4	3.6	4.9	3.2	Extreme	7.1
						Very High	0.5
						High	8.9
						Moderate	26.9
						Low	56.7
						Very Low	0
West Fork	86.9	4.9	3.6	8.2	5.5	Extreme	0.7
						Very High	4.4
						High	17.3
						Moderate	19.5
						Low	45.5
						Very Low	12.5
Hughes Creek	35.4	1.6	0	1.6	16.4	Extreme	0
						Very High	0
						High	0
						Moderate	22.5
						Low	60.9
						Very Low	16.6
Laird/Gilbert Creek	15.8	0	4.5	4.5	18.9	Extreme	0
						Very High	0
						High	18.5
						Moderate	63.4
						Low	18.1
						Very Low	0
Moose Creek	16.8	0.2	0	0.2	32.6	Extreme	8.2
						Very High	0
						High	0
						Moderate	58.5
						Low	33.2
						Very Low	0
Meadow Creek	20.2	0	2.3	2.3	23.7	Extreme	16.0
						Very High	0
						High	0
						Moderate	58.5
						Low	25.5
						Very Low	0

As is shown in Table 4-6, total bank instability estimates ranged from a low of 0.2% of total bank length in Moose Creek to a high of 8.2 % of total bank length in West Fork.

4.5 Future Development

Future developments within the BHTPA may have a negative impact on beneficial use support of cold-water fisheries and aquatic life. Potential future development includes timber harvest, agriculture, road construction and maintenance, mining, subdivision development, and increased recreational pressure. Future developments should consider the potential negative impacts on cold-water fisheries and aquatic life. Negative impacts to be avoided include road encroachment and the addition of riprap, placement of culverts that act as fish passage barriers and the removal of large woody debris and riparian vegetation. Other negative impacts with the potential to increase sediment and thermal loads may arise on a site-specific basis. Future developments should proceed only after potential negative impacts to water quality have been addressed and mitigation plans developed.

4.6 Water Quality Goals and Restoration Targets

As noted in Section 1.1, MDEQ is required to assess the waters for which TMDLs have been completed to determine whether compliance with water quality standards has been attained. The process by which this will be accomplished is discussed in Section 3.3 (Targets and Supplemental Indicators Applied as Water Quality Goals) and is shown in Figure 3-1. The sediment targets listed in Table 3-7 are proposed as the thresholds against which compliance with water quality standards will be measured in the BHTPA. If all the target threshold values are met, it will be assumed that beneficial uses are fully supported and water quality standards have been achieved. Alternatively, if one or more of the target threshold values are exceeded, it will be assumed that beneficial uses are not fully supported and water quality standards have not been achieved. However, it will not be automatically assumed that implementation of this TMDL was unsuccessful just because one or more of the target threshold values have been exceeded. The circumstances around the exceedance will be investigated. For example, the exceedance might be a result of natural causes such as floods, drought, fire or the physical character of the watershed. In addition, in accordance with MCA 75-5-703(9), an evaluation will be conducted to determine whether:

- The implementation of a new or improved suite of control measures is necessary;
- More time is needed to achieve water quality standards;
- Revisions to components of the TMDL are necessary; or
- Changes in land management practices occur.

Targets for the sediment-listed streams in the Bitterroot Headwaters TPA are presented in Section 3.3. However, the following “water quality goals” are the primary basin-wide objectives of this restoration project. These goals would be achieved through implementation efforts outlined in this restoration plan included in this report.

1. Ensure protection of all streams within the Bitterroot Headwaters TPA, with the intent of avoiding any future impairment conditions and ultimately reducing the overall threat of an impairment to any beneficial use;
2. Ensure full recovery of aquatic life beneficial uses to all impaired and threatened streams within the Bitterroot Headwaters TPA;

3. Avoid conditions where additional waterbodies within the Bitterroot Headwaters TPA become impaired;
4. Work with landowners and other stakeholders in a cooperative manner to ensure implementation of water quality protection activities; and
5. Continue to monitor conditions in the watershed to identify any additional impairment conditions, track progress toward protecting waterbodies in the watershed, and provide early warning if water quality starts to deteriorate.

These goals are further developed as part of the Restoration Strategy and Monitoring Plan sections of this document (Sections 8.0 and 9.0). To help define measurable objectives toward meeting Goals 1 through 3, numeric targets are developed within subsequent sections of the document. These targets are meant to reflect those conditions that need to be satisfied to ensure protection and/or recovery of beneficial uses. Goals 4 and 5 are designed to ensure cooperation exists among all parties involved.

A secondary objective of the restoration plan is to improve the connectivity of aquatic habitats throughout the watershed. This would be accomplished by correcting fish passage barriers at stream crossing culverts as outlined in Section 8.0.

4.7 Waterbody Specific Discussions

The following sections provide a stream-by-stream results of the sediment source assessment, as well as sediment TMDLs, allocations, and targets for each of the sediment-listed streams. These streams include Buck Creek, Ditch Creek, Reimel Creek, East Fork Bitterroot River, Gilbert/Laird Creek, Hughes Creeks, and West Fork Bitterroot River. Results are also presented for Moose and Meadow Creeks; however, as discussed in Section 3.0, beneficial uses in these streams do not appeared to be impaired by sediment and thus no sediment TMDLs have been developed.

4.7.1 Buck Creek

4.7.1.1 Results of Sediment Source Assessment

As was described in Section 4.3, 5 potential sources of sediment were assessed in Buck Creek. Sediment from natural background sources, the fires of 2000, and timber harvest were evaluated via computer modeling (Section 4.3.1). Sediment from forest roads was evaluated via an on-the-ground assessment that was described in Section 4.3.2. Stream bank instability was determined via a screening level assessment to be an insignificant source of sediment and it was therefore not included in subsequent more detailed assessments. Sediment source assessment results for Buck Creek are presented in Table 4-7.

Natural background sediment was estimated to be 72 tons/year. Modeled estimates of sediment from timber harvest relate only to sediment load to streams that would result from the overland flow of water and resultant erosion. The WEPP model predicts 100% cover of vegetation within five years of timber harvest and assumes zero delivery of sediment from harvest activities conducted at a distance of more than 1,200 feet from a stream. Because no recent, near-stream timber harvest has occurred in Buck Creek, the estimate of harvest-generated sediment is zero. The fires of 2000 did not burn in Buck Creek and thus no fire-related sediment was generated. Sediment from forest roads was estimated to be 192 tons/year, or approximately 266% of the natural background sediment load (Table 4-7). The source assessment was conducted in 2001 and 2002 and thus the results may not reflect current conditions.

Table 4-7. Buck Creek Sediment Source Assessment Results.

Watershed Size (mi^2)	Background Sediment tons/year	Sediment from Timber Harvest[1]	Fires of 2000		Forest Roads			
			Area Burned (mi^2)	Sediment tons/year	Miles of Roads	# Of Potential Crossings[2]	Road Density (mi/mi^2)	Sediment from Forest Roads (tons/year)
2.4	72	0	0	0	15.0	49	6.2	192

[1] Sediment from overland flow only. Does not include sediment from other harvest related sources.
[2] Based on GIS road and stream layers. Some crossings that appear on GIS layers do not actually exist on the ground.

4.7.1.2 Buck Creek Allocations and TMDL

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

TMDL = WLAs + LAs + MOS

Sediment from natural background sources is beyond human control. The Buck Creek Watershed did not burn in 2000 and no recent near stream timber harvest has occurred, thus modeling results indicate no sediment load from these sources. Stream banks in the watershed appeared to be largely stable. This leaves forest roads as the primary potential anthropogenic source of sediment in Buck Creek. The TMDL for Buck Creek will be expressed as a 50% reduction in total sediment load to Buck Creek. This will be achieved by a 68% reduction in the forest road sediment load resulting in a future total load of 133 tons/year. The uncertainties with this are further discussed in Section 4.10. Additional, but unquantifed reductions in sediment loading to Buck Creek can be expected from the implementation of other restoration and management actions prescribed in Section 8.0.

The reduction in forest road sediment loading for Buck Creek is shown in Table 4-8. As this is a non-point source TMDL, no waste load allocation is necessary. The load allocation is based on estimated road sediment delivery reductions that would occur if the tread, cut slope and fill slope lengths of all road crossings were reduced to a maximum of 200 ft.

Table 4-8. Existing Loads and Allocation for Buck Creek in Tons/Year.

Forest Roads (Existing)	Natural	Fires of 2000 (as of June 01)	Timber Harvest	Total	Proposed Reduction in Human Loading (Roads)
192	72	0	0	264	68%

The TMDL for Buck Creek is outlined in Table 4-9 below:

Table 4-9. TMDL for Buck Creek in Tons/Year.

Est. Background Load	Est. Load From Forest Roads Following Reduction	TMDL without Fires
72	61	133 (a 50% reductionin total load)

Roads

As was presented in Section 4.4, 49 potential sediment contributing stream crossings and near-stream road segments were evaluated as part of the sediment source assessment, resulting in an estimated 192 tons/year of sediment loading to Buck Creek. To address this sediment source, a road sediment reduction target has been set at 68 percent, representing a reduction of 131 tons of sediment per year. This road sediment reduction was calculated using the FroSAM road assessment methodology described in Section 4.3.2, and represents the estimated sediment load that would remain once all contributing road treads, cut slopes, and fill slopes were reduced to a maximum of 200 feet. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Although the FroSAM analysis was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from road may be occur through a variety of methods.

Unstable Stream Banks

As was discussed in the sediment source assessment methods (Section 4.3), stream bank instability was determined to be a currently insignificant source of sediment in Buck Creek. Although stream banks appeared largely stable, a stream bank stability goal has been developed as a measure of protection against degradation in the future. The goal condition has been set as no more than 10% of banks unstable in any reach. The goal was developed in recognition of bank instability as a natural component and sediment source in all streams. The bank instability assessment that was conducted as part of the Bitterroot Headwaters TMDL does not differentiate between natural and anthropogenic causes of bank instability; thus this task will fall to the implementation phase of the TMDL.

4.7.2 Ditch Creek

4.7.2.1 Results of Sediment Source Assessment

As was described in Section 4.3, 5 potential sources of sediment were assessed in Ditch Creek. Sediment from natural background sources, the fires of 2000, and timber harvest were evaluated via computer modeling (Section 4.3.1). Sediment from forest roads was evaluated via an on-the-ground assessment that was described in Section 4.3.2. Stream bank instability was determined via a screening level assessment to be an insignificant source of sediment and it was therefore not included in subsequent more detailed. Sediment Source Assessment results for Ditch Creek are presented in Table 4-10.

Natural background sediment was estimated to be 40 tons/year. Modeled estimates of sediment from timber harvest relate only to sediment load to streams that would result from the overland flow of water and resultant erosion. The WEPP model predicts 100% cover of vegetation within five years of timber harvest and assumes zero delivery of sediment from harvest activities conducted at a distance of more than 1,200 feet from a stream. Because no recent, near-stream timber harvest has occurred in Ditch Creek, the estimate of harvest-generated sediment is zero. The fires of 2000 did not burn in Ditch Creek and thus no fire-related sediment was generated. Sediment from forest roads was estimated to be 70 tons/year, or approximately 175% of the natural background sediment load (Table 4-10). The source assessment was conducted in 2001 and 2002 and thus the results may not reflect current conditions.

Table 4-10. Ditch Creek Sediment Source Assessment Results.

Watershed Size (mi^2)	Background Sediment tons/year	Sediment from Timber Harvest[1]	Fires of 2000		Forest Roads			
			Area Burned (mi^2)	Sediment tons/year	Miles of Roads	# Of Potential Crossings[2]	Road Density (mi/mi^2)	Sediment from Forest Roads (tons/year)
1.7	40	0	0	0	8.3	18	8.3	70

[1] Sediment from overland flow only. Does not include sediment from other harvest related sources.
[2] Based on GIS road and stream layers. Some crossings that appear on GIS layers do not actually exist on the ground.

4.7.2.2 Ditch Creek Allocations and TMDL

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

TMDL = WLAs + LAs + MOS

Sediment from natural background sources is beyond human control. The Ditch Creek Watershed did not burn in 2000 and no recent near stream timber harvest has occurred, thus modeling results indicate no sediment load from these sources. Stream banks in the watershed appeared to be largely stable. This leaves forest roads as the primary potential anthropogenic source of sediment in Ditch Creek. The TMDL for Ditch Creek will be expressed as a 40% reduction in total sediment load to Ditch Creek. This will be achieved by a 63% reduction in the forest road sediment load resulting in a future total load of 66 tons/year. The uncertainties with this are further discussed in Section 4.10. Additional, but unquantifed reductions in sediment loading to Ditch Creek can be expected from the implementation of other restoration and management actions prescribed in Section 8.0.

The reduction in human sediment loading for Ditch Creek is shown in Table 4-11. As this is a non-point source TMDL, no waste load allocation is necessary. The load allocation is based on estimated road sediment delivery reductions that would occur if the tread, cut slope and fill slope lengths of all road crossings were reduced to a maximum of 200 ft.

Table 4-11. Existing Loads and Allocation for Ditch Creek in Tons/Year.

Forest Roads (Existing)	Natural	Fires of 2000 (as of June 01)	Timber Harvest	Total	Proposed Reduction in Human Loading (Roads)
70	40	0	0	110	63%

The TMDL for Ditch Creek is outlined in Table 4-12 below:

Table 4-12. TMDL for Ditch Creek in Tons/Year.

Est. Background Load	Est. Load From Forest Roads Following Reduction	TMDL without Fires
40	26	66 (a 40% reduction in total load)

Road Sediment

As was presented in Section 4.4, 18 potential sediment contributing stream crossings and near-stream road segments were evaluated as part of the sediment source assessment, resulting in an estimated 70 tons/year of sediment loading to Ditch Creek. To address this sediment source, a road sediment reduction target has been set at 63 percent, representing a reduction of 44 tons of sediment per year. This road sediment reduction was calculated using the FroSAM road assessment methodology described in Section 4.3.2, and represents the estimated sediment load that would remain once all contributing road treads, cut slopes, and fill slopes were reduced to a maximum of 200 feet. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Although the FroSAM analysis was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from road may be occur through a variety of methods.

Unstable Stream Banks

As was discussed in the sediment source assessment methods (Section 4.3), stream bank instability was determined to be a currently insignificant source of sediment in Ditch Creek. Although stream banks appeared largely stable, a stream bank stability goal has been developed as a measure of protection against degradation in the future. The goal condition has been set as no more than 10% of banks unstable in any reach. The goal was developed in recognition of bank instability as a natural component and sediment source in all streams. The bank instability assessment that was conducted as part of the Bitterroot Headwaters TMDL does not differentiate between natural and anthropogenic causes of bank instability; thus this task will fall to the implementation phase of the TMDL.

4.7.3 Meadow Creek

4.7.3.1 Results of Sediment Source Assessment

As summarized in Section 3.8.4.5, Meadow Creek is not impaired for sediment and therefore no TMDL is developed as part of this WQRP. However, the data and analysis results of the source assessment that were used to support this conclusion are presented below.

As was described in Section 4.3, 5 potential sources of sediment were assessed in Meadow Creek. Sediment from natural background sources, the fires of 2000, and timber harvest were evaluated via computer modeling (Section 4.3.1). Sediment from forest roads was evaluated via an on-the-ground assessment that was described in Section 4.3.2. Stream bank instability was assessed with a multi-scale approach described in Section 4.3.3. A summary of source assessment results in all sediment-listed streams was presented in Section 4.4. The results specific to Meadow Creek are presented below in Table 4-13 (stream bank instability assessment) and Table 4-14 (background, timber harvest, fires of 2000, and forest roads).

As is shown in Table 4-13, the banks of Meadow Creek are largely stable. Of the approximately 20 miles of stream bank assessed, 0% appeared to be unstable from the air photo assessment; 2.3% of the stream bank length appeared to be unstable in the on-the-ground assessment. Approximately 24 percent of the stream bank length is bordered by riparian vegetation that was estimated to be more than 20 years from its seral condition, indicating that banks were possibly at risk of accelerated erosion. BEHI results indicated that most banks (84%) were at not more than a moderate risk of erosion (58.5% were at moderate risk; and 25.5% were at low risk); 16% were rated at extreme risk.

Table 4-13. Meadow Creek Bank Instability Assessment Results.

Total Bank Length (miles)	% Unstable (air photo assessment)	% Unstable (on-the-ground assessment)	Total % Unstable (overlap removed)	% 20+ Years To Late Seral Condition	BEHI Results	
					BEHI Erosion Risk Category	% Of Banks Sampled
20.2	0	2.3	2.3	23.7	Extreme	16.0
					Very High	0
					High	0
					Moderate	58.5
					Low	25.5
					Very Low	0

Natural background sediment was estimated to be 514 tons/year. Recent near-stream timber harvest resulted in an estimated 15 tons of sediment/year. The fires of 2000 burned extensively throughout the watershed, resulting in an estimated 4,046 tons of sediment/year, or approximately 790 percent of the pre-fire natural background sediment load. Sediment from forest roads was estimated to be 173 tons/year, or approximately 34% of the natural background sediment load (Table 4-14). The source assessment was conducted in 2001 and 2002 and thus the results may not reflect current conditions.

Table 4-14. Meadow Creek Sediment Source Assessment Results.

Watershed Size (mi^2)	Background Sediment tons/year	Sediment from Timber Harvest[1]	Fires of 2000		Forest Roads			
			Area Burned (mi^2)	Sediment tons/year	Miles of Roads	# Of Potential Crossings[2]	Road Density (mi/mi^2)	Sediment from Forest Roads (tons/year)
32.1	514	15	21	4,046	81.9	177	2.5	173

[1] Sediment from overland flow only. Does not include sediment from other harvest related sources.
[2] Based on GIS road and stream layers. Some crossings that appear on GIS layers do not actually exist on the ground.

4.7.4 Reimel Creek

4.7.4.1 Results of Sediment Source Assessment

As was described in Section 4.3, 5 potential sources of sediment were assessed in Reimel Creek. Sediment from natural background sources, the fires of 2000, and timber harvest (overland flow) were evaluated via computer modeling (Section 4.3.1). Sediment from forest roads was evaluated via an on-the-ground assessment that was described in Section 4.3.2. Stream bank instability was determined via a screening level assessment to be an insignificant source of sediment and it was therefore not included in subsequent more detailed assessment (Section 4.3.3). Sediment Source Assessment results for Reimel Creek are presented in Table 4-15.

Natural background sediment was estimated to be 150 tons/year. Modeled estimates of sediment from timber harvest relate only to sediment load to streams that would result from the overland flow of water and resultant erosion. The WEPP model predicts 100% cover of vegetation within five years of timber harvest and assumes zero delivery of sediment from harvest activities conducted at a distance of more than 1,200 feet from a stream. Because no recent, near-stream timber harvest has occurred in Reimel Creek, the estimate of harvest-generated sediment is zero. The fires of 2000 heavily impacted the Reimel Creek Watershed, producing an estimated sediment load of 1,686 tons/year, 1,124% of the natural background load. The sediment load from forest roads was estimated at 3.4 tons/year, or approximately 2.3% of the natural background sediment load (Table 4-15). The source assessment was conducted in 2001 and 2002 and thus the results may not reflect current conditions.

Table 4-15. Reimel Creek Sediment Source Assessment Results.

Watershed Size (mi²)	Background Sediment tons/year	Sediment from Timber Harvest[1]	Fires of 2000		Forest Roads			
			Area Burned (mi²)	Sediment tons/year	Miles of Roads	# Of Potential Crossings[2]	Road Density (mi/mi²)	Sediment from Forest Roads (tons/year)
9.2	150	0	5.2	1,686	6.4	13	0.7	3.4

[1] Sediment from overland flow only. Does not include sediment from other harvest related sources.
[2] Based on GIS road and stream layers. Some crossings that appear on GIS layers do not actually exist on the ground.

4.7.4.2 Reimel Creek Allocations and TMDL

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

TMDL = WLAs + LAs + MOS

Sediment from natural background sources and the fires of 2000 are beyond human control, leaving timber harvest and forest roads as potential anthropogenic sources of sediment in Reimel Creek. Because no near-stream timber harvest has occurred in the Reimel Creek watershed in the last five years, the estimated sediment load from this source was zero tons/year, leaving forest roads as the only significant anthropogenic source of sediment. The TMDL for Reimel Creek will be expressed as a 1% reduction in total sediment load to Reimel Creek. This will be achieved by a 65% reduction in the forest road sediment load resulting in a future total load of 151 tons/year. The uncertainties with this are further discussed in Section 4.10. Additional, but unquantifed reductions in sediment loading to Reimel Creek can be expected from the implementation of other restoration and management actions prescribed in Section 8.0.

The reduction in human sediment loading for Reimel Creek is shown in Table 4-16. As this is a non-point source TMDL, no waste load allocation is necessary. The load allocation is based on estimated road sediment delivery reductions that would occur if the tread, cut slope and fill slope lengths of all road crossings were reduced to a maximum of 200.

Allocations and TMDLs are presented with and without fire related sediment loads so that the impact of the fires on relative sediment loads can be observed.

Table 4-16. Existing Loads and Allocation for Reimel Creek in Tons/Year.

Forest Roads (Existing)	Natural	Fires of 2000 (as of June 01)	Timber Harvest	Total	Total Excluding Fires of 2000	Proposed Reduction in Human Loading (Roads)
3.4	150	1,686	0	1,839	153	65%

The TMDL for Reimel Creek is outlined in Table 4-17 below:

Table 4-17. TMDL for Reimel Creek in Tons/Year.

Est. Background Load including fires of 2000	Est. Background Load excluding fires of 2000	Est. Load From Forest Roads Following Reduction	TMDL with Fires	TMDL without Fires
1,836	150	1.2	1,837	151 (a 1% reduction in total load)

Road Sediment

As was presented in Section 4.4, 13 potential sediment contributing stream crossings and near-stream road segments were evaluated as part of the sediment source assessment, resulting in an estimated 3.4 tons/year of sediment loading to Reimel Creek. To address this sediment source, a road sediment reduction target has been set at 65 percent, representing a reduction of 2.2 tons of sediment per year. This road sediment reduction was calculated using the FroSAM road assessment methodology described in Section 4.3.2, and represents the estimated sediment load that would remain once all contributing road treads, cut slopes, and fill slopes were reduced to a maximum of 200 feet. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Although the FroSAM analysis was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from road may be occur through a variety of methods.

Unstable Stream Banks

As was discussed in the sediment source assessment methods (Section 4.3), stream bank instability was determined to be an insignificant source of sediment in Reimel Creek. Although stream banks appeared largely stable, a stream bank stability goal has been developed as well as a measure of protection against degradation in the future. The goal condition has been set as no more than 10% of banks unstable in any reach. The goal was developed in recognition of bank instability as a natural component and sediment source in all streams. The bank instability assessment that was conducted as part of the Bitterroot Headwaters TMDL does not differentiate between natural and anthropogenic causes of bank instability; thus this task will fall to the implementation phase of the TMDL.

4.7.5 East Fork

4.7.5.1 Results of Sediment Source Assessment

As was described in Section 4.3, 5 potential sources of sediment were assessed in the East Fork Watershed. Sediment from natural background sources, the fires of 2000, and timber harvest (overland flow) were evaluated via computer modeling (Section 4.3.1). Sediment from forest roads was evaluated via an on-the-ground assessment that was described in Section 4.3.2. Stream bank instability was assessed with a multi-scale approach described in Section 4.3.3. The results of the stream bank instability assessment are presented in Table 4-18. The results of the other sediment source assessments are presented in Table 4-19.

As is shown in Table 4-18, stream banks along the East Fork appeared to be largely stable. Of the approximately 87 miles of stream bank assessed, 1.4 % appeared to be unstable from the air photo assessment; 3.6% of the stream bank length appeared to be unstable in the on-the-ground assessment; for a total of 4.9% of the banks in an unstable condition after overlap between the two assessments was removed. Approximately 3.2 percent of the stream bank length is bordered by riparian vegetation that was estimated to be more than 20 years from its seral condition, indicating that these banks were possibly at risk of accelerated erosion. BEHI results indicated that approximate 83.6% of the banks were in at moderate (26.9%) or low (56.7%) risk of erosion. Approximately 16.5% of the banks were at high (8.9%), very high (0.5%) or extreme (7.1%) risk of erosion.

Table 4-18. Bank Instability Assessment Results.

Total Bank Length (miles)	% Unstable (air photo assessment)	% Unstable (on-the-ground assessment)	Total % Unstable (overlap removed)	% 20+ Years To Late Seral Condition	BEHI Results	
					BEHI Erosion Risk Category	% Of Banks Sampled
87	1.4	3.6	4.9	3.2	Extreme	7.1
					Very High	0.5
					High	8.9
					Moderate	26.9
					Low	56.7
					Very Low	0

As is shown in Table 4-19, natural background sediment was estimated to be 7,246 tons/year. Recent near-stream timber harvest resulted in an estimated 617 tons of sediment/year. The fires of 2000 burned extensively throughout the watershed, resulting in an estimated 50,642 tons of sediment/year, or approximately 700 percent of the pre-fire natural background sediment load. Sediment from forest roads was estimated to be 1,570 tons/year, or approximately 22% of the natural background sediment load (Table 4-19). The source assessment was conducted in 2001 and 2002 and thus the results may not reflect current conditions.

Table 4-19. East Fork Bitterroot River Sediment Source Assessment Results.

Watershed Size (mi^2)	Background Sediment tons/year	Sediment from Timber Harvest[1]	Fires of 2000		Forest Roads			
			Area Burned (mi^2)	Sediment tons/year	Miles of Roads	# Of Potential Crossings[2]	Road Density (mi/mi^2)	Sediment from Forest Roads (tons/year)
407.3	7,246	617	203	50,642	1,482	1,962	3.6	1,570

[1] Sediment from overland flow only. Does not include sediment from other harvest related sources.
[2] Based on GIS road and stream layers. Some crossings that appear on GIS layers do not actually exist on the ground.

East Fork Bitterroot River Allocations and TMDL

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

TMDL = WLAs + LAs + MOS

Sediment from natural background sources and the fires of 2000 are beyond human control, leaving timber harvest, stream bank instability and forest roads as potential anthropogenic sources of sediment in the East Fork.

Due to difficulties in estimating the sediment load resulting from unstable banks and partitioning this load between natural and anthropogenic sources, the TMDL and allocation for bank-related sediment is performance-based and presented as a reduction in bank instability as discussed below.

Timber harvest in the East Fork Watershed was estimated to have produced a sediment load of 617 tons/year, or approximately 8.5% of the estimated natural background load, and 1.2% of the sediment load from the fires of 2000. Because the sediment effects of timber harvest are typically short-lived and because in the East Fork they are relatively insignificant in light of the sediment produced by the fires of 2000, no reduction in this source is proposed for the TMDL. However, the sediment load produced from timber harvest is addressed indirectly through improvements in BMP applications and forest road rehabilitation.

The TMDL for the East Fork of the Bitterroot River will be expressed as a 42% reduction in the forest road sediment load and a 75% reduction in sediment from human caused bank erosion. The uncertainties with this are further discussed in Section 4.10. Additional, but unquantifed reductions in sediment loading to the East Fork can be expected from the implementation of other restoration and management actions prescribed in Section 8.0.

The reduction in human sediment loading for the East Fork is shown in Table 4-20. As this is a non-point source TMDL, no waste load allocation is necessary. The road allocation is based on estimated road sediment delivery reductions that would occur if the tread, cut slope and fill slope lengths of all road crossings were reduced to a maximum of 200 ft.

Allocations and TMDLs are presented with and without fire related sediment sources so that the impact of fires on relative sediment loads can be observed.

Table 4-20. Existing Loads and Allocation for the East Fork Bitterroot River in Tons/Year.

Forest Roads (Existing)	Natural	Fires of 2000 (as of June 01)	Timber Harvest	Total	Total Excluding Fires of 2000	Proposed Reduction in Sediment from Roads	Proposed Reduction in Sediment from Stream banks
1,570	7,246	50,642	617	60,075	9,433	42%	75%

Road Sediment

As was presented in Section 4.4, 371 of 1962 potential sediment contributing stream crossings and near-stream road segments were evaluated as part of the sediment source assessment. Results from the visited sites were extrapolated to the remaining sites to produce a basin-wide road sediment estimate of 1,570 tons/year. To address this sediment source, a road sediment reduction target has been set at 42% percent, representing a reduction of 659 tons of sediment per year. This road sediment reduction was calculated using the FroSAM road assessment methodology described in Section 4.3.2, and represents the estimated sediment load that would remain once all contributing road treads, cut slopes, and fill slopes were reduced to a maximum of 200 feet. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Although the FroSAM analysis was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from road may be occur through a variety of methods.

Performance-Based Allocation for Unstable Stream Banks

As shown in Table 4-18 stream banks in the East Fork appeared to be mostly stable. However, some localized erosion did appear to exist, as 7.1% of the banks assessed on the ground were in extreme BEHI risk category and 8.9% were in the high risk category. Although the extreme BEHI ratings are not necessarily indicative of human-caused instability (natural eroding high terraces often fall into the extreme BEHI category) they do warrant further on-the-ground evaluation and, if necessary, restoration. Potential bank instability problems appeared to be concentrated in assessment reaches 1, 2, 6, and 7, which are discussed in more detail in the restoration plan (Section 8.2.1.5.3). The allocation applied to accelerated bank erosion from human activities is a 75% reduction. As discussed above, this reduction is not based on the total bank erosion load since the assessment results did not provide this type of value. It is instead consistent with the percentage of human related bank erosion considered controllable along the banks of the East Fork. As an added measure of safety, an adaptive management strategy is outlined in Section 9.10. This strategy includes methods for achieving this performance-based allocation.

4.7.6 Gilbert and Laird Creeks

4.7.6.1 Results of Sediment Source Assessment

As was described in Section 4.3, 5 potential sources of sediment were assessed in Gilbert/Laird Creek. Sediment from natural background sources, the fires of 2000, and timber harvest (overland flow) were evaluated via computer modeling (Section 4.3.1). Sediment from forest roads was evaluated via an on-the-ground assessment that was described in Section 4.3.2. Stream bank instability was assessed with a multi-scale approach described in Section 4.3.3. The results of the stream bank instability assessment are presented in Table 4-21. The results of the other sediment source assessments are presented in Table 4-22.

As is shown in Table 4-21, of the approximately 15.8 miles of stream bank assessed, 0% appeared to be unstable from the air photo assessment and 4.5% of the stream bank length appeared to be unstable in the on-the-ground assessment. Approximately 18.9 of the stream bank length is bordered by riparian vegetation that was estimated to be more than 20 years from its seral condition, indicating that banks were possibly at risk of accelerated erosion. BEHI results indicated that most of the bank length (81.5%) was at low (18.1%) or moderate (63.4%) risk of erosion; 18.5% of the bank length was at high risk of erosion.

Table 4-21. Bank Instability Assessment Results.

Total Bank Length (miles)	% Unstable (air photo assessment)	% Unstable (on-the-ground assessment)	Total % Unstable (overlap removed)	% 20+ Years To Late Seral Condition	BEHI Results	
					BEHI Erosion Risk Category	% Of Banks Sampled
15.8	0	4.5	4.5	18.9	Extreme	0
					Very High	0
					High	18.5
					Moderate	63.4
					Low	18.1
					Very Low	0

As is shown in Table 4-22, natural background sediment was estimated to be 178 tons/year. Modeled estimates of sediment from timber harvest relate only to sediment load to streams that would result from the overland flow of water and resultant erosion. The WEPP model predicts 100% cover of vegetation within five years of timber harvest and assumes zero delivery of sediment from harvest activities conducted at a distance of more than 1,200 feet from a stream. Because no recent, near-stream timber harvest has occurred in Gilbert/Laird Creek, the estimate of harvest-generated sediment is zero. The fires of 2000 burned extensively throughout the watershed, resulting in an estimated 3,718 tons of sediment/year, or approximately 2100 percent of the pre-fire natural background sediment load. Sediment from forest roads was estimated to be 90 tons/year, or approximately 51% of the natural background sediment load. The source assessment was conducted in 2001 and 2002 and thus the results may not reflect current conditions.

Table 4-22. Gilbert/Laird Creek Sediment Source Assessment Results.

Watershed Size (mi^2)	Background Sediment tons/year	Sediment from Timber Harvest[1]	Fires of 2000		Forest Roads			
			Area Burned (mi^2)	Sediment tons/year	Miles of Roads	# Of Potential Crossings[2]	Road Density (mi/mi^2)	Sediment from Forest Roads (tons/year)
11.8	178	0	10	3,718	52	119	4.4	90

[1] Sediment from overland flow only. Does not include sediment from other harvest related sources.
[2] Based on GIS road and stream layers. Some crossings that appear on GIS layers do not actually exist on the ground.

4.7.6.2 Gilbert/Laird Creek Allocations and TMDL

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

TMDL = WLAs + LAs + MOS

Sediment from natural background sources and the fires of 2000 are beyond human control, leaving timber harvest, stream bank instability and forest roads as potential anthropogenic sources of sediment in Gilbert/Laird Creek.

Due to difficulties in estimating the sediment load resulting from unstable banks and partitioning this load between natural and anthropogenic sources, the TMDL and allocation for bank-related sediment will be performance-based and is presented as a reduction in bank instability as discussed below**.**

Because no recent, near-stream timber harvest has occurred in the Gilbert/Laird Creek watershed, the estimated sediment load from this source was 0 tons/year.

The TMDL for Gilbert/Laird Creek will be expressed as a 63% reduction in the forest road sediment load and a 75% reduction in sediment from human caused bank erosion. The uncertainties with this are further discussed in Section 4.10. Additional, but unquantifed reductions in sediment loading to Gilbert/Laird Creek can be expected from the implementation of other restoration and management actions prescribed in Section 8.0.

The reduction in human sediment loading for Gilbert/Laird Creek is shown in Table 4-23. As this is a non-point source TMDL, no waste load allocation is necessary. The road allocation is based on estimated road sediment delivery reductions that would occur if the tread, cut slope and fill slope lengths of all road crossings were reduced to a maximum of 200 ft.

Allocations and TMDLs are presented with and without fire related sediment sources so that the impact of fires on relative sediment loads can be observed.

Table 4-23. Existing Loads and Allocation for Gilbert/Laird Creek in Tons/Year.

Forest Roads (Existing)	Natural	Fires of 2000 (as of June 01)	Timber Harvest	Total	Total Excluding Fires of 2000	Proposed Reduction in Sediment from Roads	Proposed Reduction in Sediment from Stream banks
90	178	3,718	0	3,986	268	63%	75%

Road Sediment

As was presented in Section 4.4, 119 potential sediment contributing stream crossings and near-stream road segments were evaluated as part of the sediment source assessment, resulting in an estimated 90 tons/year of sediment loading to Gilbert/Laird Creek. To address this sediment source, a road sediment reduction target has been set at 63 percent, representing a reduction of 57 tons of sediment per year. This road sediment reduction was calculated using the FroSAM road assessment methodology described in Section 4.3.2, and represents the estimated sediment load that would remain once all contributing road treads, cut slopes, and fill slopes were reduced to a maximum of 200 feet. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Although the FroSAM analysis was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from road may be occur through a variety of methods.

Performance-Based Allocations for Unstable Stream Banks

As shown in Table 4-21, stream banks in Gilbert/Laird Creek appear to be mostly stable. However some localized erosion does appear to exist, as 18.5% of banks assessed on the ground fell into the high BEHI erosion risk category. Although the high-risk BEHI ratings are not necessarily indicative of human-caused instability (natural eroding high terraces often fall into the high BEHI category) they do warrant further on-the-ground evaluation and, if necessary, restoration. Potential bank instability problems appeared to be concentrated in assessment reaches 1 and 3, which are discussed in more detail in the restoration plan (Section 8.2.1.6.3). The allocation applied to accelerated bank erosion from human activities is a 75% reduction. As discussed above, this reduction is not based on the total bank erosion load since the assessment results did not provide this type of value. It is instead consistent with the percentage of human related bank erosion considered controllable along the banks of Gilbert/Laird Creek. As an added measure of safety, an adaptive management strategy is outlined in Section 9.10. This strategy includes methods for achieving this performance-based allocation.

4.7.7 Hughes Creek

4.7.7.1 Results of Sediment Source Assessment

As was described in Section 4.3, 5 potential sources of sediment were assessed in Hughes Creek. Sediment from natural background sources, the fires of 2000, and timber harvest were evaluated via computer modeling (Section 4.3.1). Sediment from forest roads was evaluated via an on-the-ground assessment that was described in Section 4.3.2. Stream bank instability was assessed with a multi-scale approach described in Section 4.3.3. The results of the stream bank instability assessment are presented in Table 4-24. The results of the other sediment source assessments are presented in Table 4-25.

As is shown in Table 4-24, of the approximately 34.5 miles of stream bank assessed, 1.6% appeared to be unstable from the air photo assessment, and 0% of the stream bank length appeared to be unstable in the on-the-ground assessment. Approximately 16.4% of the stream bank length is bordered by riparian vegetation that was estimated to be more than 20 years from its seral condition, indicating that banks were possibly at risk of accelerated erosion. BEHI results indicated that all of the bank length is at moderate or lower risk of erosion.

Table 4-24. Bank Instability Assessment Results.

Total Bank Length (miles)	% Unstable (air photo assessment)	% Unstable (on-the-ground assessment)	Total % Unstable (overlap removed)	% 20+ Years To Late Seral Condition	BEHI Results	
					BEHI Erosion Risk Category	% Of Banks Sampled
35.4	1.6	0	1.6	16.4	Extreme	0
					Very High	0
					High	0
					Moderate	22.5
					Low	60.9
					Very Low	16.6

As is shown in Table 4-25, natural background sediment was estimated to be 1,095 tons/year. Modeled estimates of sediment from timber harvest relate only to sediment load to streams that would result from the overland flow of water and resultant erosion. The WEPP model predicts 100% cover of vegetation within five years of timber harvest and assumes zero delivery of sediment from harvest activities conducted at a distance of more than 1,200 feet from a stream. Because no recent, near-stream timber harvest has occurred Hughes Creek, the estimate of harvest-generated sediment is zero. The fires of 2000 add a moderate impact in the watershed, resulting in an estimated 1,491 tons of sediment/year, or approximately 136 percent of the pre-fire natural background sediment load. Sediment from forest roads was estimated to be 112 tons/year, or approximately 10% of the natural background sediment load (Table 4-58). The source assessment was conducted in 2001 and 2002 and thus the results may not reflect current conditions.

Table 4-25. Hughes Creek Sediment Source Assessment Results.

Watershed Size (mi^2)	Background Sediment tons/year	Sediment from Timber Harvest[1]	Fires of 2000		Forest Roads			
			Area Burned (mi^2)	Sediment tons/year	Miles of Roads	# Of Potential Crossings[2]	Road Density (mi/mi^2)	Sediment from Forest Roads (tons/year)
59.8	1,095	0	6.8	1,491	87.1	151	1.5	112

[1] Sediment from overland flow only. Does not include sediment from other harvest related sources.
[2] Based on GIS road and stream layers. Some crossings that appear on GIS layers do not actually exist on the ground.

4.7.7.2 Hughes Creek Allocations and TMDL

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

TMDL = WLAs + LAs + MOS

Sediment from natural background sources and the fires of 2000 are beyond human control, leaving timber harvest, stream bank instability and forest roads as potential anthropogenic sources of sediment in Hughes Creek.

Due to difficulties in estimating the sediment load resulting from unstable banks and partitioning this load between natural and anthropogenic sources, the TMDL and allocation for bank-related sediment will be performance-based and is presented as a reduction in bank instability as discussed below.

Because little near-stream timber harvest has occurred in the Hughes Creek watershed in the last five years, the estimated sediment load from this source was 0 tons/year.

The TMDL for Hughes Creek will be expressed as a 36% reduction in the forest road sediment load and a 75% reduction in sediment from human caused bank erosion. The uncertainties with this are further discussed in Section 4.10. Additional, but unquantifed reductions in sediment loading to Hughes Creek can be expected from the implementation of other restoration and management actions prescribed in Section 8.0.

The reduction in human sediment loading for Hughes Creek is shown in Table 4-26. As this is a non-point source TMDL, no waste load allocation is necessary. The road allocation is based on estimated road sediment delivery reductions that would occur if the tread, cut slope and fill slope lengths of all road crossings were reduced to a maximum of 200 ft.

Allocations and TMDLs are presented with and without fire related sediment sources so that the impact of fires on relative sediment loads can be observed.

Table 4-26. Existing Loads and Allocation Hughes Creek in Tons/Year.

Forest Roads (Existing)	Natural	Fires of 2000 (as of June 01)	Timber Harvest	Total	Total Excluding Fires of 2000	Proposed Reduction in Sediment from Roads	Proposed Reduction in Sediment from Stream banks
112	1,095	1,491	0	2,698	1,603	36%	75%

Road Sediment

As was presented in Section 4.4, 151 potential sediment contributing stream crossings and near-stream road segments were evaluated as part of the sediment source assessment, resulting in an estimated 112 tons/year of sediment loading to Hughes Creek. To address this sediment source, a road sediment reduction target has been set at 36 percent, representing a reduction of 40 tons of sediment per year. This road sediment reduction was calculated using the FroSAM road assessment methodology described in Section 4.3.2, and represents the estimated sediment load that would remain once all contributing road treads, cut slopes, and fill slopes were reduced to a maximum of 200 feet. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Although the FroSAM analysis was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from road may be occur through a variety of methods.

Performance-Based Allocations for Unstable Stream Banks

As shown in Table 4-24, stream banks in Hughes Creek appear to be mostly stable. However, because ongoing and historic mining has created some localized instability, an allocation has been developed. The allocation applied to accelerated bank erosion from human activities is a 75% reduction. Potential bank instability problems appeared to be concentrated in assessment reach 13, which is discussed in more detail in the restoration plan (Section 8.2.1.7.3). As discussed above, this reduction is not based on the total bank erosion load since the assessment results did not provide this type of value. It is instead consistent with the percentage of human related bank erosion considered controllable along the banks of Hughes Creek. As an added measure of safety, an adaptive management strategy is outlined in Section 9.10. This strategy includes methods for achieving this performance-based allocation.

4.7.8 Moose Creek

4.7.8.1 Results of Sediment Source Assessment

As summarized in Section 3.8.9.7, Moose Creek is not impaired for sediment and therefore no TMDL is developed as part of this WQRP. However, the data and analysis results of the source assessment that were used to support this conclusion are presented below.

As was described in Section 4.3, 5 potential sources of sediment were assessed in Moose Creek. Sediment from natural background sources, the fires of 2000, and timber harvest (overland flow) were evaluated via computer modeling (Section 4.3.1). Sediment from forest roads was evaluated via an on-the-ground assessment that was described in Section 4.3.2. Stream bank instability was assessed with a multi-scale approach described in Section 4.3.3. The results of the stream bank instability assessment are presented in Table 4-27. The results of the other sediment source assessments are presented in Table 4-28.

As is shown in Table 4-27, of the approximately 16.8 miles of stream bank assessed, 0.2% appeared to be unstable from the air photo assessment; 0% of the stream bank length assessed on-the-ground appeared to be unstable. Approximately 32.6 of the stream bank length is bordered by riparian vegetation that was estimated to be more than 20 years from its seral condition, indicating that banks were possibly at risk of accelerated erosion. BEHI results indicated that most of the stream banks (91.7%) were at moderate (58.5%) or low (33.2%) risk of erosion; another 8.2% were at extreme risk.

Table 4-27. Bank Instability Assessment Results.

Total Bank Length (miles)	% Unstable (air photo assessment)	% Unstable (on-the-ground assessment)	Total % Unstable (overlap removed)	% 20+ Years To Late Seral Condition	BEHI Results	
					BEHI Erosion Risk Category	% Of Banks Sampled
16.8	0.2	0	0.2	32.6	Extreme	8.2
					Very High	0
					High	0
					Moderate	58.5
					Low	33.2
					Very Low	0

As is shown in Table 4-28, natural background sediment was estimated to be 413 tons/year Modeled estimates of sediment from timber harvest relate only to sediment load to streams that would result from the overland flow of water and resultant erosion. The WEPP model predicts 100% cover of vegetation within five years of timber harvest and assumes zero delivery of sediment from harvest activities conducted at a distance of more than 1,200 feet from a stream. Because no recent, near-stream timber harvest has occurred in Moose Creek, the estimate of harvest-generated sediment is zero. The fires of 2000 had a minor impact in the watershed, resulting in an estimated 66 tons of sediment/year, or approximately 16 percent of the pre-fire natural background sediment load. Sediment from forest roads was estimated to be 35 tons/year, or approximately 8.5% of the natural background sediment load. The source assessment was conducted in 2001 and 2002 and thus the results may not reflect current conditions.

Table 4-28. Moose Creek Sediment Source Assessment Results.

Watershed Size (mi^2)	Background Sediment tons/year	Sediment from Timber Harvest[1]	Fires of 2000		Forest Roads			
			Area Burned (mi^2)	Sediment tons/year	Miles of Roads	# Of Potential Crossings[2]	Road Density (mi/mi^2)	Sediment from Forest Roads (tons/year)
24.9	413	0	2	26	37.7	67	1.5	35

[1] Sediment from overland flow only. Does not include sediment from other harvest related sources.
[2] Based on GIS road and stream layers. Some crossings that appear on GIS layers do not actually exist on the ground.

4.7.9 West Fork

4.7.9.1 Results of Sediment Source Assessment

As was described in Section 4.3, 5 potential sources of sediment were assessed in the West Fork Watershed. Sediment from natural background sources, the fires of 2000, and timber harvest (overland flow) were evaluated via computer modeling. Sediment from forest roads was evaluated via an on-the-ground assessment that was described in Section 4.3.2 and Appendix E. Stream bank instability was assessed with a multi-scale approach described in Section 4.3.3. The results of the stream bank instability assessment are presented in Table 4-29. The results of the other sediment source assessments are presented in Table 4-30.

As is shown in Table 4-29, of the approximately 86.9 miles of stream bank assessed, 4.9 % appeared to be unstable from the air photo assessment; 3.6% of the stream bank length appeared to be unstable in the on-the-ground assessment; for a total of 8.2% of the banks in an unstable condition after overlap between the two assessments was removed. Approximately 5.5 percent of the stream bank length is bordered by riparian vegetation that was estimated to be more than 20 years from its seral condition, indicating that these banks were possibly at risk of accelerated erosion. BEHI results indicated that approximate 77.5% of the banks were in at moderate or lower risk of erosion, with 12.5% very low, 45.5% low and 19.5% moderate. Most of the remaining banks were at high risk of erosion (17.3%), with an additional 4.4% at very high risk and 0.7 at extreme risk.

Table 4-29. Bank Instability Assessment Results.

Total Bank Length (miles)	% Unstable (air photo assessment)	% Unstable (on-the-ground assessment)	Total % Unstable (overlap removed)	% 20+ Years To Late Seral Condition	BEHI Results	
					BEHI Erosion Risk Category	% Of Banks Sampled
86.9	4.9	3.6	8.2	5.5	Extreme	0.7
					Very High	4.4
					High	17.3
					Moderate	19.5
					Low	45.5
					Very Low	12.5

As is shown in Table 4-30, natural background sediment was estimated to be 9,473 tons/year. Recent near-stream timber harvest resulted in an estimated 8.5 tons of sediment/year. The fires of 2000 burned extensively throughout the watershed, resulting in an estimated 19,220 tons of sediment/year, or approximately 200 percent of the pre-fire natural background sediment load. Sediment from forest roads was estimated to be 3,041 tons/year, or approximately 32% of the natural background sediment load. The source assessment was conducted in 2001 and 2002 and thus the results may not reflect current conditions.

Table 4-30. West Fork Bitterroot River Sediment Source Assessment Results.

Watershed Size (mi^2)	Background Sediment tons/year	Sediment from Timber Harvest[1]	Fires of 2000		Forest Roads			
			Area Burned (mi^2)	Sediment tons/year	Miles of Roads	# Of Potential Crossings[2]	Road Density (mi/mi^2)	Sediment from Forest Roads (tons/year)
559.4	9,473	8.5	75	19,220	1,272	1,787	2.3	3,041

[1] Sediment from overland flow only. Does not include sediment from other harvest related sources.
[2] Based on GIS road and stream layers. Some crossings that appear on GIS layers do not actually exist on the ground.

4.7.9.2 West Fork Bitterroot River Allocations and TMDL

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

TMDL = WLAs + LAs + MOS

Sediment from natural background sources and the fires of 2000 are beyond human control, leaving timber harvest, stream bank instability and forest roads as potential anthropogenic sources of sediment in the West Fork.

Due to difficulties in estimating the sediment load resulting from unstable banks and partitioning this load between natural and anthropogenic sources, the TMDL and allocation for bank-related sediment will be performance-based and is presented as a reduction in bank instability as discussed below.

Timber harvest in the West Fork Watershed was estimated to have produced a sediment load of 8.5 tons/year. Because the sediment effects of timber harvest are typically short-lived and because in the West Fork they are relatively insignificant in light of the sediment produced by the fires of 2000, no reduction in this source is proposed for the TMDL. However, the sediment load produced from timber harvest is addressed indirectly through improvements in BMP applications and forest road rehabilitation.

The TMDL for the West Fork will be expressed as a 57% reduction in the forest road sediment load and a 75% reduction in sediment from human caused bank erosion. The uncertainties with this are further discussed in Section 4.10. Additional, but unquantifed reductions in sediment loading to the West Fork Creek can be expected from the implementation of other restoration and management actions prescribed in Section 8.0.

The reduction in human sediment loading for the West Fork is shown in Table 4-31. As this is a non-point source TMDL, no waste load allocation is necessary. The road allocation is based on estimated road sediment delivery reductions that would occur if the tread, cut slope and fill slope lengths of all road crossings were reduced to a maximum of 200 ft.

Allocations and TMDLs are presented with and without fire related sediment sources so that the impact of fires on relative sediment loads can be observed.

Table 4-31. Existing Loads and Allocation for the West Fork in Tons/Year.

Forest Roads (Existing)	Natural	Fires of 2000 (as of June 01)	Timber Harvest	Total	Total Excluding Fires of 2000	Proposed Reduction in Sediment from Roads	Proposed Reduction in Sediment from Stream banks
3,041	9,473	19,220	8.5	31,742	12,522	57%	75%

Road Sediment

As was presented in Section 4.4, 218 of 1,787 potential sediment contributing stream crossings and near-stream road segments were evaluated as part of the sediment source assessment. Results from the visited sites were extrapolated to the remaining sites to produced a basin-wide road sediment estimate of 3,041 tons/year. To address this sediment source, a road sediment reduction target has been set at 57% percent, representing a reduction of 1,733 tons of sediment per year. This road sediment reduction was calculated using the FroSAM road assessment methodology described in Section 4.3.2, and represents the estimated sediment load that would remain once all contributing road treads, cut slopes, and fill slopes were reduced to a maximum of 200 feet. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Although the FroSAM analysis was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from road may be occur through a variety of methods.

Performance-Based Allocations for Unstable Stream Banks

As was discussed in the sediment source assessment methods (Section 4.3), stream bank instability was determined to be a potentially significant source of sediment in the West Fork, with 8.2% of the total bank length unstable. However, no loads were quantified and the cause of the instability was not determined. These task will fall to the implementation stage of the TMDL. More details are provided in Section 8.2.1.8.3. The allocation applied to accelerated bank erosion from human activities is a 75% reduction. As discussed above, this reduction is not based on the total bank erosion load since the assessment results did not provide this type of value. It is instead consistent with the percentage of human related bank erosion considered controllable along the banks of the West Fork. As an added measure of safety, an adaptive management strategy is outlined in Section 9.10. This strategy includes methods for achieving this performance-based allocation.

4.8 Waterbody Summary

There are no point sources associated with the overall load of the Bitterroot Headwaters TPA. Non-point sources such as surface erosion and surface runoff from roads have been identified as the greatest factors to the overall anthropogenic sediment load. Primary contributors are roads and unstable stream banks. Airborne sediment sources are thought to be negligible.

The reduction in human loading for all impaired streams in BHTPA are shown in Table 4-32. As this is a non-point source TMDL, no waste load allocation is necessary. The load allocation for Buck Creek, Ditch Creek, Reimel Creek, East Fork, Gilbert and Laird Creeks, Hughes Creek and the West Fork are based on modeled sediment delivery given planned road BMP improvements and road closures in the basin. These load allocations also include estimates of natural background sediment loading as discussed in Section 4.3. In the East Fork, Gilbert and Laird, Hughes, and the West Fork, allocations are based on best professional judgment and the percentage of human caused bank erosion considered controllable along the BHTPA streams.

Table 4-32. Sediment Load Allocation, Percent Reductions and TMDLs for the Bitterroot Headwaters TPA (Values are in Tons/Year).

Buck Creek	
Natural Load	72
Existing Forest Road Load	192
Percent of stream with significant bank erosion[1]	0
Reduction from Forest Roads	131 (68%)
Reduction from Stream banks	NA
Ditch Creek	
Natural Load	40
Existing Forest Road Load	70
Percent of stream with significant bank erosion[1]	0
Reduction from Forest Roads	44 (63%)
Reduction from Stream banks	NA
Reimel Creek	
Natural Load (with Fires)	1, 836
Existing Forest Road Load	3.4
Percent of stream with significant bank erosion[1]	0
Reduction from Forest Roads	2.2(65%)
Reduction from Stream banks	NA
East Fork	
Natural Load (with Fires)	57,888
Existing Forest Road Load	1, 570
Load from Timber Harvest	617
Percent of stream with significant bank erosion[1]	43.4
Reduction from Forest Roads	659(42%)
Reduction from Stream banks	75%
Gilbert/Laird Creeks	
Natural Load (with Fires)	3, 896
Existing Forest Road Load	90

Table 4-32. Sediment Load Allocation, Percent Reductions and TMDLs for the Bitterroot Headwaters TPA (Values are in Tons/Year).

Percent of stream with significant bank erosion[1]	81.9
Reduction from Forest Roads	57 (63%)
Reduction from Stream banks	75%
Hughes Creek	
Natural Load (with Fires)	2, 586
Existing Forest Road Load	112
Percent of stream with significant bank erosion[1]	22.5
Reduction from Forest Roads	40 (36%)
Reduction from Stream banks	75%
West Fork	
Natural Load (with Fires)	28,693
Existing Forest Road Load	3,041
Load from Timber Harvest	8.5
Percent of stream with significant bank erosion[1]	41.9
Reduction from Forest Roads	1,733 (57%)
Reduction from Stream banks	75%

[1] Length of stream bank in moderate, high, very high, or extreme BEHI categories as shown in Table 4-4.

4.9 Future Allocations for All Waterbodies

Potential future developments within the Bitterroot Headwaters Planning Area were considered and potential impacts addressed. It is not reasonable to assume that there will be no future development in the Bitterroot Headwaters Planning Area. An allocation is therefore required to account for potential future sediment loading. This allocation proposes no future sediment loading increases associated with the aforementioned sediment sources in this document, other than minor, short-term increases that may be predicted and associated with compliance with applicable best management practices.

4.10 Uncertainty Analysis

In order to complete many of the steps required for this WQRP, the best available and feasible technical analyses and subsequent linkages were used to draw conclusions. However, as with most natural resource issues, these conclusions must weigh natural variability and uncertainties that may arise. Variability, uncertainty, seasonality and a Margin of Safety (MOS) as they pertain to the sediment analyses and their subsequent conclusions are described below. Uncertainties associated with target and indicator development was discussed in Section 3.7.

To help address all the assumptions and uncertainties that exist in this WQPR, a monitoring and adaptive management strategy was developed as outlined in Section 9.0. One purpose of this strategy is to both gather additional data and utilize new technologies as they arise. Together, both will help gain better confidence in the decisions that are made today and in the future surrounding beneficial use support in the Bitterroot Headwaters TPA.

4.10.1 Source Assessment Uncertainty

As described above, a substantial effort was made to identify all significant anthropogenic sources of sediment loading in the listed watersheds of the Bitterroot Headwaters TPA. Where possible, estimates of sediment loads from each of the sources were also made. Although it is felt that this has resulted in sufficient information to reach the conclusions presented in this report, there are still some uncertainties regarding whether or not all of the significant sources have been identified, and regarding the quantification of sediment loads. The primary uncertainties include:

- Bank erosion analysis used to estimate the sediment load from eroding banks looked at only a sample of stream banks in the BHTPA and assumed that the banks that were assessed were typical of banks throughout the listed watersheds.
- It was assumed in the stream bank instability assessment that the land use in closest proximity to each eroding bank was the primary cause of the erosion. It may be possible however that some or all of the erosion results from more complicated systemic problems that were not considered, such as increased water yield or peak flows.
- All modeling estimates have not been verified with recent sediment monitoring.
- Sediment load estimates represent average conditions, but actual sediment loads may vary by an order of magnitude due to natural variability. Modeling estimates were completed in 2001 and may not accurately reflect current conditions. However, they serve as a starting point in the WQRP.

4.10.2 TMDL and Load Allocation Uncertainty

The analysis presented in this document assumes that the load reductions proposed for each of the listed streams will enable the streams to meet target condition, and further assumes that meeting target conditions will ensure full support of all beneficial uses. To validate this assumption, implementation monitoring has been proposed in the monitoring plan and adaptive management strategy in Section 9.0. This monitoring is intended to track progress toward meeting targets. If it looks like greater reductions in loading or improved performance is necessary to meet targets, then a new TMDL and/or allocations will be developed based on achievable reductions via application of reasonable land, soil, and water conservations practices. The linkage between meeting targets and supporting beneficial uses will be monitored through several of the supplemental indicators described in Section 9.0, including juvenile trout densities and macroinvertebrates, which are direct measures of aquatic life and cold-water fisheries beneficial use support.

4.10.3 Margin of Safety

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

- Conservative assumptions were used in all source assessment modeling, such as:
    - o All tributary streams evaluated where treated as perennial and assumed to have connectivity with downstream waterbodies. This is conservative because it assumes dilevery of sediment in all cases, when this may not always hold true.
    - o Assumed all observed bank instability was a result of the closest man-caused activity.
    - o Assumed that sediment delivery occurred at distances up to 1,200 feet from stream channel.
- The suite of proposed supplemental indicators is intended to help verify target compliance and full beneficial use support.
- The proposed supplemental indicators may also provide an early warning method to identify pollutant-loading threats that may not otherwise be identified.
- The WQRPs presented in this document go beyond what is required by the USEPA for TMDL development by including restoration and monitoring for non-pollutants such as habitat alteration, dewatering, and non-listed pollutants such as temperature. By doing so, the WQRPs provide a holistic approach to water quality restoration and thus an additional MOS for beneficial use support.
- A large amount of data and assessment information were considered prior to finalizing any impairment determinations. Impairment determination were based on conservative assumptions that error on the side of keeping streams listed and developing TMDLs unless overwhelming evidence of use support was available.
- To be protective, additional monitoring was developed as part of this WQRP even though they were not required in all cases.
- The adaptive management approach evaluates target attainment and allows for refinement of load allocation, targets, and restoration strategies to ensure restoration of beneficial uses. The adaptive management strategy also accounts for the uncertainties described above.
- Multiple targets with the use of indicators addressing biota measures and physical channel conditions are developed to address excess fines and other impairments.
- Impairment determinations were based on conservative assumptions that favored the resource when impairments were not obvious.
- The monitoring plan calls for evaluation of tributaries not on the 303(d) list that may contribute sediment to the Bitterroot Headwaters Planning Area.

4.10.4 Seasonality

Addressing seasonal variations is an important and required component of TMDL development. Throughout this plan, seasonality is an integral factor. Water quality and habitat parameters such as fines sediment, suspended sediment, turbidity, macroinvertebrate and periphyton communities, and metals concentrations are all recognized to have seasonal cycles.

Specific examples of how seasonality has been addressed include:

- Seasonality and high flow/runoff conditions are incorporated into the sediment loading model developed to address hill slope erosion processes, and erosion from forest roads.

- Targets where developed with seasonality in mind: the % <6 fine sediment target data is collected in the summer, after the flushing flows have passed; macroinvertebrate and supplemental indicator data is collected during the summer months when these biological communities most accurately reflect stream conditions.
- Throughout this document, the data reviewed cover a wide range of years, seasons, and geographic area within the BHTPA.
- Bull trout spawning areas are monitored during the fall and cutthroat during the summer.
- The index period developed for macroinvertebrates also has a built in mechanism for addressing seasonality. The index period begins following spring runoff and extends through September. This captures the period when conditions are likely to be most stressful to aquatic life. For example, low flows during this time period will result in accumulation of fine sediment. Furthermore, other stressful conditions associated with riparian and habitat degradation such as warm water temperatures is more pronounced in the period.

SECTION 5.0 TEMPERATURE

5.1 Introduction

This section provides:

1. A description of the methodologies used to assess shade as a surrogate of temperature in the Bitterroot Headwaters TPA.
2. A summary of the results of the shade assessment.
3. A description of the modeling tool used in conjunction with the shade assessment.
4. TMDLs for all temperature listed streams.
5. TMDL targets for all temperature listed streams.

Streams within the Bitterroot Headwaters TPA that are currently listed for thermal modifications (temperature) and a-re therefore discussed in Section 5.0 include:

- Hughes Creek
- Nez Perce Fork
- Overwhich Creek
- West Fork Bitterroot River

Additionally, the East Fork of the Bitterroot River, although not formally listed for thermal modifications, has been included for temperature TMDL development at the request of the Bitterroot Headwaters TMDL Technical Advisory Committee.

5.2 Source Characterization

This section provides a summary of all potentially significant sources of thermal impairment.

5.2.1 Point Sources

There are no point sources associated with thermal impairments in the BHPA.

5.2.2 Non-Point Sources

The primary non-point sources associated with temperature impairments in the Bitterroot Headwaters TPA are natural input from geology and groundwater, and loss of riparian shade from natural fire, timber harvest (to include home sites), mining and road building. All anthropogenic sources were characterized through aerial photo analysis and subsequent field verification. Irrigation diversions are thought to be insignificant along the streams that are currently listed as thermally impaired, with the possible exception of the East Fork Bitterroot River. Further investigations of the effects of irrigation are outlined in Section 6.0.

5.2.3 Source Assessment Methods

It is recognized that riparian shade is not the sole variable affecting stream temperature; however it was the focus of this analysis for the following reasons:

- It can be quantified through aerial photography, which is readily available and repeatable.
- In absence of fire, it is a variable that we can directly manage and influence.
- It can easily be tracked over time.
- It is thought to be the primary anthropogenic source of temperature impairment in the BHPA.

As previously stated, groundwater influences also play an important role in affecting local stream temperatures, but they are considered natural and not discussed in this WQRP. Additionally, while irrigation return flows play a significant role in affecting in-stream temperatures, their affect on the current thermally impaired listed streams are thought to be minor, except potentially in the East Fork of the Bitterroot, where further analysis is planned (Section 6.0).

5.2.3.1 Aerial Photo Interpretation, Mapping, and Conditions Assessment

The aerial photo assessment consisted of interpretation or measurement of shade parameters, riparian vegetation, and channel conditions derived from aerial photos taken in 1998 or 2000 by the Bitterroot National Forest and/or from USGS topographic maps. Streams that had been listed included: Martin Creek in the East Fork watershed and the West Fork Bitterroot River including the tributaries Hughes Creek, Nez Perce Fork, and Overwhich Creek. The East Fork of the Bitterroot was also assessed. In addition to the listed streams, any perennial tributary to the East or West Forks of the Bitterroot that met one of the following criteria was also assessed:

1. Road density was three miles per square mile or greater; or
2. Canopy disturbance within 300 feet of either side of the channel was 10 percent or greater of the overall area.

Perennial tributaries meeting these criteria included: Blue Joint Creek, Piquett Creek, and Slate Creek. These streams were included in the analysis because the level of disturbance in their watersheds was significant enough for the streams to be considered potential sources thermal pollution to temperature-impaired streams.

The riparian assessment was further extended to those streams listed for habitat alterations and sediment and included: Buck Creek, Deer Creek, Hughes Creek, and Ditch Creek in the West Fork watershed and Gilbert Creek, Laird Creek, Meadow Creek, Moose Creek, and Reimel Creek in the East Fork watershed. The assessment was extending to these streams because riparian condition provides a convenient proxy measurement of bank stability and potential sediment loading. Additionally, several of these watersheds burned in the fires of 2000, and the assessment of riparian condition provided a measure of the potential impact of the fires on these streams.

Stereo-pair aerial photography and topographic maps were used to delineate reaches and assess 24 parameters for each stream. For portions of the Bitterroot watershed that burned in the 2000 fires, recent aerial coverage taken in October 2000 was used. For the unburned portions of this watershed, aerial coverage taken July 1998 was used. Color aerial photographs were at the scale of 1:15,840 while 7½' USGS quadrangle maps were at the scale of 1:24,000. Protocols for assessing the 24 parameters are outlined in Table 5-1 and the accuracy level or resolution required for some protocols are presented in Table 5-2.

Streams were broken into smaller assessment reaches with reach breaks delineated using the following criteria:

1. Ownership boundaries as identified by the NRIS Stewardship map;
2. Significant changes in channel slope and/or valley type;
3. Functional changes in riparian vegetation;
4. Confluences of tributary streams; and
5. Changes in aspect class (i.e. North-South, East-West, diagonal).

Reach breaks were assigned a unique alphanumeric identification and manuscripted onto a hard copy 7 ½ minute USGS quadrangle maps.

Data for all parameters was inputted into a spreadsheet. Based on photo-interpretation (PI) results, 55 ground-truth locations were identified. Ground-truth sites were located in each vegetation type, in reaches where a PI parameter(s) was in question, in each land use type, or in reaches exemplifying different parameter conditions. Ground-truth sites were 200 feet long and should represent the measured or estimated parameters for that reach. Each ground-truth site was identified on the aerial photograph and recorded with a 200-foot line scribed to mark the site. The same site was marked directly on the USGS map.

Based on photo-interpretation results, 10 reference sites were also identified. Reference sites were located where stream segments were in healthy condition or pristine condition. These sites could be used as models for impacted and disturbed reaches. Reference sites are also 200 feet long and were located on both aerial photographs and topographic maps using the same method as for ground-truth sites. Some stream segments served as both ground-truth and reference sites.

Reach breaks along with ground-truth and reference sites were digitized onto electronic forms of the USGS maps. A written summary was completed after all aerial photography and mapping interpretations were done. The summaries provide a narrative description of the stream and riparian condition from its mouth to its headwater, including impacts, land-use, and a synthesis of the PI data.

Table 5-1. Protocols for Assessing Measured Parameters.

Parameter Name	Measurement Protocols/Classifications
Stream Name	Name of the primary stream or location of the named tributary confluence.
Reach Name	Consists of a three-letter code followed by a number. Reaches are numbered consecutively from the stream's mouth to its headwater. Special conditions are denoted by a code (e.g. E/W = east/west, if each side of a reach is assessed separately; RES = reservoir; P = lake, pond, or impoundment). Unnamed tributaries are named in order of occurrence and numbered as a decimal (e.g. – two tributaries entering Reach NEZ 1 would be named NEZ 1.1, NEZ 1.2).
Overhang (percent)	The percentage of riparian vegetation (trees/shrubs) that overhangs the stream and would provide shade when the sun is directly overhead on the stream.
Active Channel (feet)	The width of the channel at bankfull.
Reach Length (feet)	The linear length of the specified stream segment. Measured to the nearest foot using a planimeter and topographic map.
Tree Height (feet)	Average height of the primary shade producing trees or vegetation.
Terrain Slope (percent)	The channel-to-tree slope as measured from the edge of the active channel to the base of riparian trees.
Aspect Class	The bearing of the stream segment when the compass is placed at the lower reach break. The compass is broken into four categories: **0**, **+45**, **90**, **-45**. **0** is defined as north/south streams oriented between 330°-30° or 150°-210°. **+45** is defined as northeast/southwest streams oriented between 30°-60° or 210-240°. **90** is defined as east/west streams oriented between 60°-120° or 240°-300°. **–45** is defined as northwest/southeast streams oriented between 300°-330° or 120°-150°.
Tree-to-Channel Distance (feet)	The horizontal distance from the edge of bankfull to the base of the riparian canopy (usually trees).
Shade Density (percent)	The ratio (as expressed in decimal percent) of light to shaded area within a unit length of shadow. It measures the effectiveness of vegetation to block sunlight. It can be estimated by tree shadows cast onto the stream or from estimating riparian canopy cover (closure).
Stream Class	As per SMZ law: **F** = fish bearing; **NF** = non-fish bearing with information obtained from the Bitterroot National Forest's Fish Biologist.
Land Use	**URB** = Urban infrastructure and facilities **PF** = Private forestry **AG** = Irrigated or cultivated agricultural lands **RS** = Private resource lands (non-cultivated agriculture; mining; county) **NR** = Private non-resource lands (rural residential) **MIX** = Mixed private land uses **FS** = United States Forest Service managed land **ST** = State of Montana (DNRC) managed land

Table 5-1. Protocols for Assessing Measured Parameters.

Parameter Name	Measurement Protocols/Classifications
Impervious Surface	The presence or absence of a non-removable impervious surface (e.g., paved road, dirt road) that would inhibit the growth of riparian vegetation within 100 feet of the stream bank. **Y** = present; **N** = absent.
Irrigation Flow	Known or observable diversions or points of return flow. **IN** = flow is returning to the stream; **OUT** = flow is removed from the stream.
Stream Order	Numeric ranking of relative stream size as developed by Horton and modified by Strahler (1952). 1st order streams are usually intermittent or perennial headwater segments.
Valley Slope (percent)	Slope of the valley type as measured between contour intervals from the topographic map. Equation: change in elevation in feet/distance in feet.
Channel Sinuosity	Sinuosity of the stream segment <u>as measured from an aerial photograph</u>. This should be measured using the same contour interval locations as used on the topographic map for valley slope. Equation: stream length in feet/valley length in feet.
Stream Slope (percent)	Slope of the stream segment as defined for valley slope. Equation: valley slope/sinuosity.
Rosgen Level 1 Channel Type	Stream channel classification based on channel slope, sinuosity, valley type, and stream pattern and form. **A**, **A+**, **B**, **C**, **D**, **E**, **F**, **G**.
Channel Confinement	**U =** Unconfined: floodplain width > 4X bankfull width **M** = Moderate: floodplain width 2X to 4X bankfull width **C** = Confined: floodplain width < 2X bankfull width
Bank Stability	**Y** = Stream bank vegetated with no evidence of erosion or mass wasting. **N** = Stream bank not vegetated with evidence of channel widening or erosion.
Buffer Width (feet)	Average horizontal width of forested riparian vegetation. Buffers are measured from the channel edge to a maximum of either 100 ft (private/state land) or 300 ft (federal land). If a road is encountered, the buffer ends.
Percent of Buffer Width (percent)	Percent of reach length exhibiting the described buffer width.

Table 5-1. Protocols for Assessing Measured Parameters.

Parameter Name	Measurement Protocols/Classifications
Existing Vegetation Composition	Existing type of riparian vegetation. PI Classes: **HB** = herbaceous; whereby, the grasses or forbs are being grown into the riparian and almost no woody vegetation is present. **MD** = mixed deciduous forest. **MC** = mixed coniferous forest. **MC/shrub** = mixed coniferous forest with upland shrubs. **MC/partial** = mixed coniferous forest; whereby, riparian has burned leaving green and brown trees. **MC/dead** = mixed coniferous forest; whereby, riparian has burned leaving 90% or more brown or black trees. **MD/C** = mixed deciduous/coniferous forest; whereby, deciduous trees dominate. **MC/D** = mixed deciduous/coniferous forest; whereby, conifer trees dominate. **MC/D/partial** = mixed deciduous/coniferous forest; whereby, conifer trees dominate and the riparian has burned leaving green and brown trees. **NV** = no vegetation present. **WL** = wetland.
Existing Habitat Type (TSMRS)	Using the Bitterroot NF's TSMRS database a habitat type was assigned to each reach designation. Since several timber stands potentially occur within a reach that which incorporated most of the reach length was used. These stands were habitat typed using Forest Habitat Types of Montana by Pfister et al. (1977) and thus, exhibit upland conditions more than riparian conditions.
Existing Forest Type (TSMRS)	Using the Bitterroot NF's TSMRS database a forest type was assigned to each reach designation.
Existing Forest Type (PI)	Where TSMRS forest type data was not available, a forest type was assigned from PI work and a nearest neighbor approach using the closest TSMRS information.
Site Index for Forest Type (TSMRS)	Based on habitat and forest type, a site index number was generated from Forest Habitat Types of Montana by Pfister et al. (1977).
Site Index for Forest Type (STATSGO)	Where TSMRS habitat and forest type data was not available, a site index value was assigned to each reach using the STATSGO soils database.
Age	Age of dominant riparian trees based on average stand height and forest growth models.
Comments	Any type of disturbance to, condition of, or structure within the reach segment seen under stereo aerial photographs was noted.

Table 5-2. Resolution or Accuracy Level for Measured Parameters.

Assessment Parameters	Measurement Increments	Data Input	Source of Measurement
Overhang	10%	Decimal percent	Stereo aerial photos
Active Channel	5 ft.	5, 10, 15, 20, 25, 30, 35, 40, 60, 80, 100, 120	Stereo aerial photos; measured & estimated
Reach Length	1 ft.	Whole number	GIS or topographic map calculated
Tree Height	10 ft.	Decimal percent	Stereo aerial photos; measured & estimated
Terrain Slope	10%	Decimal percent	Topographic map; estimated
Tree-to-Channel Distance	5 ft.	5 ft. increment	Stereo aerial photos; average measurement
Shade Density	10%	Decimal percent; if riparian trees have SD < 10%, then SD = 0 %	Stereo aerial photos; estimated
Buffer Width	10 ft.	Federal = 300' max; Non-federal = 100' max	Stereo aerial photos; measured
Percent of Reach	10%	Decimal percent; if <10% then 0.	Stereo aerial photos; estimated
Valley Slope	0.001	0.001	▲ Elevation/Valley length (measured; topographic map)
Channel Sinuosity	0.01	0.01	Stream length/Valley length (measured; aerial photo)
Stream Slope	0.001	0.001	Valley slope/Sinuosity (measured; aerial photo)

5.2.3.2 Aerial Photo Interpretation (PI) Ground-Truthing

Within the Bitterroot Headwaters Planning Area, 55 potential ground-truth and 10 reference sites were identified on 15 streams: Blue Joint Creek, Deer Creek, East Fork Bitterroot River, Gilbert Creek, Hughes Creek, Laird Creek, Martin Creek, Meadow Creek, Moose Creek, Nez Perce Fork, Overwhich Creek, Piquett Creek, Reimel Creek, Slate Creek, and West Fork Bitterroot River. Ground-truth sites were located in each vegetation type, in reaches where a PI parameter(s) was in question, in each land use type, or in reaches exemplifying different parameter conditions. Reference sites were located where stream segments were in healthy, pristine, or relatively good condition. Reference sites could be used as models for impacted and disturbed reaches. Both ground-truth and reference sites represent the measured and estimated parameters for that reach and are 200 feet long. Some sites serve as both a ground-truth and a reference location. Each ground-truth and reference site was delineated on the aerial photograph (1:15840) with a 200-foot line on the photo. The same site location was marked directly onto the USGS map (1:24000). Ground-truth and reference sites along with reach breaks were later digitized onto electronic USGS topographic maps.

Of the 55 potential ground-truth and 10 reference sites, 17 and 1, respectively, were chosen for field verification. These 18 sites were located on Buck Creek, Ditch Creek, East Fork Bitterroot River, Gilbert Creek, Laird Creek, Meadow Creek, Moose Creek, Reimel Creek, and West Fork Bitterroot River. Using the USGS topographic map and aerial photograph, each 200-foot ground-truth/reference site was located in the field. At each site three transects were located: Transect 1 (T1) was placed 100 feet upstream of the middle transect; T2 was the middle transect; and T3 was placed 100 feet downstream of the middle transect. Eleven parameters were measured in the field to provide comparative field data to the PI data (Table 5-3). In addition, the following self-explanatory data was also recorded: Date, Stream Name, Reach Segment, Site Number, Collectors/Recorders, Channel Type, Directions to Site, Comments.

Table 5-3. Ground-Truth Parameters for Photo Interpretation Assessments.

Parameter Name	Measurement Protocols/Classifications
Bankfull Width (feet)	The width at bankfull was measured at TI, T2, and T3. The average for the site was calculated.
Bankfull Depth (feet)	Depth of the river at bankfull was taken at the quarter, half, and three-quarter distance along each transect. Average depth was then calculated for each transect.
Width/Depth Ratios	Width/depth ratio was calculated for each transect and then averaged for the site.
Shade Density (percent)	Shade density was measured with a densiometer using the procedure described by Platts et al. (1987). Shade density readings were recorded at the four cardinal directions within the right- and left-riparian zones along each transect. Thus, a total of four readings at each of six locations were recorded. Averages were calculated for the right bank, left bank, and entire site.
Tree-Channel Distance (feet)	The distance from bankfull to the nearest tree that comprised the dominant shade height was measured at the left and right banks for each transect. The average for the site was calculated.
Tree-Channel Slope (percent)	The slope from bankfull to the base of the tree used in the Tree-Channel Distance was measured with a clinometer. The six slope measurements were averaged for the site.
Percent Shade	A solar pathfinder following the August 1st line was used to measure overhead shade. For streams of 25 feet or less wide, the solar pathfinder was placed mid-stream along T1, T2, and T3. For streams of more than 25 feet wide, the solar pathfinder was placed at the quarter, half, and three-quarter distance along each transect. The number of units along the August 1st line that were covered by shade from 6am to 6pm was counted. An average was calculated for the site.
Percent Overhang	The portion of the active stream channel that was located under overhanging riparian vegetation was determined using a densitometer by standard forestry methods.

Table 5-3. Ground-Truth Parameters for Photo Interpretation Assessments.

Parameter Name	Measurement Protocols/Classifications
Dominant Shade Tree Height (feet)	At least one tree height was measured on either stream bank for T1, T2, and T3. Trees that composed the dominant canopy layer within the stream corridor were measured for height. Height was calculated with standard procedures using a clinometer and measuring tape. The average tree height for the site was calculated.
Stream Azimuth (true north)	At mid-stream, the direction of the stream was taken using a compass. The average for the site was calculated.
Dominant Shade Tree Species	For each transect the most common tree species making up the shade cover was recorded. Tree species may or may not relate to habitat type or to forest type since that information was unavailable during the field survey.

5.2.3.3 Source Assessment Results and Interpretation

Ground-truthed (GT) and PI collected data were compared side-by-side and any deviation of 15% or 15 feet was considered greater than a reasonable measurement error. A consistent deviation, high or low comparatively, was considered a measurement bias in the PI data. If a consistent bias was found the original PI data assessments were adjusted by an appropriate factor prior to computation of percent shade for each individual reach.

Of the original 18 GT sites, three sites were dropped from comparison to PI data since the field crew was unable to access the exact identified site or the field crew and photo analyst did not appear to be focused on exact same set of physical features.

Comparison of the GT sites and PI data suggested, in general, that the PI parameter values may be considered reasonable and that there is no consistent bias with the exception of percent overhang (underestimate bias) and tree-to-channel slope (overestimate bias) (Table 5-4). However, the SHADOW model for which the data were used (described below) is not highly sensitive to these parameters. In addition, construction of shade curves uses a conservative, average value for these parameters for large and small stream channels. Therefore, these parameters in the original database were not adjusted.

Initial evaluation of the data also indicated the possibility of some PI measurement bias in shade density, tree-to-channel distance, and tree heights. However, at some of the GT sites the differences between PI data and GT data appeared to be much greater than the overall trend and that these measurements do not appear to be taken from the same location and/or focused on the same set of physical features (these cases are footnoted and italicized in Table 5-4). This is not unexpected to some degree given the photo-scale used in PI work (1:15,840) and the fact that the photo analyst did not accompany the field crew during all the GT work. Ignoring those particular measurements for each individual parameter eliminateed any specific bias of over or under estimation. Thus the final interpretation of the GT-PI data suggested leaving the original PI database intact and developing shade targets based on these data.

Table 5-4. Photo Interpretation Evaluation with Ground-Truth Data.

	W ac (ft)			**% S.D.**			**% OH**			**C-T (ft)**			**Slope (%)**			**Tree height (ft)**			**% Shade**		
Site	**P.I.**	**G.T.**	**Diff.**	**P.I.**	**G.T.**	**Diff.**	**P.I.**	**G.T.**	**Diff.**	**P.I.**	**G.T.**	**Diff.**	**P.I.**	**G.T.**	**Diff.**	**P.I.**	**G.T.**	**Diff.**	**SP**	**Shadow**	**Diff.**
REF-17	45	73	**-28**	0.70	0.72	**-0.02**	0.10	0.16	**-0.06**	0.0	5.3	**-5**	0.1	0.35	**-0.25**	70	79	**-9**	0.50	0.68	**-0.18**
1	20	24	**-4**	0.40	0.25	**0.15**	0.00	0.18	**-0.18**	10.0	36.0	**-26**	0.1	0.15	**-0.05**	80	86	**-6**	0.39	0.66	**-0.27**
6	40	25	**15**	*0.70*[1]	*0.26*[1]	**0.44**	0.00	0.04	**-0.04**	20.0	49.0	**-29**	0.2	0.05	**0.15**	70	76	**-6**	0.21	0.48	**-0.27**
12	80	48	**32**	*0.50*[1]	*0.04*[1]	***0.46***	0.00	0.00	**0.00**	*15.0*[1]	*62.5*[1]	***-48***	0.1	0.04	**0.07**	50	36	**14**	0.14	0.17	**-0.03**
14	10	10	**0**	0.60	0.74	**-0.14**	0.50	0.85	**-0.35**	0.0	3.3	**-3**	0.3	0.02	**0.28**	50	82	**-32**	0.92	0.91	**0.01**
15	25	27	**-2**	0.80	0.47	**0.33**	0.10	0.58	**-0.48**	0.0	16.7	**-17**	0.2	0.02	**0.18**	80	91	**-11**	0.73	0.86	**-0.13**
26	15	15	**0**	0.80	0.82	**-0.02**	0.40	0.93	**-0.53**	0.0	0.0	**0**	0.1	0.00	**0.10**	80	105	**-25**	0.95	0.92	**0.03**
37	25	27	**-2**	0.20	0.04	**0.16**	0.00	0.24	**-0.24**	*5.0*[1]	*48.6*[1]	***-44***	0.1	0.05	**0.05**	60	75	**-15**	0.16	0.14	**0.02**
38	10	17	**-7**	0.30	0.29	**0.01**	0.00	0.24	**-0.24**	0.0	5.3	**-5**	0.2	0.08	**0.12**	*60*[1]	*100*[1]	***-40***	0.30	0.76	**-0.46**
40	10	8	**2**	0.30	0.39	**-0.09**	0.00	0.22	**-0.22**	0.0	0.0	**0**	0.1	0.00	**0.10**	90	100	**-10**	0.42	0.82	**-0.40**
42	10	22	**-12**	0.60	0.59	**0.01**	0.10	0.45	**-0.35**	5.0	1.7	**3**	0.3	0.05	**0.25**	40	49	**-9**	0.72	0.76	**-0.04**
45	5	3	**2**	*0.30*[1]	*0.69*[1]	***-0.39***	0.50	0.32	**0.18**	0.0	0.0	**0**	0.2	0.00	**0.20**	60	32	**28**	0.63	0.95	**-0.32**
46	5	5	**0**	0.80	0.67	**0.13**	0.30	0.82	**-0.52**	0.0	9.2	**-9**	0.3	0.09	**0.21**	80	95	**-15**	0.69	1.00	**-0.31**
48	5	8	**-3**	0.10	0.35	**-0.25**	0.10	0.21	**-0.11**	15.0	0.0	**15**	0.1	0.00	**0.10**	*70*[1]	*28*[1]	***43***	0.44	0.31	**0.13**
54	25	28	**-3**	*0.80*[1]	*0.34*[1]	***0.46***	0.10	0.21	**-0.11**	10.0	6.0	**4**	0.2	0.03	**0.17**	70	66	**4**	0.63	0.60	**0.03**
Min.			-28			-0.39			-0.53			-47.5			-0.25			-40			-0.46
Max.			32.3			0.46			0.18			15			0.283			42.5			0.133
Abs. Mean			2.47			0.04			0.26			5.25			0.15			5			0.15
Median			-1.70			0.01			-0.22			-5.30			0.12			-9			-0.13
Stnd Dev			12.8			0.26			0.20			18.1			0.13			21.4			0.18

[1] *Italic cells* suspected difference between location of ground truth measurement and PI measurement ("outliers")

PI/GT photo interpretation data/ground truth data

W_{ac} width of the bankfull (active) channel (feet)

% SD percent shade density (i.e. canopy density)

% OH percent vegetation overhang computed from solar pathfinder and solar azimuth tables

C-T horizontal distance from bankfull channel edge to base of dominant shade trees (feet)

Slope percent slope from bankfull channel edge to base of dominant shade trees

Tree Height average height of dominant shade trees (feet)

% Shade percent shade measured solar pathfinder (SP)

SHADOW percent shade calculate with the SHADOW model using PI data for input

5.3 Shade Modeling

5.3.1 SHADOW: Stream Temperature Management Program

The SHADOW model was developed by a USFS Hydrologist on the Siskiyou National Forest in Oregon for use in evaluating forest management impacts on stream temperatures (Park, 1993). The model was programmed in the software package Lotus 123 and contains three sub-models: solar, shade, and stream temperature. The solar and shade components of the model compute the solar radiation reaching the stream surface. The application of the model for this project focused strictly on the solar and shade components and the model output of percent solar radiation reaching the stream surface, or, conversely the measure of percent shade. The model uses stream channel, terrain, and vegetative characteristics as well as solar azimuth and zenith angles to determine percent shade. The former parameters are user inputs to the model while the latter are programmed into the models algorithms. It should be noted that topographic shading is not built into the SHADOW model. Factors that drive the shade/solar component of the SHADOW model include:

- Date
- Latitude
- Declination
- Stream aspect
- Tree height
- Stream channel width
- Shade density (i.e. canopy density)
- Tree-to-channel distance
- Tree-to-channel slope
- Vegetative overhang

5.3.2 Shadow Models for the Bitterroot Headwaters

For purposes of modeling riparian shade for the project area, two separate base models were developed, one for large or main stem type streams and one for smaller or tributary streams, as defined by channel width. Large streams were defined as those with an active channel width greater than 30 feet while small streams were those with an active channel width of 30 feet or less.

A model input matrix was developed in MS Excel using a set of universal parameters for both stream sizes and specific parameter assumptions generally describing riparian conditions for each size class of stream (Table 5-5). These specific parameters, vegetative overhang, tree-to-channel distance, and tree-to-channel slope, were set conservatively where the values tend to reflect the lower end of the range of assessed values and thereby computing generally lower shade values.

The model matrix was pasted into the SHADOW model input page and the universal parameters were set. The model was run consecutively for each model scenario (i.e. stream size and orientation combination) with only shade density varying step-wise by ten percent. Model output of solar radiation was copied into an Excel spreadsheet where it was converted to percent shade. The percent shade values were then compiled into shade tables for each model scenario for all tree height channel width combinations using 80 percent as the “base” shade density. The mean difference between shade density model steps and the 80 percent base density was calculated and the values placed in a “density adjustment” table.

Table 5-5. SHADOW Model Input Parameter Values.

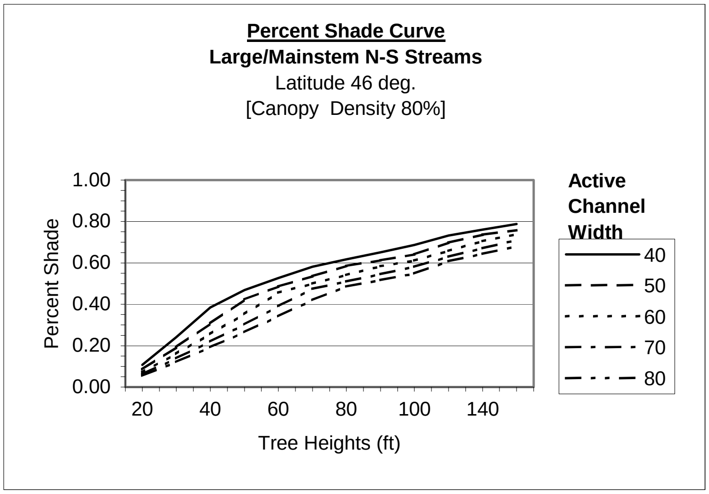
Parameter Name	Parameter Description	Large Streams	Small Streams
Vegetative Overhang	Percent of stream shaded by vegetation when the sun is directly aligned with the stream	0%	30%
Tree-to-Channel Distance	Distance from the edge of the stream channel to base of vegetation forming riparian canopy	15 feet	10 feet
Tree-to-Channel Slope	Slope of the riparian area	0%	10%
Active Channel Width	Width of the active channel as denoted from aerial photos	40, 50, 60, 70, 80, 100, 125, 150, 175, 200	5, 10, 15, 20, 25, 30
Orientation	Bearing from true north	N-S; E-W; Diagonal	
Latitude	Latitude that most closely describes area	46 degrees N	
Declination	Magnetic declination	18 degrees	
Tree Heights	Height of dominant shading vegetation	20, 30, 40, 50, 60, 70, 80, 90, 100, 120, 140, 160	
Shade Density	Density of riparian canopy	10, 20, 30, 40, 50, 60, 70, 80, 90	

5.3.3 Painted Rocks Reservoir

Given the width of the reservoir and that downstream stream temperatures in the West Fork Bitterroot River are a function more of the location of the spill way than by the amount of shading present, or not, this waterbody was not included in the shade model and subsequent shade target calculations.

5.3.4 Shade Curves

The SHADOW model was used to generate percent shade values for six different shade curves, one each for the stream size and orientation combinations. Shade curves are presented for 80 percent shade density for various tree height channel width combinations. The density adjustment table is used in conjunction with its associated shade curve by allowing the computation of percent shade for a tree height-channel width combination where the shade density varies from 80 percent (Figure 5-1). To calculate a percent shade from the shade curve, one locates the intersection of the tree height from the X-axis with curve denoting the channel size (active channel width) and then reads across to the percent shade value on the Y-axis. If the shade density is different than 80 percent, the percent shade from curve is adjusted by the value corresponding to the actual density condition. The complete set of shade tables, shade curves, and density correction tables are in Appendix J.



N-S Streams Shade Density Correction Table	
90%	0.02
70%	-0.03
60%	-0.06
50%	-0.10
40%	-0.14
30%	-0.19
20%	-0.25
10%	-0.32

Figure 5-1. Example of a Shade Curve and an Associated Shade Density Correction Table.

5.3.5 Calculation of Riparian Shade

Stream channel shade is a product of the earth-sun geometric configuration and the physical characteristics of the riparian vegetation. The shade curves discussed in the previous section were developed under the vegetation conditions that existed in 1998 or 2000 at the time of the aerial photography flights. Determination of how the riparian vegetation evolves from its current state at a given location employs the use of tree growth curves, which are based on forest growth and yield models.

5.3.6 Forest Growth &Yield Curves and Site Index Values

Growth and yield curves have been developed for various tree species by the USFS and are reported in the Forester's Field Book (USFS, 1994). These curves implicitly take into consideration local soils, moisture, and other site conditions by using extensive field data (i.e. height measurements, tree cores, basal area measurements, diameter at breast height (dbh), habitat type, etc.) in their development. Growth and yield curves for individual tree species are identified using Site Index (SI) values.

Site Index (SI) values denote by the average height measured at a specific "base age" which varies between tree species. As an example, the base age for Ponderosa pine is 100 years with SI values (i.e. average height at 100 years of age) ranging from 40 to 160 (USFS, 1994). SI values in Pfister, et al., (1977) are reported for specific tree species growing in various forest habitat types, while the STATSGO soils database contains only one SI value per soil type and are based on "*the height in feet of the large trees at some given age…*" (NRCS, 1994). SI values used for the project area were obtained from the USFS Timber Stand Management Record System (TSMRS) and the STATSGO soils database in areas that the TSMRS did not have data for. It should also be noted that site index curves tend to be biased toward upland stands while this shade/temperature analysis focuses more specifically on riparian areas.

The TSMRS database includes data on habitat type and forest type. Habitat Type describes the dominant tree/shrub species combination (e.g. PSME/ACST) in which that particular location would regenerate into at a late seral (i.e. "old growth") ecological stage. Forest Type is the dominant tree species present at the time the area was habitat typed. Habitat type tree species are not always the same as the existing forest type tree species. In addition, some reaches in the assessment did not have information in the TSMRS database. On those reaches, the existing forest type was determined using a "nearest neighbor" approach that entailed using the nearest TSMRS forest type and the photo analyst's interpretation of the forest (i.e. mixed conifer or deciduous) and then a "PI Forest Type" tree specie was assigned.

Growth and yield curves for subalpine fir (SAF) are not reported in the Forester's Field Book (USFS, 1994). For reaches where SAF was the identified forest type the growth and yield curves for Grand fir were substituted. In addition, no formal growth and yield curves are available for cottonwoods grown in natural settings. However, growth and yield curves have been established for hybrid poplars grown on industrial plantations. Generalized growth curves for cottonwoods in natural settings were estimated based on consultation with industry and research professionals (personal communication in 1999 with Don Rice, Fort James Paper Company; Dina Brown, Post-doctorate, Oregon State University, and Dr. Bill Emmingham, Silviculturalist, Oregon State University). Based on these communications an average growth rate for cottonwoods in natural environments has been established at three feet per year.

5.3.7 Source Assessment Summary

As discussed in the previous sections, existing and potential shade was analyzed to help establish water quality goals and targets as part of this WQRP. In addition, quantification of the anthropogenic sources was determined to help establish future allocations. This was accomplished through aerial photograph interpretation, subsequent field verification and GIS spatial analysis.

Riparian disturbance within 100 feet of the channel was used to estimate linear distances of sources that are impacting potential shade to the stream channel. Considerations were made as to stream direction (north/south, east/west) and location of sources as they would affect shading. Riparian harvest and fire believed to be affecting riparian shade were determined by calculating the linear distance of channel that was adjacent to harvest or burned areas that equated to greater than 50% of the pre-disturbance crown area. Other riparian disturbances within 100 feet of the stream channel thought to be affecting effective shade were also quantified. Thermal sources influencing effective shade in the BHTPA are defined in Table 5-6.

Table 5-6. Definitions of Thermal Sources in the BHTPA.

Anthropogenic Sources	Natural Sources
Main roads	Fire
Mining	
Other roads and impervious surfaces[1]	
Timber harvest[2]	

[1] Defined as home sites, driveways and parking lots.
[2] Timber harvest is an anthropogenic source. However, for purposes of allocations, it will be treated as natural (similar to fires). This is because the proposal is to leave past harvest units to re-grow naturally.

The total linear distance of disturbance for Hughes Creek, Martin Creek, Nez Perce Fork, Overwhich, West Fork Bitterroot River, and the East Fork Bitterroot River is summarized in Section 5.5.

5.4 Water Quality Goals & Restoration Targets

As noted in Section 3.2, MDEQ is required to assess the waters for which TMDLs have been completed to determine whether compliance with water quality standards has been attained. The process by which this will be accomplished is discussed in Section 3.3 (Targets and Supplemental Indicators Applied as Water Quality Goals) and is shown in Figure 3-1. The temperature targets and indicators listed in Table 3-8 and summarized in Table 5-18 are proposed as the thresholds against which compliance with water quality standards will be measured in the BHTPA. If all the target threshold values are met, it will be assumed that beneficial uses are fully supported and water quality standards have been achieved. Alternatively, if one or more of the target threshold values are exceeded, it will be assumed that beneficial uses are not fully supported and water quality standards have not been achieved. However, it will not be automatically assumed that implementation of this TMDL was unsuccessful just because one or more of the target threshold values have been exceeded. The circumstances around the exceedance will be investigated. For example, the exceedance might be a result of natural causes such as floods, drought, fire or the physical character of the watershed. In addition, in accordance with MCA 75-5-703(9), an evaluation will be conducted to determine whether:

- The implementation of a new or improved suite of control measures is necessary;
- More time is needed to achieve water quality standards;
- Revisions to components of the TMDL are necessary; or
- Changes in land management practices occur.

Targets for the sediment-listed streams in the Bitterroot Headwaters TPA are presented in Section 3.3 on a stream-by-stream basis. However, the following “water quality goals” are the primary basin-wide objectives of this restoration project. These goals would be achieved through implementation efforts outlined in this restoration plan included in this report.

1. Ensure protection of all streams within the Bitterroot Headwaters TPA, with the intent of avoiding any future impairment conditions and ultimately reducing the overall threat of an impairment to any one beneficial use;

2. Ensure full recovery of aquatic life beneficial uses to all streams within the Bitterroot Headwaters TPA;
3. Avoid conditions where additional waterbodies within the Bitterroot Headwaters TPA become impaired;
4. Work with landowners and other stakeholders in a cooperative manner to ensure implementation of water quality protection activities; and
5. Continue to monitor conditions in the watershed to identify any additional impairment conditions, track progress toward protecting waterbodies in the watershed, and provide early warning if water quality starts to deteriorate.

These goals are further developed as part of the Restoration Strategy and Monitoring Plan sections of this document (Sections 8.0 and 9.0). To help define measurable objectives toward meeting Goals 1 through 3, numeric targets are developed within subsequent sections of the document. These targets are meant to reflect those conditions that need to be satisfied to ensure protection and/or recovery of beneficial uses. Goals 4 and 5 are designed to ensure a cooperative exists among all parties involved.

5.5 Waterbody Specific Discussions

The following sections provide stream-by-stream results of the temperature and shade assessment, as well as temperature TMDLs, allocations, and targets for each of the thermally impaired listed streams. These streams include Hughes Creek, Nez Perce Fork, Overwhich Creek, West Fork Bitterroot River, and East Fork Bitterroot River. Assessment results are also presented for Martin Creek, which was listed for thermal modifications in 1996; however, as discussed in Section 3.0, recent data indicate that temperature does not impair beneficial uses in Martin Creek and thus no TMDL has been developed.

5.5.1 TMDLs and Allocations Specific to all Waterbodies

Because factors that affect water temperature are interrelated, the supplemental indicator (percent effective shade) relies on restoring/protecting riparian vegetation to increase stream surface shade levels, reducing stream bank erosion, stabilizing channels, reducing the near-stream disturbance zone width and reducing the surface area of the stream exposed to radiant processes.

The Bitterroot Headwaters WQRP incorporates measures other than “daily loads” to fulfill requirements of the Clean Water Act. Although loading capacities for each stream for heat capacity were derived, they are of limited value in guiding land management activities needed to reduce impacts to beneficial uses. These values were then equated to a specific percent shade value in the water quality supplemental indicators. Therefore, solar “loads” were calculated for each thermally impaired waterbody, but the potential percent shade target becomes analogous to the desired solar load. Additionally, percent effective shade is a surrogate measure that can be calculated directly from the loading capacity. Finally, percent effective shade is achievable by quantification in the field or via aerial photography.

Since the non-point source-loading capacity is based on system potential, and the use of this target is expected to equate to full potential in-stream temperatures, the non-point source loading capacity is by definition 100% allocated to natural recovery (i.e. growth) of the riparian vegetation. However, in order for this target to be realized, specific measures would need to be set in place to ensure recovery of the riparian shade component. This is due to the fact that natural processes could not occur along all existing, anthropogenic sources.

Conceptually, if no activities were to take place in existing harvest units and/or burned areas, natural re-growth would then occur. This goal can be achieved by simply committing to a no riparian harvest standard. The current Streamside management Zone Law and subsequent management practices applied today, help to achieve this goal. Forest fires are natural and considered out of human control.

However, this does not hold true for other sources such as roads, mining, and other impervious surfaces. For purposes of this WQRP, these sources are considered “permanent” or an “irretrievable commitment of resources” and therefore would not allow “natural” re-growth to occur unless they were removed. Removal may not be feasible. It is also realized that it may not take total removal of these structures to achieve full beneficial use support. Consequently, it is proposed that the allocation for roads, mining and other impervious sources are incorporated into a phased study. This study and potential phased allocations are discussed in Section 5.8. As an added measure of protection, an adaptive management strategy is also proposed to address the uncertainties associated with these allocations. The purpose of this strategy is to strive to reach better conditions than can be conceivably achieved today. This strategy is outlined in Section 9.10.

The analysis did, however, quantify the extent of disturbance from each source (in linear feet) as displayed in Tables 5-7, 5-9, 5-10, 5-12, 5-14, and 5-16. These values were converted to percentages to help describe the extent of problems associated with any one source and make it easier for land managers to prioritize restoration efforts.

Finally, the TMDLs and allocations that follow were developed under the scenario that natural vegetative re-growth would only occur if all the sources affecting riparian shade were removed immediately. While recognizing that complete removal of all sources (i.e. roads, building, mining, etc.) in not achievable, the analysis utilized the best possible situation.

To summarize:

- At this time, allocations will only be developed for fire and timber harvest because the other sources (roads, mining, and other impervious surfaces) may be irretrievable commitments of resources.
- For each thermally impaired stream, a 100% reduction is proposed and allocated to all thermal sources that are achievable. It is understood that full allocation to all sources may not be feasible.
- It is feasible to achieve a 100% recovery of fire and past timber harvest sources. Which would occur if re-growth were allowed in existing harvest units and burned areas.
- The allocations were developed as 5-year “benchmarks” to account for natural re-growth.
- Solar loads were quantified and are correlated to each benchmark allocation.

- In order to realize that net benefit of mitigation on each source over time, a phased allocation study is proposed for all impervious surfaces and an adaptive management strategy (Section 9.0) will also be included.

5.5.2 Hughes Creek

5.5.2.1 Results of the Shade Source Assessment

Potential sources of thermal modifications were assessed in Hughes Creek. Additionally, existing and potential shade was assessed to help formulate the supplemental indicator targets. Also, as described earlier, anthropogenic sources of shade loss were calculated, as were natural sources in the assessment. Table 5-7 below, summarizes the extent of shade loss in Hughes Creek.

Table 5-7. Summary of Shade Loss Along Hughes Creek.

Reach Length (ft.)	Existing Stream Shade	Shade Loss from Main Roads (ft.)	Shade Loss from Mining (ft.)	Shade Loss from Secondary Roads and Impervious Surfaces (ft.)	Shade Loss from Fire (ft.)	Shade Loss from past Timber Harvest (ft.)
92657	55%	2373 (2.6%)[1]	4277 (4.6%)[1]	3881 (4.2%)[1]	149 (.16%)[1]	1080 (1.2%)[1]

[1] Expressed as a percent of the total reach defined in the first column.

5.5.2.2 Hughes Creek Allocations and TMDLs

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

TMDL = WLAs + LAs + MOS

There are no point sources of temperature in the Hughes Creek watershed; therefore, that variable can be removed from the equation. The thermal sources in the watershed are roads, mining, secondary roads and other impervious surfaces, fire, and past timber harvest. The best TMDL scenario for Hughes Creek could be expressed as a 50% reduction in total thermal loading (see Table 5-8). This would be achieved by a 100% natural recovery of riparian vegetation allocated to ALL thermal loading sources. The resulting future total load would then be 375 btu/ft^2/day. It is important to again note that this 50% reduction and subsequent load may not be achieved.

To articulate the TMDL in a format that is usable to land managers, the TMDL will be expressed as a percent reduction in thermal loading sources that equates to a percent increase in effective shade. The uncertainties associated with this are further discussed in Section 5.7.

The existing effective shade in Hughes Creek is 55%. The late seral potential effective shade is 78%, for a difference of 23%. The TMDL is therefore expressed 100% reduction in thermal loading from timber harvest and fire sources. The result will be a 1.36% increase in effective shade (Table 5-7). Additionally, a performance-based allocation will strive for additional decreases in the other identified thermal sources that would result in an overall increase in effective shade.

Table 5-8 displays the existing solar load (derived from existing shade values) and the reductions in that load for each benchmark. The percent reduction is directly correlated to an "increase" in effective shade that would result from reductions in thermal sources and natural re-growth if no fires or future riparian harvest were to occur. It is predicted that if 100% reductions occurred for all sources today, that it would take 48 years to reach effective shade potential in Hughes Creek under natural growing conditions.

Table 5-8. Existing Loads and Benchmark Load Allocations for Hughes Creek.

Existing Load (btu/ft²/day)	Existing Effective Shade	Proposed Reductions From Past Timber Harvest and Fire	Proposed Reduction from Roads, Mining and other Sources	Benchmark	Resulting Increase in Effective Shade (expressed as total)	Reduction in Solar Load (btu/ft²/day)[2]
755	55%	100%	100%[1]	5 year	56%	755 (0%)
				10 year	58%	722 (4.3%)
				15 year	65%	601 (20.4%)
				Late Seral	78%	375 (50.3%)

[1] This allocation may not be feasible.
[2] Benchmark TMDLs are directly correlated to benchmark percent shade targets.

5.5.2.3 Future Development

It is not reasonable to assume that there will be no future development in the Hughes Creek watershed. An allocation is therefore required to account for potential future thermal loading. This allocation proposes no future decreases in riparian shade that would result in increased temperature loading.

5.5.3 Martin Creek

5.5.3.1 Results of Shade Assessment

As summarized in Section 3.8.13.5, Martin Creek is not impaired for thermal modifications and therefore no TMDL is developed as part of this WQRP. However, it was determined appropriate to display the data and analysis results of the source assessment that helped draw this conclusion. Moreover, it is recommended as part of this WQRP that continued monitoring exist on Martin Creek to ensure that water quality standards are maintained and all beneficial uses are fully supported.

Potential sources of thermal modifications were assessed in Martin Creek. Additionally, existing and potential shade was assessed to help formulate the supplemental indicator targets. Also, as described earlier, “permanent” sources (anthropogenic impervious surfaces) of shade loss were calculated as were non-permanent (past harvest and past burned areas) in the assessment. Table 5-9 below, summarizes the extent of shade loss in Martin Creek.

Table 5-9. Summary of Shade Loss Along Martin Creek.

Reach Length (ft.)	Existing Stream Shade	Shade Loss from Main Roads (ft.)	Shade Loss from Mining (ft.)	Shade Loss from Secondary Roads and Impervious Surfaces (ft.)	Shade Loss from Fire (ft.)	Shade Loss from Past Timber Harvest (ft.)
52920	67%	1978 (3.7%)[1]	NA	4124 (7.8%)[1]	0	0

[1] Expressed as a percent of the total reach defined in the first column.

5.5.3.2 Future Development

It is not reasonable to assume that there will be no future development in the Martin Creek watershed. An allocation is therefore required to account for potential future thermal loading. This allocation proposes no future decreases in riparian shade that would result in increased temperature loading. This is further articulated in the adaptive management strategy in Section 9.0.

5.5.4 Nez Perce Fork

5.5.4.1 Results of Shade Assessment

Potential sources of thermal modifications were assessed in the Nez Perce Fork of the Bitterroot River. Additionally, existing and potential shade was assessed to help formulate the supplemental indicator targets. Also, as described earlier, “permanent” sources (anthropogenic impervious surfaces) of shade loss were calculated as were non-permanent (past harvest and past burned areas) in the assessment. Table 5-10 below, summarizes the extent of shade loss in the Nez Perce Fork.

Table 5-10. Summary of Shade Loss Along the Nez Perce Fork Bitterroot River.

Reach Length (ft.)	Existing Stream Shade	Shade Loss from Main Roads (ft.)	Shade Loss from Mining (ft.)	Shade Loss from Secondary Roads and Impervious Surfaces (ft.)	Shade Loss from Fire (ft.)	Shade Loss from past Timber Harvest (ft.)
78936	38%	19322 (24.5%)[1]	NA	13755 (17.4%)[1]	0	4272 (5.4%)[1]

[1] Expressed as a percent of the total reach defined in the first column.

5.5.4.2 Nez Perce Fork Allocations and TMDL

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

TMDL = WLAs + LAs + MOS

There are no point sources of temperature in the Nez Perce Fork watershed; therefore, that variable can be removed from the equation. The thermal sources in the watershed are roads, other impervious surfaces, and timber harvest. The best TMDL scenario for the Nez Perce Fork could be expressed as an 11% reduction in total thermal loading. This would be achieved by a 100% natural recovery of riparian vegetation allocated to ALL thermal sources. The resulting future total load would then be 949 btu/ft^2/day.

To articulate the TMDL in a format that is usable to land managers, the TMDL will be expressed as a percent reduction in thermal loading sources that equates to a percent increase in effective shade. The uncertainties associated with this are further discussed in Section 5.7.

The existing effective shade in the Nez Perce Fork is 38%. The late seral potential effective shade is 45%, for a difference of 7%. The TMDL is therefore expressed 100% reduction in thermal loading from past timber harvest sources. The result will be a 5.4% increase in effective shade. Additionally, a performance-based allocation will strive for additional decreases in the other identified thermal sources that would result in an overall increase in effective shade.

Table 5-11 displays the existing solar load (derived from existing shade values) and the reductions in that load for each benchmark. The percent reduction is directly correlated to an "increase" in effective shade that would result from reductions in impervious surfaces and natural re-growth if no fires or future riparian harvest were to occur. It is predicted that if 100% reductions occurred for all sources today, that it would take 19 years to reach effective shade potential in the Nez Perce Fork under natural growing conditions.

Table 5-11. Existing Loads and Load Allocations for the Nez Perce Fork.

Existing Load (btu/ft^2/day)	Existing Effective Shade	Proposed Reductions From Past Timber Harvest and Fire	Proposed Reduction from Roads, Mining and other Sources	Benchmark	Resulting Increase in Effective Shade (expressed as total)	Reduction in Solar Load (btu/ft^2/day)[2]
1,067	38%	100%	100%[1]	5 year	38%	1%
				10 year	39%	1%
				15 year	42%	6%
				Late Seral	45%	11%

[1] This allocation may not be feasible.
[2] Benchmark TMDLs are directly correlated to benchmark percent shade targets.

5.5.4.3 Future Development

It is not reasonable to assume that there will be no future development in the Nez Perce Fork watershed. An allocation is therefore required to account for potential future thermal loading. This allocation proposes no future decreases in riparian shade that would result in increased temperature loading.

5.5.5 Overwhich Creek

5.5.5.1 Results of Shade Assessment

Potential sources of thermal modifications were assessed in Overwhich Creek. Additionally, existing and potential shade was assessed to help formulate the supplemental indicator targets. Also, as described earlier, “permanent” sources (anthropogenic impervious surfaces) of shade loss were calculated as were non-permanent (past harvest and past burned areas) in the assessment. Table 5-12 below, summarizes the extent of shade loss in Overwhich Creek.

Table 5-12. Summary of Shade Loss Along Overwhich Creek.

Reach Length (ft.)	Existing Stream Shade	Shade Loss from Main Roads (ft.)	Shade Loss from Mining (ft.)	Shade Loss from Secondary Roads and Impervious Surfaces (ft.)	Shade Loss from Fire (ft.)	Shade Loss from Past Timber Harvest (ft.)
92934	51%	4665 (5.0%)[1]	NA	1917 (2.1%)[1]	18498 (19.9%)[1]	0

[1] Expressed as a percent of the total reach defined in the first column.

5.5.5.2 Overwhich Creek Allocations and TMDL

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

TMDL = WLAs + LAs + MOS

There are no point sources of temperature in the Overwhich Creek watershed; therefore, that variable can be removed from the equation. The thermal sources in the watershed are roads, other impervious surfaces, and fire. The best TMDL scenario for Overwhich Creek would be expressed as a 46% reduction in total thermal loading. This could be achieved by a 100% natural recovery of riparian vegetation allocated to ALL thermal sources. The resulting future total load would then be 456 btu/ft^2/day.

To articulate the TMDL in a format that is usable to land managers, the TMDL will be expressed as a percent reduction in thermal loading sources that equates to a percent increase in effective shade. The uncertainties associated with this are further discussed in Section 5.7.

The existing effective shade in Overwhich Creek is 51%. The late seral potential effective shade is 73%, for a difference of 22%. The TMDL is therefore expressed 100% reduction in thermal loading from forest fire sources. The result will be a 19.9% increase in effective shade. Additionally, a performance-based allocation will strive for additional decreases in the other identified thermal sources that would result in an overall increase in effective shade.

Table 5-13 displays the existing solar load (derived from existing shade values) and the reductions in that load for each benchmark. The percent reduction is directly correlated to an "increase" in effective shade that would result from reductions in impervious surfaces and natural re-growth if no fires or future riparian harvest were to occur. It is predicted that if 100% reductions occurred for all sources today, that it would take 49 years to reach effective shade potential in Overwhich Creek under natural growing conditions.

Table 5-13. Existing Loads and Load Allocations for Overwhich Creek.

Existing Load (btu/ft^2/day)	Existing Effective Shade	Proposed Reductions From Past Timber Harvest and Fire	Proposed Reduction from Roads, Mining and other Sources	Benchmark	Resulting Increase in Effective Shade (expressed as total)	Reduction in Solar Load (btu/ft^2/day)[2]
851	51%	100%	100%[1]	5 year	51%	846 (1%)
				10 year	52%	819 (4%)
				15 year	59%	701 (18%)
				Late Seral	73%	456 (46%)

[1] This allocation may not be feasible.
[2] Benchmark TMDLs are directly correlated to benchmark percent shade targets.

5.5.5.3 Future Development

It is not reasonable to assume that there will be no future development in the Overwhich Creek watershed. An allocation is therefore required to account for potential future thermal loading. This allocation proposes no future decreases in riparian shade that would result in increased temperature loading.

5.5.6 West Fork Bitterroot River

5.5.6.1 Results of Shade Assessment

Potential sources of thermal modifications were assessed in the West Fork Bitterroot River. Additionally, existing and potential shade was assessed to help formulate the supplemental indicator targets. Also, as described earlier, "permanent" sources (anthropogenic impervious surfaces) of shade loss were calculated as were non-permanent (past harvest and past burned areas) in the assessment. Table 5-14 below, summarizes the extent of shade loss in the West Fork Bitterroot River.

Table 5-14. Summary of Shade Loss Along the West Fork Bitterroot River.

Reach Length (ft.)	Existing Stream Shade	Shade Loss from Main Roads (ft.)	Shade Loss from Mining (ft.)	Shade Loss from Secondary Roads and Impervious Surfaces (ft.)	Shade Loss from Fire (ft.)	Shade Loss from Past Timber Harvest (ft.)
199396	25%	52093 (26.1%)[1]	132 (.07%)[1]	16788 (8.4%)[1]	0	0

[1] Expressed as a percent of the total reach defined in the first column.

5.5.6.2 West Fork Bitterroot River Allocations and TMDL

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

TMDL = WLAs + LAs + MOS

There are no point sources of temperature in the West Fork Bitterroot River watershed; therefore, that variable can be removed from the equation. The thermal sources in the watershed are roads, mining, and other impervious surfaces. The TMDL for the West Fork cannot be formulated at this time. Therefore, a phased approach is suggested in Section 5.8.

The shade analysis outlined previously in this section calculated both existing and potential effective shade in the West Fork Bitterroot watershed. These values are provided below in Table 5-15 to assist land managers, as further study in the West Fork is still suggested.

It is predicted that if 100% reductions occurred for all sources today, that it would take 23 years to reach effective shade potential in the West Fork Bitterroot River under natural growing conditions.

Table 5-15. Existing Loads and Load Allocations for the West Fork Bitterroot River.

Existing Load (btu/ft^2/day)	Existing Effective Shade	Proposed Reduction from Roads, Mining and other Sources	Benchmark[1]	Resulting Increase in Effective Shade (expressed as total)
1,291	25%	Proposal is to follow the Phased allocation outlined in Section 5.8.	5 year	26%
			10 year	27%
			15 year	33%
			Late Seral	45%

[1] Benchmark TMDLs are directly correlated to benchmark percent shade targets.

5.5.6.3 Future Development

It is not reasonable to assume that there will be no future development in the West Fork Bitterroot River watershed. An allocation is therefore required to account for potential future thermal loading. This allocation proposes no future decreases in riparian shade that would result in increased temperature loading.

5.5.7 East Fork Bitterroot River

5.5.7.1 Results of Shade Assessment

Potential sources of thermal modifications were assessed in the East Fork Bitterroot River. Additionally, existing and potential shade was assessed to help formulate the supplemental indicator targets. Also, as described earlier, “permanent” sources (anthropogenic impervious surfaces) of shade loss were calculated as were non-permanent (past harvest and past burned areas) in the assessment. Table 5-16 below, summarizes the extent of shade loss in the East Fork.

Table 5-16. Summary of Shade Loss Along the East Fork Bitterroot River.

Reach Length (ft.)	Existing Stream Shade	Shade Loss from Main Roads (ft.)	Shade Loss from Mining (ft.)	Shade Loss from Secondary Roads and Impervious Surfaces (ft.)	Shade Loss from Fire (ft.)	Shade Loss from Past Timber Harvest (ft.)
225172	31%	80832 (35.8%)[1]	0	22493 (9.9%)[1]	45394 (20.2%)[1]	0

[1] Expressed as a percent of the total reach defined in the first column.

5.5.7.2 East Fork Bitterroot River Allocations and TMDL

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

$$\textbf{TMDL = WLAs + LAs + MOS}$$

There are no point sources of temperature in the East Fork Bitterroot River watershed; therefore, that variable can be removed from the equation. The thermal sources in the watershed are roads, other impervious surfaces, and fire. It is also believed that flow alterations may be contributing to thermal loading. This is addressed in Section 6.0 and 9.9. The best TMDL scenario for the East Fork would be expressed as a 35% reduction in total thermal loading. This could be achieved by a 100% natural recovery of riparian vegetation allocated to ALL thermal sources. The resulting future total load would then be 770 btu/ft^2/day.

To articulate the TMDL in a format that is usable to land managers, the TMDL will be expressed as a percent reduction in thermal loading sources that equates to a percent increase in effective shade. The uncertainties associated with this are further discussed in Section 5.7.

The existing effective shade in the East Fork is 31%. The late seral potential effective shade is 55%, for a difference of 43%. The TMDL is therefore expressed 100% reduction in thermal loading forest fire sources. The result will be a 20.2% increase in effective shade. Additionally, a performance-based allocation will strive for additional decreases in the other identified thermal sources that would result in an overall increase in effective shade.

Table 5-17 displays the existing solar load (derived from existing shade values) and the reductions in that load for each benchmark. The percent reduction is directly correlated to an "increase" in effective shade that would result from reductions in impervious surfaces and natural re-growth if no fires or future riparian harvest were to occur. It is predicted that if 100% reductions occurred for all sources today, that it would take 15 years to reach effective shade potential in the East Fork Bitterroot River under natural growing conditions.

Table 5-17. Existing Loads and Load Allocations for the East Fork Bitterroot River.

Existing Load ($btu/ft^2/day$)	Existing Effective Shade	Proposed Reductions From Timber Harvest and Fire	Proposed Reduction from Roads, Mining and other Sources	Benchmark [2]	Resulting Increase in Effective Shade (expressed as total)	Reduction in Solar Load ($btu/ft^2/day$)[2]
1, 182	31%	100%	100%[1]	5 year	33%	1, 158 (2%)
				10 year	34%	1, 142 (3%)
				15 year	44%	962 (19%)
				Late Seral	55%	770 (35%)

[1] This allocation may not be feasible.
[2] Benchmark TMDLs are directly correlated to benchmark percent shade targets.

5.5.7.3 Future Development

It is not reasonable to assume that there will be no future development in the East Fork Bitterroot River watershed. An allocation is therefore required to account for potential future thermal loading. This allocation proposes no future decreases in riparian shade that would result in increased temperature loading.

5.6 Waterbody Summary

There are no point sources associated with the overall load of the Bitterroot Headwaters TPA. Non-point sources such as riparian clearing from past timber harvest, mining, road construction, other impervious surfaces, and fire have been identified as the greatest factors to the overall temperature load.

Natural allocations were set for all streams where past timber harvest and/or fire has affected riparian shade. A Phase II allocation is set as described in Section 5.8. Additionally, an adaptive management approach is outlined in Section 9.10.

The intent of loading allocations is to achieve a natural condition by which the streams in the BHTPA are at their potential. The true in-stream temperature potential is unknown, but expected to be achieved as riparian vegetation reaches its potential. Thus shade was used as a supplemental indicator in this WQRP. All temperature targets and supplemental indicators are again summarized in Table 5-18.

Table 5-18. Summary of the Proposed Targets & Indicators for the Thermally Impaired Streams in the Bitterroot Headwaters TPA.

Targets			
Parameter	**Stream**	**Proposed Metrics/Threshold**	**Monitoring Location**
In-stream Temperature[3]	Hughes Creek	Upper site: 15^0 C (59^0 F)	Mile 9.0
		Lower site: 15^0 C (59^0 F)	Mile 1.4
	Nez Perce Fork	Upper site: 12^0 C (53.6^0 F)	Mile 11.0
		Lower site: 15^0 C (59^0 F)	Mile 1.0
	Martin Creek	Upper site: 15^0 C (59^0 F)	Mile 7.5
		Lower site: 15^0 C (59^0 F)	Mile 1.3
	Overwhich Creek	Upper site: 12^0 C (53.6^0 F)	Mile 7.0
		Lower site: 15^0 C (59^0 F)	Mile 2.0
	West Fork Bitterroot River	Upper site: 12^0 C (53.6^0 F)	Mile 40.1
		Middle site: 15^0 C (59^0 F)	Mile 22.2
		Lower site: 15^0 C (59^0 F)	Mile 1.2
	East Fork Bitterroot River[1]	Upper site: 12^0 C (53.6^0 F)	Mile 31.4
		Middle site: 15^0 C (59^0 F)	Mile 17.8
		Lower site: 15^0 C (59^0 F)	Mile 0.5
Supplemental Indicators			
% Shade[2]	Hughes Creek	78%	Entire stream length
	Nez Perce Fork Creek	45%	
	Martin Creek	85%	
	West Fork Bitterroot River	45%	
	Overwhich Creek	73%	
	East Fork Bitterroot River[1]	55%	

[1] The East Fork has not been formally listed as impaired for thermal modifications on the 303(d) list to date.
[2] For ease of display, only the late seral stage percent shade was shown here. For more detail on shade targets in 5-year increments, see Section 5.5.2.2
[3] Mid-summer maximum as measured by a 7-day moving average.

5.7 Uncertainty Analysis

In order to complete many of the steps required for this WQRP, the best available and feasible technical analyses and subsequent linkages were used to draw conclusions. However, as with most natural resource issues, these conclusions must weigh natural variability and uncertainties that may arise. Variability, uncertainty, seasonality and a Margin of Safety (MOS) as they pertain to the temperature analyses and subsequent conclusions are described below.

5.7.1 Source Assessment Uncertainty

As described above, a substantial effort was made to identify all significant anthropogenic sources of temperature loading in the BHTPA. Where possible, estimates of temperature loads from each of the sources were also made. Although it is felt that this has resulted in sufficient information to reach the conclusions presented in this report, there are still some uncertainties regarding whether or not all of the significant sources have been identified, and regarding the quantification of temperature sources and subsequent loads.

Estimation of riparian shade at 5-, 10-, and 15-year benchmarks as well as for late seral, (i.e. old growth conditions), were necessary for the development of temperature TMDL targets using percent shade as a surrogate measure for actual stream temperature. The estimation of percent shade created by riparian vegetative (forest) cover is a function of both the canopy density as well as the vegetation height. Changes to a forest canopy density are assumed to be negligible in the near term (i.e. over a ten-year period) but could increase by about ten percent in a 15-year period (T. Opperman, Forest Ecologist, Bitterroot N.F., Personal communication). However, if the existing canopy densities were assessed at 90% density the 15-year benchmark were constrained to not exceed 90%, or the existing shade density. Late seral canopy densities are assumed to range from 50% to 70% depending on forest type (Table 5-19).

Stream reaches that were assessed as having an existing canopy (shade) density of less than 10% were recorded as 0% shade density. The only reaches where this occurred had Cottonwood and Doug fir forest types identified for future riparian forests and shade density values needed to be assigned for the 5-, 10-, and 15-year benchmarks. With the assumption of a natural regeneration process, the 5-year shade density for cottonwood was set at 10% and Doug fir 30%, which takes into account the growth characteristics of these forest types.

Maximum tree heights for species that typically grow in the project area range from 50 feet to 150 feet on average depending on species (Table 5-20). Site conditions are critical driving factors that ultimately determine what the maximum height potential of a species is and these factors are intrinsically incorporated in habitat types, site index values, and growth and yield curves discussed previously.

Table 5-19. Canopy Density Estimates for Forest Types at Late Seral Conditions.

Ponderosa pine	50%	Doug fir/Cottonwood	70%
Ponderosa/Doug fir	60%	Doug fir/Alder	60%
Lodgepole pine	70%	Doug fir/Talus	50%
Lodgepole/Grand fir	70%	Grand fir	70%
Lodgepole/Subalpine fir	70%	Subalpine fir	70%
Lodgepole/Talus	50%	Cottonwood	70%
Engelmann spruce	70%	Cottonwood/Doug fir	70%
Doug fir	70%		

Table 5-20. Average Maximum Tree Heights [1, 2].

Ponderosa pine	90 – 130 ft
Lodgepole pine	70 – 100 ft
Spruce	50 – 150 ft
Doug fir	80 – 130 ft
True fir (SAF)	50 – 140 ft
Cottonwood	~ 110 ft

[1] Non-cottonwood species from Forest Habitat Types of Montana, (Pfister, et. al., 1977).
[2] Cottonwood heights are based on average literature values for research conducted in the Pacific Northwest (Burns and Honkala, 1990).

5.7.2 TMDL and Load Allocation Uncertainty

The analysis presented in this document assumes that the load reductions proposed for each of the listed streams will enable the streams to meet target condition, and further assumes that meeting target conditions will ensure full support of all beneficial uses. To validate this assumption, implementation monitoring has been proposed in the monitoring plan in Section 8.0. This monitoring is intended to track progress toward meeting targets. If it looks like greater reductions in loading or improved performance is necessary to meet targets, then a new TMDL and/or allocations will be developed based on achievable reductions via application of reasonable land, soil, and water conservations practices.

The potential shade analysis assumes the following:

- The analysis utilized growth and yield curves based on site index as described in Section 5.3.6. However, climate and other natural variables could affect growth rates.
- The analysis does not formally quantify loads or percent reductions from each land use source.
- Rather, the analysis assumes that increases in potential shade would occur if all significant sources were removed today and natural re-grow were allowed to occur immediately.
- A 100% reduction in solar loading loss does not equate to 100% shade cover. Even in the densest canopies, solar radiation reaches the stream channel.
- Complete removal of all "permanent" structures may not be required to achieve full beneficial use support.
- The shade analysis assumed that all streams were at their potential when structures (roads, mining, other impervious surfaces) were constructed. This is unlikely, but was assumed for purposes of the analysis.
- There is uncertainty associated with the values presented of linear distance of disturbance from each source. This assumes that the air photo analysis captured all streamside disturbances. It is unlikely that this is the case, but the data presented represents the best available data. The adaptive management strategy outlined in Section 9.10, is designed to helps address this uncertainty.

5.7.3 Margin of Safety

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

- Conservative assumptions were used in all source assessment modeling, to include:
    - Shade was modeled for August 1st, which falls somewhere half-way between summer solstice and fall equinox. This could allow for more stringent targets and allocations than are actually needed to achieve full beneficial use support.
    - Stream reaches assessed as having < 10% canopy, were treated as zero percent. This by default resulted in higher surrogate shade targets and allocations, even though lesser shade values may actually be needed to achieve beneficial use support.
    - A minimum linear distance of 100 feet was used to assess potential sources of solar loading in the BHTPA. In some cases, topography may have been a limiting factor inside of the 100-foot assessment distance. This could allow for more stringent targets and allocations than are actually needed to achieve full beneficial use support.
- Targets and supplemental indicators are used to address both the beneficial uses and potential of a given stream channel.
- A large amount of data and assessment information were considered prior to finalizing any impairment determinations. Impairment determination were based on conservative assumptions that error on the side of keeping streams listed and developing TMDLs unless overwhelming evidence of use support was available.
- To be protective, temperature TMDLs and subsequent restoration and monitoring were developed as part of this WQRP (East Fork Bitterroot River) even though they were not required in all cases.
- The adaptive management approach evaluates target attainment and allows for refinement of load allocation, targets, and restoration strategies to ensure restoration of beneficial uses. The adaptive management strategy also accounts for the uncertainties described above.
- Impairment determinations were based on conservative assumptions that favored the resource when impairments were not obvious.

5.7.4 Seasonality

Addressing seasonal variations is an important and required component of TMDL development. Throughout this plan, seasonality is an integral factor. Water quality and habitat parameters such as fines sediment, suspended sediment, turbidity, macroinvertebrate and periphyton communities, and metals concentrations are all recognized to have seasonal cycles.

Specific examples of how seasonality has been addressed include:

- Targets are based during the season when fish life stages are thought to be most greatly impacted by temperature in the BHPA.
- Throughout this document, the data reviewed cover a wide range of years, seasons, and geographic area within the BHTPA.
- Bull trout spawning areas are monitored during the fall and cutthroat during the summer.
- Both temperatures and fish life stages vary with season. Despite seasonal variations, in-stream conditions need to ensure beneficial use support throughout the year.

5.8 Phased Allocation Study for Temperature Sources

As discussed in Section 5.5, the primary identified sources to thermal loading in the BHTPA streams are roads, mining, impervious surfaces, past timber harvest and fire. Allocations were set for timber harvest and fire as discussed in Section 5.5.1. However, no allocations were set for roads, other impervious surfaces, and mining. This is because based on the available data today, these sources may constitute an irretrievable commitment of resources and restoration or removal of these sources may not be feasible. However, the phased allocation strategy is added to help verify this conclusion on Hughes Creek, Nez Perce Fork, East and West Forks of the Bitterroot River, and Overwhich Creek. The adaptive management strategy outlined in Section 9.10 will also help address this situation.

Martin Creek was determined not impaired for thermal modifications, however as an added measure of protection, this plan proposes future monitoring to ensure water quality standards are maintained.

After applying the criteria outlined in Section 5.0, for riparian disturbance that constitutes a loss in effective shade, it was determined that no timber harvest or fire thermal sources on the West Fork Bitterroot River exist. Therefore, no allocations for those sources could be developed. Thus, this phased allocation approach is proposed for the West Fork Bitterroot River in combination with the adaptive management strategy outlined in Section 9.10.

Phase I

Roads, mining and other impervious surfaces are all sources that affect thermal loading in the BHTPA. As discussed in Section 5.5.1, it may not be feasible to allocate a 100% reduction of these sources. Additionally, it is not possible at this time to specifically quantify the relative importance of the thermal load from these sources. Therefore, it is proposed that a phased allocation study address these other sources. The first phase of the thermal allocation was addressed in this WQRP by quantifying the linear distances of riparian disturbance from each source. Additionally, the percentage of each identified source along each overall stream reach was quantified. This helps lands managers focus on priority sources.

Phase II

The Phase II allocation study proposes a feasibility analysis that would investigate each source (roads, mining, and other impervious surfaces) identified in the Phase I allocation. Conceptually, this analysis would help land managers prioritize areas for restoration. It will be important for the Phase II study to take into account any new information and/or data that arises from the shade and temperature monitoring outlined in Section 9.0. This monitoring may reveal that shade and subsequent in-stream temperatures are at their potential and thus, not require any additional restoration. However, land managers should always look for ways to prioritize and schedule restoration efforts so as to help maintain full beneficial use support.

In the event that the feasibility analysis identified potential areas for restoration, a load quantification would be conducted. Specifically quantifying the amount of restoration (e.g. road obliteration) can be correlated to a reduction in load. This, in conjunction with the adaptive management approach outlined in Section 9.10, would help land managers realize an actual reduction in thermal loading to the BHTPA streams.

A performance-based allocation could be used to relocate and/or obliterate all streamside roads and subsequently measure the success of these allocations. However, this may not always be possible or even feasible. Therefore, following the feasibility analysis, reduction would start by identifying and characterizing all roads identified in the source assessment. Next, appropriate buffer width would have to be determined (for purposes of the source assessment, 100’ was used, but this distance may not be appropriate in all cases) in order to prioritize. Then, feasible roads that are not being used would be removed for the first reduction phase and so forth. This would occur in conjunction with the proposed benchmarks as well as in-stream temperature monitoring. At any time where it is recognized that in-stream temperatures are equal to reference stream temperatures, the road reduction strategy may decrease or end.

SECTION 6.0
FLOW

6.1 Introduction

This section of the document addresses flow alterations in the Bitterroot Headwaters TPA streams. While developing TMDLs for flow alteration is not a requirement of the Clean Water Act, this plan recognizes the importance of maintaining natural in-stream flows in the Bitterroot basin. In-stream flow conditions are an important consideration of water quality restoration planning and maintaining natural flow conditions is critical to the success of beneficial uses, primarily native salmonids.

Four streams were listed for flow alterations in the Bitterroot Headwaters TPA when the TMDL process began. The first two, the East and West Forks of the Bitterroot River were listed from suspected dewatering resulting from agricultural practices. The remaining two streams, Overwhich and Martin Creeks, were listed because of suspected increases in peak flows resulting from timber harvesting. However, as was described in Section 3.0 of this document, three of these streams were found to be currently NOT impaired for flow alterations, leaving only the East Fork of the Bitterroot River as impaired for flow alterations.

The Bitterroot River Basin was closed to new surface water appropriations on March 29, 1999. All surface water permit applications received prior to the closure have been processed. With the exception of two small controlled groundwater areas downstream of the BHTPA, the entire Bitterroot Basin makes up approximately 60% of the Montana Department of Natural Resources and Conservation (DNRC) Missoula Regional office’s annual groundwater applications. Under Montana’s Administrative Rules, TMDLs cannot diminish, divest or imperil water rights. Ensuring sufficient in-stream flows to the Bitterroot River under existing water right law will have to be a voluntary effort achieved through locally coordinated efforts.

6.2 Source Characterization in the East Fork of the Bitterroot River

The East Fork[11] of the Bitterroot River was listed on the 1996 303(d) list as impaired for flow alterations resulting from agriculture. Decreased in-stream flows often result in adverse affects to aquatic life and cold-water fisheries. Decreased flows may produce increased stream temperatures, low dissolved oxygen levels, increased concentrations of nutrients and/or metals, and loss of pool habitat for fish (Gordon et. al, 1992). In western Montana, this de-watering affect typically results from impoundments and water diversions used for the irrigation of hay and other crops. The DNRC water rights query database lists a total allocation from the East Fork of the Bitterroot River of 3,055.22 acre-feet per year (http://nris.state.mt.us/apps/dnrc2002/waterrightmain.asp).

11 The East Fork is not formally listed but is being treated as potentially threatened or impaired by dewatering at the request of the Bitterroot Headwaters TMDL Technical Advisory Committee.

6.2.1 Assessment Methods

While it is expected that the primary sources of dewatering in the East Fork are associated with irrigation diversions, the complexity that exists lends itself to the need for better, more complete information. Given the size of this watershed and the long history of water-use practices in the basin, specific sources cannot be realized at this time. In order to accurately define the potential of all designated beneficial uses in the Bitterroot Headwaters TPA, a comprehensive basin-scale hydrologic investigation is proposed to answer the following questions:

1. What is the natural hydrologic regime of the East Fork and what are its expected mean annual natural flows?
2. What is the extent of surface water-use in the basin and how is it used?
3. What is the extent of groundwater-use in the basin?
4. How efficient are the water use mechanisms in the basin?
5. What is the fate of all diverted water in the basin?
6. Given all the water-use in the basin and the need for full support of all beneficial uses, what is the minimum and maximum flows that can be expected in the basin?
7. What is the effect of the timing, magnitude, duration and location of irrigation return flows?

Given the uncertainties that exist, and lack of resources at this time, it is recommended as part of this WQRP, that the above questions be answered through a phased approach. Another rationale behind the phased approach would be to help answer the suspected thermal impairment thought to exist on the East Fork Bitterroot River. The phased approach would also be designed to serve as a starting point to answer similar, yet more complicated flow issues that reside downstream of the BHTPA. The phased approach is outlined in Section 9.8.

SECTION 7.0
ENDANGERED SPECIES ACT CONSIDERATIONS

7.1 Introduction

This Water Quality Restoration Plan contains recommendations for future activities to improve or maintain water quality within the project area. These along with other foreseeable actions will be evaluated by the United States Fish and Wildlife Service (USFWS) to determine the potential for detrimental impacts on Threatened or Endangered Species. Foreseeable actions that result from this Plan include:

- Road sediment mitigation
- Road obliteration
- Development of livestock management plans that may include fencing riparian areas
- Fish habitat enhancement
- Stream bank stabilization using revegetation
- Culvert removal to address barriers to fish passage

7.2 Listed Species in the Project Area

The project area is the watershed of the East Fork and West Fork of the Bitterroot River above their confluence near Conner, Montana. Within that area the following species are threatened or endangered under the Endangered Species Act (ESA):

- Gray Wolf (*Canis lupis*)
- Bald Eagle (*Haliaeetus leucocephalus*)
- Canada Lynx (*Lynx canadensis*)
- Bull Trout (*Salvenlinus confluentus*)

7.3 Species-Specific Descriptions

7.3.1 Gray Wolf

7.3.1.1 General Description of Species and Habitat Requirements

The gray wolf is adapted to an extremely wide variety of habitats and can survive in any area that supports ungulates (its main food source). Wolf packs usually live within a specific territory. Territories in the northern Rocky Mountains range in size from 200 to 400 square miles depending on how much prey is available and seasonal prey movement. Wolves may travel as far as 30 miles in a day.

Prior to reintroduction efforts by the USFWS in 1995 there was no evidence of gray wolf presence in the project area. Since that time, however, there have been confirmed reports of tracks, howling and wolf sightings in the project area.

Gray Wolves have no particular habitat preference. In Minnesota and Wisconsin, they are usually found in areas with few roads, which increase human access and incompatible land uses but apparently can occupy semi-wild lands if ungulate prey are abundant and if not killed by humans. A minimum of 10,000-13,000 sq km (with low road density) might be necessary to support a viable population. Young are born in an underground burrow that has been abandoned by another mammal or dug by wolf. In the Northwest Territories, dens were most commonly located within 50 km of northern tree line, which resulted in maximal availability of caribou during the denning and pup rearing period; within the tundra zone, dens were not preferentially located near caribou calving grounds. In Minnesota, dens usually were not near territory boundaries; den use was traditional in most denning alpha females studied for more than 1 year; possibly the availability of a stable food supply source helped determine den location.

7.3.1.2 Potential Impacts on Gray Wolf

Of the anticipated actions resulting from this Water Quality Restoration Plan, nearly all will occur in the valley bottoms. The exception is work that may occur at higher elevations on forest roads. The activities in the valley bottoms may include construction activities such as fish habitat enhancement and stream bank stabilization. These activities will be short-term (typical project duration is less than one month) and are not expected to pose a threat to wolves. In addition, these activities as well as any livestock management plans that are developed will ultimately improved wildlife habitat in riparian areas and are therefore likely to benefit wolves.

7.3.2 Bald Eagle

7.3.2.1 General Description of Species and Habitat Requirements

Bald Eagles focus on habitats such as quiet coastal areas, rivers, and lakeshores with large, tall trees. Man-made reservoirs can provide excellent habitat. Nesting and wintering habitats are both critical to the continued survival of the bald eagle. In winter, bald eagles often congregate at specific wintering sites that are generally close to open water and offer good perch trees and night roosts. Night roosts typically offer isolation and thermal protection from winds. Carrion and easily scavenged prey provides important sources of winter food in terrestrial habitats far from open water. Fish is the major component of its diet, but waterfowl, seagulls, and carrion are also eaten.

7.3.2.2 Potential Impacts on Bald Eagle

Of the anticipated actions resulting from this Water Quality Restoration Plan, nearly all will occur in the valley bottoms. The exception is work that may occur at higher elevations on forest roads. The activities in the valley bottoms may include construction activities such as fish habitat enhancement and stream bank stabilization. These activities will be short-term (typical project duration is less than one month) and are not expected to pose a threat to Bald Eagles. In addition, these activities as well as any livestock management plans that are developed will ultimately improved fish habitat and are therefore likely to benefit eagles.

7.3.3 Canadian Lynx

7.3.3.1 General Description of Species and Habitat Requirements

Lynx in the contiguous United States are at the southern margins of a widely distributed lynx population that is most abundant in northern Canada and Alaska. Within the contiguous United States, the lynx's range coincides with that of the southern margins of the boreal forest along the Appalachian Mountains in the Northeast, the western Great Lakes and the Rocky Mountains and Cascade Mountains in the West. In these areas, the boreal forest is at its southern limits, becoming naturally fragmented into patches of varying size as it transitions into subalpine forest in the West and deciduous temperate forest in the east.

The lynx is a rare forest-dwelling cat of northern latitudes. Lynx feed primarily on snowshoe hares but also will eat small mammals and birds. Downed logs and windfalls provide cover for denning sites, escape, and protection from severe weather. Earlier successional forest stages provide habitat for the lynx’s primary prey, the snowshoe hare.

In the contiguous United States, lynx populations occur at naturally low densities; the rarity of lynx at the southern portion of the range compared to more northern populations in Canada is normal. The rarity of lynx is based largely on limited availability of its primary prey, snowshoe hare. Such habitat prevents hare populations from achieving high densities similar to those in the extensive northern boreal forest. Lynx in the contiguous United States are part of a larger meta-population whose core is located in central Canada.

In the Northern Rocky Mountain/Cascades Region, the majority of lynx occurrences are associated at a broad scale with the “Rocky Mountain Conifer Forest;” within this type, most of the occurrences are in moist Douglas fir and western spruce/fir forests. Most of the lynx occurrences are in the 4,920-6,560 feet elevation class. These habitats are found in the Rocky Mountains of Montana, Idaho, eastern Washington, and Utah and the Cascade Mountains in Washington and Oregon. The majority of verified lynx occurrences in the U.S. and the confirmed presence of resident populations are from this region. The boreal forest of Washington, Montana, and Idaho is contiguous with that in adjacent British Columbia and Alberta, Canada.

USFWS concludes that a resident population of lynx is distributed throughout suitable habitat in the northern and central mountain ranges in western Montana, whereas in the mountains in southwestern Montana, habitat naturally becomes more marginal (more patchy and drier forest types) and supports dispersers more often than resident populations.

The size of lynx home ranges vary and have been documented from 3 to 300 square miles. Lynx are capable of moving extremely long distances in search of food or to establish new home ranges. Lynx populations rise and fall following the cyclic highs and lows of snowshoe hare populations. When hare populations are low, the change in the lynx’s diet causes the productivity of adult female lynx and survival of young to nearly cease. Lynx movements may be negatively influenced by high traffic volumes on roads that bisect suitable lynx habitat.

7.3.3.2 Potential Impacts to Canadian Lynx

Of the anticipated actions resulting from this Water Quality Restoration Plan, nearly all will occur in the valley bottoms. The exception is work that may occur at higher elevations on forest roads. This work may include culvert removal, road obliteration, or road sediment mitigation activities. These activities will be short-term (typical project duration is less than one month) and are not expected to pose a threat to Lynx. Long-term closures and road obliteration would likely be a benefit to lynx.

7.3.4 Bull Trout

7.3.4.1 General Description of Species and Habitat Requirements

Bull trout are threatened by activities that damage riparian areas and cause stream siltation; logging, road construction, mining, and overgrazing may be harmful to spawning habitat. This species is very sensitive and severely impacted by siltation of spawning streams. Timber harvest and associated activities may have negative impacts on stream channels through sedimentation and/or increasing flooding or scour events; although BMPs and the Montana SMZ law can help to reduce these impacts.

Habitat fragmentation may be a problem, but it is unclear whether the fragmented distribution is natural due to specific habitat requirements or caused by human impacts. Some migratory populations have been virtually eliminated by water diversions or habitat disruption (e.g., in the Bitterroot basin). Climate change (warming) is a potential threat because it would decrease the amount of suitable habitat.

Hybridization appears to be a common problem where isolated or remnant resident populations overlap with introduced brook trout (spawning times and conditions are similar). Hybrids are likely to be sterile and experience developmental problems, and sometimes, sharp declines in bull trout populations have occurred. In Montana, introduced brook trout progressively depressed a bull trout population (Leary et. al. 1993). Brook trout have been widely introduced and now occupy most basins inhabited by bull trout, though they often occupy different streams or stream reaches. Introduced brown trout and rainbow trout have been associated with bull trout declines, apparently due to competitive interactions; lake trout may have a negative impact on bull trout, due to predation by lake trout on juvenile bull trout, probable competitive interactions, and increased harvest associated with increased fishing pressure for lake trout. Lake trout can displace bull trout and may prevent bull trout from becoming established in certain low elevation lakes.

Preferred habitat is the bottom of deep pools in cold rivers and large tributary streams, often in moderate to fast currents with temperatures of 45-50ºF; also large cold-water lakes and reservoirs. In the contiguous U.S., bull trout are now extirpated in most large rivers that historically were inhabited and are confined mostly to headwater streams. Conditions that favor the persistence of populations include stable channels, relatively stable stream flow, low levels of fine substrate sediments, high stream channel complexity with various cover types, temperatures not exceeding about 15ºC, and the presence of suitable corridors for movement between suitable winter and summer habitats and for genetic exchange among populations.

Migratory forms live in tributary streams for up to several years before migrating downstream into a larger river or lake, where they spend several years before returning to tributaries to spawn. Some or most juveniles move to larger rivers or to a lake by mid-summer, while others stay in spawning areas for 2-4 years. Adults return to river or lake after spawning in small streams. May move to lower reaches of Mainstream River for winter. Resident populations often occur in small headwater streams where they spend their entire lives. In lakes, inhabits all depths in fall, winter, and spring; moves to cooler, deeper water for summer.

Bull trout usually spawn in gravel riffles of small tributary streams, including lake inlet streams. Spawning sites often are associated with springs or groundwater upwhellings. Spawning requires a large volume of cold water**.** Optimum temperatures for incubation are about 2-4ºC. Young are closely associated with stream channel substrates. Areas with large woody debris and rubble substrate are important as juvenile rearing habitat.

7.3.4.2 Potential Impacts to Bull Trout

Much of the work anticipated to result from this Water Quality Restoration Plan will be implemented to improve water quality and fish habitat. There may, however, be short-term impacts to localized reaches of streams or rivers in the project area. The projects associated with these impacts may be culvert removal, road sediment mitigation, road obliteration, in-stream habitat enhancement (e.g. placement of woody debris) and stream bank stabilization using biodegradable materials.

The projects will typically have a duration of from one day to a season and the impacts will be intermittent during that time and will be mainly associated with localized physical disturbance and fine sediment disturbance and transport to the downstream reach. These activities along with other anticipated work such as riparian fencing would provide a long-term benefit to bull trout.

The following section provides details on the portions of this Plan that are pertinent to the protection of bull trout.

7.3.4.3 Sediment Targets

Several of the waterbodies in this WQRP are listed as impaired by siltation. The water quality targets, performance-based allocations and restoration activities will reduce this siltation and are anticipated to benefit bull trout. The specific sediment-related targets in this WQRP are shown in Table 7-1.

Table 7-1. Summary of the Proposed Targets & Indicators for the Sediment[1] Impaired Streams in the Bitterroot Headwaters TPA.

Target Parameter	**Proposed Metrics/Threshold**	
Wolman pebble counts % Fines< 2mm (data collected in riffles)	B3 channels	Mean = 12%
		Range = 5-19%
	B4 channels	Mean = 19%
		Range = 11-27
	C3 channels	Mean = 13%
		Range = 6-20%
	C4 channels	Mean = 23%
		Range = 14-32%
Wolman pebble counts % Fines < 6mm (data collected in riffles)	B3 channels	Mean = 16%
		Range = 7-25%
	B4 channels	Mean = 27%
		Range = 16-38%
	C3 Channels	Mean = 16%
		Range = 8-24%
	C4 channels	Mean = 33%
		Range = 17-49%
Wolman pebble counts D_{50} (data collected in riffles)	B3 channels	64-256 mm
	B4 channels	7-64 mm
	C3 channels	71-89 mm
	C4 channels	3-47 mm
Clinger Richness	All	≥ 14
Supplemental Indicator Parameter[3]		
Residual Pool Depth	≥ 1.5 feet	
LWD/mile (at least 30 cm diameter and 10 meters long)	East and West Forks: > 20/mile Tributaries: > 50/mile	
Pools/mile	Stream width class (ft)	Pools/mile target
	0-5	39
	5-10	60
	10-15	48
	15-20	39
	20-30	23
	30-35	18
	35-40	10
	40-65	9
	65-100	4
Suspended Solids Concentration	Comparable to reference condition	
Turbidity	High Flow – ≤ 50 NTU instantaneous maximum Summer base flow – ≤ 10 NTU	
Montana Mountain Macroinvertebrate Index of Biological Integrity	> 75%	
Percentage of Clinger Taxa	"High"	
EPT Richness	≥ 22	
Juvenile Bull Trout & Westslope Cutthroat Trout Densities	Documented increasing or stable trend.	
Human Caused Sediment Sources[2]	No preventable sources	
Fish Passage Barriers	No barrier except to protect native salmonid genetics	

[1]*Throughout this document, several related impairment, including sediment, siltation, suspended solids and habitat alterations are treated collectively as sediment for ease of presentation.*
[2] *This supplemental indicator is only applied to the verification of impairment determinations. This is not intended to be a water quality goal.*
[3]*The supplemental indicators are not Rosgen stream type dependent.*

Several of the waterbodies in this WQRP are listed as impaired by temperature. The water quality targets, performance-based allocations and restoration activities are formulated to reduce this impairment and are anticipated to benefit bull trout.

In-Stream Temperature

As noted in Section 3.2.2.3 and 3.3.3, the temperature standards for the BHTPA are narrative and designed to represent reference conditions. Currently, insufficient temperature reference data from the BHTPA exists to adequately set reference-based; therefore, temperature will be set based on literature values.

Targets will be based on cold-water fish life stages, specifically targeting the time of the year and life stage believed to be the limiting factors in the Bitterroot Headwaters TPA streams.

In the Bitterroot Headwaters TPA, it is believed that spawning and incubation temperatures are not the limiting factors for cold-water fish (particularly bull trout), but rather mid-summer temperatures that may be influencing migration or rearing. While critical spawning temperatures have been shown to trigger spawning and other activities and are believed to be critical for the propagation success of cold-water species, it is felt that sufficient research has not yet adequately proven specific temperatures that trigger or hinder spawning in the BHTPA. Additionally, existing in-stream temperature data in the Bitterroot Headwaters TPA has shown that late summer/early fall temperatures routinely drop due to day length. Therefore the focus of this WQRP and its subsequent in-stream temperature targets would be on mid-summer maximum temperatures (measured as the 7-day average maximum). These targets would address migration and rearing life stages when cold-water fish appear most vulnerable in the Bitterroot Headwaters TPA streams.

As stated previously, the 7-day average maximum will be the matrix used to measure the in-stream targets of this WQRP. This statistic, records a running average of daily maximum temperatures in a seven-day period. The maximum of all 7-day running averages for the period of record is then reported as a single temperature. While many other matrices exist by which to report temperature, Gamett (2002) looked at 18 temperature matrices and correlated them to bull trout population metrics. He found that the correlation between temperature matrices did not vary considerably (i.e. mean period of record temperatures versus 7-day maximum had an R^2 of .94), depending on how he characterized his bull trout population. Therefore, since very little difference exists between temperature matrices, the 7-day average maximum will be used for this WQRP.

Moreover, if a 7-day maximum target is surpassed, this does not necessarily equate to temperature impairment. Instead, this 7-day target would serve as a threshold that would trigger further investigation into the temperature values across the entire season of record and verify whether or not temperatures from that season of record are adversely affecting cold-water fish. Section 8.2, later in this document, further discusses the potential investigations that would result following any possible exceedence of the 7-day maximum targets.

Finally, an adaptive management approach is also incorporated into the BHTPA temperature targets. This strategy was developed because the in-stream temperature targets developed for this WQRP are the most protective, but may not be conducive to the BHTPA streams. Additional reference data is needed to adequately develop temperature targets based on local references. This approach would be based on 3 variables: 1) the stream's potential, 2) studies on the effects of temperature on bull trout and other salmonid species, and 3) reference conditions. The adaptive management strategy is further discussed in Section 9.10.

Table 7-2. In-Stream Temperature Targets.

Target	Stream	Bull Trout Life Stage	Proposed Metrics
In-Stream Temperature	Hughes Creek	Rearing	Upper site: 15ºC
		Rearing/Migration	Lower site: 15ºC
	Martin Creek	Rearing/Migration	Upper site: 15ºC
		Rearing	Lower site: 15ºC
	Nez Perce Fork	Rearing	Upper site: 12ºC
		Rearing/Migration	Lower site: 15ºC
	Overwhich Creek	Rearing	Upper site: 12ºC
		Rearing/Migration	Lower site: 15ºC
	West Fork Bitterroot River	Rearing	Upper site: 12ºC
		Rearing/Migration	Middle site: 15ºC
		Rearing/Migration	Lower site: 15ºC
	East Fork Bitterroot River	Rearing	Upper site: 12ºC
		Rearing/Migration	Middle site: 15ºC
		Rearing/Migration	Lower site: 15ºC

Percent Shade

Forested headwater streams rely heavily on streamside shade to maintain cool water temperatures and maintaining riparian shade can be achieved through proper management techniques. Effective shade screens the water's surface from direct rays of the sun. Highly shaded streams often experience cooler stream temperatures due to reduced input of solar energy (Beschta et al., 1987; Li et al., 1994). Given the forested environment, current timber management practices and headwater stream setting of the BHTPA, it was felt that riparian vegetation would be the variable that would result in the most achievable and measurable targets. Additionally, very few water diversions exist along the BHTPA streams and the source assessment concluded that roads and past harvest are the primary sources of increased stream temperatures due to a decrease in riparian cover.

It is important to note that the shade targets will be used as supplemental indicators in this WQRP. These surrogate targets are based on the assumption that riparian disturbance and subsequent loss of shade is the primary source behind the thermal modifications in the BHTPA. While no scientific link has been made between in-stream temperatures and percent riparian shade, it is assumed that once the riparian vegetation has reached its full potential, that the in-stream temperatures will be at their natural potential, regardless of climatic conditions (Table 7-3).

Table 7-3. Riparian Shade Targets as a Surrogate to In-Stream Temperature Targets.

Stream	Existing Percent Shade	Percent Shade Target[1]	Shade Interim Benchmark
Hughes Creek	55	56	Year 5
		58	Year 10
		65	Year 15
		78	Late Seral Stage
East Fork	31	33	Year 5
		34	Year 10
		44	Year 15
		55	Late Seral Stage
Martin Creek	67	69	Year 5
		71	Year 10
		75	Year 15
		85	Late Seral Stage
Nez Perce Fork	38	38	Year 5
		39	Year 10
		42	Year 15
		45	Late Seral Stage
Overwhich Creek	51	51	Year 5
		52	Year 10
		59	Year 15
		73	Late Seral Stage
W.F. Bitterroot River	25	26	Year 5
		27	Year 10
		33	Year 15
		45	Late Seral Stage

[1] While no scientific link was made between percent shade and actual stream temperatures, it is assumed that full riparian shade potential would significantly benefit stream temperatures in headwater forest dominated stream systems. Additional discussion on stream temperature variability and the parameters that affect stream temperatures is presented in Section 5.5.1 (Monitoring Section).

7.3.4.4. Other Targets Pertinent to Bull Trout

Besides the fine sediment and temperature targets presented above this plan calls for substantial progress to be made towards the following:

1. Reduction in road sediment
2. Reduction in and prevention of excessively eroding banks
3. Improvement in Wolman pebble count values
4. Restoration or maintenance of residual pool depths that match reference conditions
5. Restoration or maintenance of the amount of LWD per mile to match reference conditions
6. Restoration or maintenance of the number of pools per mile to match reference conditions
7. Restoration or maintenance of macroinvertebrate communities to match MDEQ guidelines
8. Consideration of fish passage barriers and removal of those that are a detriment to overall health of the fishery

7.3.4.5 Beneficial use Linkage

Understanding the linkage between the known impairments, set targets and beneficial uses is difficult at best. Through efforts described in this WQRP, various methods would be implemented to help measure the success of mitigation and determine whether the set targets are adequately protecting beneficial uses. While the targets were developed from literature reviews and analysis of reference conditions, success of the beneficial uses may be measured through various inventories as further discussed in Section 9.0.

Water Quality Restoration Plan and Total Maximum Daily Loads for the Bitterroot Headwaters Planning Area

VOLUME III
MONITORING & RESTORATION PLANS

Preface

Volume III, Monitoring and Restoration Plans, contains Sections 8.0 and 9.0. These Sections include: Section 8.0: Restoration Strategy, and Section 9.0: Monitoring Strategy.

The primary goal of this WQRP is to develop a plan that, if implemented, will result in full beneficial use support as related to the State Water Quality Standards. The sections in this volume outline approaches that either mitigate known sources of impairment or monitor the uncertainties outlined in Volume II.

A detailed outline of each section within Volume III is provided below.

Section 8.0: The Restoration Strategy Section outlines the mitigation steps needed to meet the required water quality targets and load allocations and ultimately obtaining full beneficial use support for all waterbodies in the BHPA.

The strategies outlined in Section 8.0 are specific to the sources of impairment described in Volume II. However, it is important to note that not all of the strategies outlined in Section 8.0 can be met in short order. Specific commitments from each stakeholder have been clearly outlined in this section. However, additional steps identified in Section 8.0, would have to be pursued as feasible. The suggestive steps outlined in Section 8.2.2 are essential to restoring water quality in the BHPA and would be the voluntary responsibility of all stakeholders as additional resources become available. Moreover, the strategies that are currently scheduled have been structured as the highest priorities that will result in the greatest benefit to the resource in the shortest time frame.

Section 9.0: The Monitoring Strategy outlines additional data collection needed to answer the uncertainties that were outlined in Volume II. The following objectives were developed as part of the Monitoring Strategy:

1. Document water quality trends associated with future implementation efforts.
2. Monitor progress toward meeting water quality targets.
3. Fill existing data gaps on both 303(d) listed streams and on streams that, while not formally listed, are thought to impact water quality in the basin.
4. Conduct an adaptive management strategy to fulfill requirements of this WQRP.
5. Conduct a phased hydrologic study to fulfill the requirements of this WQRP.

The primary purpose of the Monitoring Section is two-fold. First, as outlined above, uncertainties exist that limit confident conclusions at this time. Secondly, it is important to monitor trends over time to ensure that the goals and objectives of this WQRP are met and maintained over time.

Similar to the Restoration Strategy outlined in Section 8.0, the monitoring strategy outlined in Section 9.0 are specific to the sources of impairment and uncertainties described in Volume II.

SECTION 8.0
RESTORATION STRATEGY

8.1 Restoration Priorities

The strategies outlined in Section 8.0 are specific to the sources of impairment described in Volume II. However, it is important to note that not all of the strategies outlined in Section 8.0 can be met in short order. Specific commitments from each stakeholder have not been clearly outlined in this section. However, steps identified in Section 8.0, would have to be pursued as feasible in order to achieve the goals of this WQRP. The suggestive steps outlined in Section 8.2 are essential to restoring water quality in the BHTPA and would be the voluntary responsibility of all stakeholders as additional resources become available. Moreover, the strategies that are currently scheduled have been structured as the highest priorities that will result in the greatest benefit to the resource in the shortest time frame.

The following priority restoration actions in the Bitterroot Headwaters TPA have been identified:

- Upgrade forest and private roads to meet Montana Forestry BMPs.
- Reclaim forest and private roads that are surplus to the needs of forest managers.
- Continue to Implement Montana's Forestry BMPs on all timber harvest operations on BNF lands and encourage widespread implementation on private lands.
- Conduct follow-up assessments of potential bank instability to determine causes of bank failure and priority restoration areas.
- Continue post fire restoration and sediment mitigation efforts.
- Upgrade undersized culverts over time to better accommodate large floods.
- Correct priority fish passage barriers that are significantly affecting the connectivity of native fish habitats.
- Continue riparian management and monitoring in areas impacted by livestock use.
- Pursue funding for the local watershed group (Bitterroot Water Forum) to implement TMDL recommendations on private land and to bring local residents and land owners into the TMDL and watershed restoration process.

8.2 Water Quality Protection and Improvement Strategy

8.2.1 Stream-specific Restoration Priorities

Sections 8.2.1.1 through 8.2.1.12 provide specific stream-by-stream restoration recommendations.

8.2.1.1 Buck Creek

8.2.1.1.1 Roads

Of the 49 potential road sediment sources evaluated in the Buck Creek sediment source assessment, 25 had contributing road treads, cut slope, and/or fill slopes that exceeded 200 ft and were thus identified as restoration priorities. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Road restoration will need to be site specific. These contributing areas are located on Forest Service roads 5715, 6186, 13432 and 5716.

Stream crossings and near stream road segments accounted for an estimated 192 tons of sediment/year in the Buck Creek watershed when they were assessed in 2002. Sediment delivery mitigation will reduce the sediment load from them to an estimated 61 tons/year, for a reduction of 131 tons/year. Although the FroSAM analysis (see Section 4.0) was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from roads may be occur through a variety of methods. Crossings in need of sediment delivery mitigation are presented below (Table 8-1). Maps showing the location of these crossings are included in Appendix G.

Table 8-1. Buck Creek Road Crossing and Segment Restoration Priorities.

2748 (USFS 5715)	2754 (USFS 5715)	2775 (USFS 13432)	2776 (USFS 5715)	2777 (USFS 13432)
2783 (USFS 5715)	2784 (USFS 13432)	2788 (USFS 5715)	2816 (USFS 5715)	2819 (USFS 8168)
2831 (USFS 5715)	2857 (USFS 8168)	2858 (USFS 8168)	2862 (USFS 5715)	2864 (USFS 5715)
2869 (USFS 5715)	2871 (USFS 8168)	2883 (USFS 5716)	2884 (USFS 5715)	2885 (USFS 8168)
2888 (USFS 8168)	2826 (USFS 5715)	2866 (USFS 5715)	2886 (USFS 5716)	2781 (USFS 5715)

Note: The first road segment number represents the number associated with the source assessment as shown in Appendix G, the second number equates to the appropriate USFS road number.

8.2.1.1.2 Culverts

There are no culverts in the Buck Creek watershed that are known to impede or block fish passage. The only known culvert on the fish-bearing portion of Buck Creek is the culvert under the West Fork Highway. That highway culvert is suitable for fish passage. However, Buck Creek flows across residential properties on both sides of the highway, and there could be other culverts on private lands that have not been evaluated. Buck Creek is a small stream that goes intermittent near the West Fork Highway during the summer and autumn, and dewatering occurs on the private lands near the West Fork Highway. It appears that having an adequate supply of water in the creek is the limiting factor for fish passage in Buck Creek, not culverts.

8.2.1.2 Ditch Creek

8.2.1.2.1 Roads

Of the 18 potential road sediment sources evaluated in the Ditch Creek sediment source assessment, 8 had contributing road treads, cut slope, and/or fill slopes that exceeded 200 ft and were thus identified as restoration priorities. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Road restoration will need to be site specific. These contributing areas are located on Forest Service roads 5715, 6186, 13432 and 5716.

Stream crossings and near stream road segments accounted for an estimated 70 tons of sediment/year in the Ditch Creek watershed when they were assessed in 2002. Sediment delivery mitigation will reduce the sediment load from them to an estimated 26 tons/year, for a reduction of 44 tons/year. Although the FroSAM analysis (see Section 4.0) was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from roads may be occur through a variety of methods. Crossings in need of sediment delivery mitigation are presented below (Table 8-2). Maps showing the location of these crossings are included in Appendix G.

Table 8-2. Ditch Creek Road Crossing and Segment Restoration Priorities.

3005 (USFS 5715)	3011 (USFS 5715)	3021 (USFS 5715)	3022 (USFS 5715)
3024 (USFS 5715)	3025 (USFS 13435)	3033 (USFS 13435)	3034 (USFS 5715)

Note: The first road segment number represents the number associated with the source assessment as shown in Appendix G, the second number equates to the appropriate USFS road number.

8.2.1.2.2 Culverts

There are two culverts in the Ditch Creek watershed that are known to impede or block fish passage. One is the culvert on Ditch Creek under the West Fork Highway, the other is the culvert on Ditch Creek on Road 91-E about 0.7 miles upstream of the highway. In both locations, Ditch Creek is intermittent and often dry during late summer. Some overland flow intermittently occurs in the section of stream between the two culverts. The rest of the culverts in the Ditch Creek watershed do not affect fish. BNF recommended that the West Fork Highway and Road 91-E culverts be replaced when the opportunity and funding allows. As with the Buck Creek culvert, replacement of the culvert on the highway will be more difficult due to the expense. It is most likely to occur whenever the highway is reconstructed in the future.

8.2.1.3 Meadow Creek

8.2.1.3.1 Roads

Of the 177 potential forest road sediment sources evaluated in the Meadow Creek sediment source assessment, 40 had contributing road treads, cut slope, and/or fill slopes that exceeded 200 ft and were thus identified as restoration priorities. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Road restoration will need to be site specific. These contributing areas are located on Forest Service roads 725 and 725B, 5761, 5762, 73609, 5759, 73614, and 5764. Forest Service roads 725, 725B, 5761, 5759, and 5764 were identified during the post 2000 Fire EIS process as needing BMP upgrades. BMP upgrades will occur as funding allows.

Stream crossings and near stream road segments accounted for an estimated 173 tons of sediment/year in the Meadow Creek watershed when they were assessed in 2002. Sediment delivery mitigation will reduce the sediment load from them to an estimated 115 tons/year, for a reduction of 58 tons/year. Although the FroSAM analysis (see Section 4.0) was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from roads may be occur through a variety of methods. Crossings in need of sediment delivery mitigation are presented below (Table 8-3). Maps showing the location of these crossings are included in Appendix G.

Some sediment delivery reduction work had occurred since the road sediment delivery analysis was completed. The Bitterroot National Forest has performed a full BMP upgrade to a portion of Road 725 where it parallels the stream (7.19 miles) and hardened the crossings at Meadow Creek and Spruce Creek. These two undersized stream crossings where upgraded to 100-year, fish friendly culverts. On Road 725, over 20 contributing road treads, cut slopes, and/or crossings have been improved. Swift Creek Road 5764 is graveled in Swift Creek riparian area. Thus the estimated sediment load from road presented above is probably an overestimate of current conditions.

Table 8-3. Meadow Creek Road Crossing and Segment Restoration Priorities.

1798 (USFS 725)	1804 (USFS 725)	1805 (USFS 725)	1812 (USFS 5762)	1815 (USFS 5762)	1879 (USFS 73609)
1817 (USFS 73609)	1855 (USFS 5762)	1856 (USFS 5762)	1871 (USFS 73609)	1874 (USFS 5762)	1964 (USFS 725)
1881 (USFS 5762)	1882 (USFS 5762)	1887	1919 (USFS 725)	1960	2038 (USFS 73614)
2262	1987 (USFS 5769)	1992 (USFS 73609)	19995 (USFS 73609)	2009 (USFS 73614)	2419 (USFS 725)
2130 (USFS 5762)	2249 (USFS 725B)	2318 (USFS 725)	2366 (USFS 725)	2417 (USFS 725)	RS4 (USFS 725)
RS1 (USFS 725)	RS10 (USFS 725)	RS11 (USFS 725)	RS2 (USFS 725)	RS3 (USFS 725)	
RS5 (USFS 725)	RS6 (USFS 725)	RS7 (USFS 725)	RS8 (USFS 725)	RS9 (USFS 725)	

Note: The first road segment number represents the number associated with the source assessment as shown in Appendix G, the second number equates to the appropriate USFS road number.

8.2.1.3.2 Culverts

There are two culverts on Meadow Creek that are believed to impede fish passage: FDR 5758 and FDR 725. BNF knows from a decade of fish population monitoring surveys that some adult migratory bull trout and westslope cutthroat trout can get upstream through these two culverts. However, at higher flows, water velocities through these culverts are probably barriers or impediments to smaller juveniles of both species. Both culverts pinch the bankfull and baseflow wetted channel of Meadow Creek by more than half, and there is no substrate in the bottom of the culvert barrels. The FishXing model predicts that both culverts are barriers for juvenile and adult bull trout. Two other culverts in the Meadow Creek watershed were identified in the Burned Area Recovery FEIS as fish barriers: the Road 725 and 73609 culverts on Bugle Creek. Bugle Creek is a tributary to Meadow Creek. The Road 725 culvert on Bugle Creek was replaced with a new stream simulation culvert in November 2003. The plan to replace the Road 73609 culvert was dropped because electrofishing surveys conducted in summer, 2003 indicated that fish are not present above or below the culvert, and habitat is unsuitable due to steep gradients.

BNF recommended that the forest replace the FDR 5758 and 725 culverts on Meadow Creek, pending funding.

8.2.1.3.3 Stream Bank Instability

Potential bank instability problems appeared to be concentrated in reach 4, in which 18% of the banks appeared to be unstable. It is uncertain, however, the extent to which the bank instability results from natural vs. anthropogenic impacts. As part of the restoration strategy for Meadow Creek, a more detailed assessment of reach 4 will be preformed, and, if necessary, restoration of the banks in this section will be implemented. The location of reach 4 is presented in the Meadow Creek stream bank condition map in Appendix H.

Some stream bank instability reduction work has already occurred in the Meadow Creek watershed. During the summer of 2004, approximately 1700 feet of Meadow Creek was fenced with a riparian cattle exclosure and one cattle watering ford hardened. This work occurred in sections 2 and 10, which include part of reach 4.

8.2.1.4 Reimel Creek

8.2.1.4.1 Forest Roads

Of the 13 potential forest road sediment sources evaluated in the Reimel Creek sediment source assessment, one Forest Service road (Road 727), had contributing road treads, cut slope, and/or fill slopes that exceeded 200 ft and was thus identified as restoration priorities. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Road restoration will need to be site specific. This road was identified during the post 2000 Fire EIS process as needing Best Management Practices (BMPs) upgrades. BMP upgrades were recently completed on this road. The crossing at Diggins Creek (2560) is a new fish-friendly, stream simulation culvert with rock embankments slopes and gravel road surface over the crossing.

This crossing (#2560) accounted for an estimated 3.4 tons of sediment/year. Bringing this crossing up to BMP standards is expected to reduce the sediment load from them to 1.2 tons/year, for a reduction of 2.2 tons/year. Maps showing the location of this crossing are included in Appendix G.

8.2.1.4.2 Culverts

There is one known culvert in the Reimel Creek watershed that blocks or impedes fish passage, and that culvert occurs on private land near the mouth of Reimel Creek. On the forest, the two culverts that affected fish (the Road 727 crossings of Reimel Creek and Diggins Creek) were replaced with new stream simulation culverts in 2000 and 2003, respectively. Both are adequately maintaining fish passage. There are no other culverts on the forest in the Reimel Creek watershed that affect fish. The BNF recommends pursuing replacement of the culvert on private land, and monitoring the two culverts on the forest to ensure that fish passage is being adequately maintained.

8.2.1.4.3 Dewatering

Reimel Creek was not listed for flow alterations, but according to the BNF's post-fire EIS, an irrigation pond on private land at the mouth of the Reimel Creek canyon results in year-round isolation from the East Fork of the Bitterroot River. The Bitterroot Headwaters Implementation Team (IT) and the Bitterroot Water Forum will contact the landowner to explore the possibility of restoring connectivity between Reimel Creek and the East Fork of the Bitterroot. USFS and MFWP fisheries biologist will be consulted as well to confirm that the currently isolation is not protecting native salmonid genetics.

8.2.1.4.4 Grazing

The Bitterroot National Forest has installed riparian fencing and conducted stream restoration on the grazing-impacted portions of Reimel Creek. The BNF will continue to monitor the success of these actions in minimizing sediment loading to Reimel Creek as a result of grazing, and will take corrective action where necessary.

8.2.1.5 East Fork

8.2.1.5.1 Forest Roads

Because of the large size of the East Fork Watershed and the extensive road network, it was not possible to evaluate the sediment load from every road in the basin. Instead, all of the roads in the sediment-listed tributaries to the East Fork of the Bitterroot River were evaluated, and results were extrapolated to the non-listed tributaries to derive a total basin-wide sediment load from forest roads. GIS data layers obtained from the Forest Service show 1,962 potential stream crossings in the East Fork Watershed. Of these, 362 were visited on the ground, and those that were identified as sediment delivery mitigation priorities are discussed the Laird, Gilbert, Moose, and Meadow Creeks restoration sections. An on-the-ground assessment of road sediment loading in non-listed tributaries is included in the monitoring plan in Section 9.0.

Roads in the East Fork Watershed accounted for an estimated 1570 tons of sediment/year. Sediment delivery mitigation will reduce the sediment load from them to an estimated 911 tons/year, for a reduction of 659 tons/year. Although the FroSAM analysis (see Section 4.0) was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from roads may be occur through a variety of methods.

Since the completion of the road sediment loading assessment, some restoration work has already been completed in the East Fork watershed. The Bitterroot National Forest has surfaced and brought four (4) roads to BMP standards: Road 369 (approximately 5.3 miles), Road 5745 (approximately 0.8 miles), and Rd 13256 (approximately 4.8 miles). Jennings Camp Road 723 will be surfaced and BMP worked completed in 2005. This will add an addition 9.0 miles of road improved in the East Fork Watershed. In addition, the Forest has obliterated approximately 3.0 miles of road (Roads 62717, including spurs, 62701, and 62702. Thus the estimate of sediment loading from roads in the East Fork watershed presented in this document is probably an overestimate of current conditions.

8.2.1.5.2 Culverts

There are no known culverts on the East Fork of the Bitterroot River that block or impede fish passage. There are several culverts on small tributaries to the East Fork that block or impede fish passage (e.g. Guide, Jennings Camp, Bertie Lord Creek and its tributaries, Tepee Creek, Springer Creek, Mink Creek, the West Fork of Camp Creek and its tributaries, Crazy Creek, Medicine Tree Creek, Laird Creek). A few of these culverts either have, or will be, proposed for replacement in current forest NEPA projects such as the Burned Area Recovery FEIS. Five of the culverts proposed in the Burned Area Recovery FEIS were replaced with new stream simulation culverts in November 2003 (Bugle Creek, Road 725; Crazy Creek, Road 370-A; West Fork of Camp Creek, Road 729; two unnamed tributaries to the West Fork of Camp Creek, Road 8112). The BNF has recommended that replacing as many of the remaining barrier culverts as possible, pending funding. The forest should also monitor the new replacements to ensure that fish passage is being adequately maintained.

8.2.1.5.3 Bank Instability

Potential bank instability problems appeared to be concentrated in reaches 1, 2, 6, and 7 where the % of banks unstable was 15.4, 24.6, 10.8, and 11.7 respectively. It is uncertain, however, the extent to which the bank instability results from natural vs. anthropogenic impacts. As part of the restoration strategy for the East Fork, a more detailed assessment of these reaches will be preformed, and, if necessary, restoration of the banks in this section will be implemented. The location of reaches 1, 2, 6, and 7 is presented in the East Fork stream bank condition map in Appendix H.

Additionally, the BNF's post-fire EIS indicated that encroachment by home construction, U. S. Highway 93 and the East Fork Highway has resulted in reductions in channel length, woody debris recruitment, and habitat complexity and potentially elevated water temperatures. The Bitterroot Headwaters TMDL IT and the Bitterroot Water Forum will work with local landowners and highway administrators to reduce road and construction impacts to the East Fork.

8.2.1.5.4 Grazing

Grazing was determined to be a man-caused factor in the sediment induced from bank erosion in the BHTPA. Restoration efforts that utilize the adaptive management strategy outlined in Section 9.11 are recommended as part of this WQRP. The adaptive management strategy will help prioritize these efforts. It is envisioned that several management strategies could be used to address grazing issues in the BHTPA. This plans recommends fencing off riparian corridors, providing off-site watering and utilizing rest rotation grazing strategies to achieve reductions in sediment load to the BHTPA streams.

8.2.1.5.5 Temperature

This plan recommends prioritization of the thermal sources identified in Section 5.0 and the restoration of those sources were feasible as outlined in Section 5.8.

8.2.1.6 Gilbert/Laird Creek

8.2.1.6.1 Roads

Of the 119 potential road sediment sources evaluated in the Gilbert/Laird Creek sediment source assessment, 17 had contributing road treads, cut slope, and/or fill slopes that exceeded 200 ft and were thus identified as restoration priorities. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Road restoration will need to be site specific. These contributing areas are located on Forest Service roads 370, 5731, 13311, 13325, 13323, and 13324.

Stream crossings and near stream road segments accounted for an estimated 90 tons of sediment/year in the Gilbert/Laird watershed when they were assessed in 2002. Sediment delivery mitigation will reduce the sediment load from them to an estimated 33 tons/year, for a reduction of 57 tons/year. Although the FroSAM analysis (see Section 4.0) was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from roads may be occur through a variety of methods. Crossings that needed sediment delivery mitigation are presented below (Table 8-4). Maps showing the location of these crossings are included in Appendix G.

All of the Forest Service roads in Table 8-4 were identified during the post 2000 Fire EIS process as needing BMP upgrades, to be decommissioned or to be put into storage. BMP upgrades were completed on Forest Service Road 370, the main Laird Road during the summer of 2003. BMP upgrades are partially completed on roads 13323 and 13324. Forest Service Road 13325 has been placed in storage. The crossing at Forest Service Road 13323 was repaired in the fall of 2002. Road crossings # 2203 and 2143 have hardened fords. Road BMP upgrades and decommissioning is continuing in the Gilbert area with work completed in 2003 and planned for 2004 and 2005 as funding allows. Crossing 2203 has been removed and the road recontoured. Crossing 2143 is an open bottom arch pipe with a hardened overflow dip. BMP work has been completed on the full length of road 370 (over 12 miles and including any pipe needs). Crossing 2241 is an open bottom arch on concrete footings with armored dip and all crossings on Rd 13323 are new installations in 2001 with rock-lined catch basins.

Table 8-4. Gilbert/Laird Creek Road Crossing and Segment Restoration Priorities.

243 (USFS 5731)	1949	1953	1955	2060 (USFS 13323)	2241 (USFS 13323)
2122 (USFS 13323)	2143 (USFS 13325)	2190 (USFS 370)	2205	2211 (USFS 13323)	2489
2268 (USFS 370)	2309 (USFS 370)	2348 (USFS 5615 New culvert upsized in 2000)	2410	2413 (USFS 5615 New culvert upsized in 2000)	

8.2.1.6.2 Culverts

There is one culvert in the Laird/Gilbert Creek watershed that is thought to potentially impede fish passage, and that culvert is located on private land under Highway 93. It is scheduled for replacement with a fish passable structure when the Conner North/South reconstruction phase of Highway 93 is implemented. Another culvert on private land near the first house just below the forest boundary was replaced by a private contractor in November 2002. Since then, some of the substrate has been flushed from the barrel, but the culvert is believed to still provide adequate fish passage. On the forest, there are four culverts on Laird Creek that could potentially affect fish movement (in order from the bottom of the stream to the top, they are Road 13325, Road 13323, Road 370, and Road 5715), and one culvert on Gilbert Creek (Road 370). All but the Road 13325 and 13323 culverts were replaced with new stream simulation culverts following the 2000 fires. The Road 13325 and 13323 culverts were not replaced following the fires of 2000 because they were fish passable. Monitoring of the five fish culverts on Forest Service land in the Laird/Gilbert Creek watershed indicates that fish passage is being adequately maintained at all sites. BNF recommended that the fish culverts on the forest continue to be monitored in the future to ensure that adequate fish passage is maintained.

8.2.1.6.3 Stream Bank Instability

Potential bank instability problems appeared to be concentrated in reaches 1 and 3 where the % of banks unstable was 38.5 and 16.4 respectively. It is uncertain, however, the extent to which the bank instability results from natural vs. anthropogenic impacts. As part of the restoration strategy for the Gilbert/Laird Creek Watershed, a more detailed assessment of these reaches will be preformed, and, if necessary, restoration of the banks in this section will be implemented. The location of reaches 1 and 3 is presented in the Gilbert/Laird stream bank condition map in Appendix H.

8.2.1.7 Hughes Creek

8.2.1.7.1 Roads

Of the 151 potential forest road sediment sources evaluated in the Hughes Creek sediment source assessment, 25 had contributing road treads, cut slope, and/or fill slopes that exceeded 200 ft and were thus identified as restoration priorities. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Road restoration will need to be site specific. These contributing areas are identified on Forest Service roads 5693, 5793, 5688, 5694, 74249, 13404, 74288, and 74287. BMP upgrades will occur as funding allows.

Stream crossings and near stream road segments currently account for an estimated 112 tons of sediment/year in the Hughes Creek watershed when they were assessed in 2002. Sediment delivery mitigation will reduce the sediment load from them to an estimated 72 tons/year, for a reduction of 40 tons/year. Although the FroSAM analysis (see Section 4.0) was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from roads may be occur through a variety of methods. Crossings in need of BMP upgrades are presented below (Table 8-5). Maps showing the location of these crossings are included in Appendix G.

In addition, road County Road 104-D encroaches on the lower ten miles of Hughes Creek's floodplain, increasing the potential for sediment delivery and potentially limiting floodplain function. The IT will work in cooperation with local land managers to determine the feasibility of reducing road encroachment in the area.

Table 8-5. Hughes Creek Road Crossing and Segment Restoration Priorities.

530 (USFS 5693)	531 (USFS 5694)	536 (USFS 5694)	540 (USFS 13404)	541 (USFS 9630) (Rd 104-D county
3300 (USFS 9630) Rd 104-D county	3290 (USFS 5693)	3296 (USFS 5694)	3297 (USFS 74288)	3298 (USFS 9630) Rd 104-D county
3402 (USFS 5793)	3330 (USFS 74249)	3338 (USFS 74249)	3368 (USFS 5793)	3382 (USFS 5793)
3474 (USFS 5688)	3417 (USFS 5793)	3423 (USFS 5688)	3431 (USFS 5793)	3453
3524 (USFS 5688)	3476	3481 (USFS 5688)	3496 (USFS 5688)	3519 (USFS 9630) Rd 104-D county

8.2.1.7.2 Culverts

There are five culverts in the Hughes Creek watershed that are known to block or impede fish passage. Four are located on the Bitterroot National Forest; one is located on private land in lower Taylor Creek. From lowest to highest in the watershed, they are: (1) Malloy Gulch, Road 104-D; (2) Mill Gulch, Road 104-D; (3) Taylor Creek, private road near mouth; (4) Taylor Creek, Road 104-D, and (5) Mine Creek, Road 5688 (only USFS culvert). The one barrier culvert on the Bitterroot National Forest will be replaced as funding allows. Replacement of the Road 104-D culverts will require cooperation with the county, as 104-D is a county road. BNF also recommended that efforts be made to work with the private landowner to replace the barrier culvert on private land in lower Taylor Creek. The rest of the culverts in the Hughes Creek watershed do not affect fish.

8.2.1.7.3 Stream Bank Instability

Potential bank instability problems in Hughes Creek appeared to be concentrated in reach 13. It is uncertain, however, the extent to which the bank instability results from natural vs. anthropogenic impacts. As part of the restoration strategy for the Hughes Creek Watershed, a more detailed assessment of this reaches will be preformed, and, if necessary, restoration of the banks in this section will be implemented. The location of reach 13 is presented in the Hughes Creek stream bank condition map in Appendix H.

8.2.1.7.4 Mining

On federal land, the reaches of Hughes Creek that were impacted by placer mining have been restored. However, no such restoration has occurred on private land. The IT and BWF will evaluate landowner willingness to consider restoration and will search for potential funding to conduct this restoration if/where landowners interested.

8.2.1.7.5 Temperature

This plan recommends prioritization of the thermal sources identified in Section 5.0 and the restoration of those sources were feasible as outlined in Section 5.8.

8.2.1.7.6 Future Impacts

This plan recommends proper planning with all future activities in the BHTPA to help ensure that the goals of this WQRP are met.

8.2.1.8 Moose Creek

8.2.1.8.1 Roads

Of the 67 potential forest road sediment sources evaluated in the Moose Creek sediment source assessment, 12 have contributing road treads, cut slope, and/or fill slopes that exceed 200 ft and were thus identified as restoration priorities. Two hundred feet was selected simply as an example to illustrate the potential for sediment reduction and is not a formal goal of the WQRP. Road restoration will need to be site specific. These contributing areas are identified on Forest Service roads 432, 5770, and 5771. BMP upgrades will occur as funding allows.

Stream crossings and near stream road segments accounted for an estimated 35 tons of sediment/year in the Moose Creek watershed when they were assessed in 2002. Sediment delivery mitigation will reduce the sediment load from them to and estimated 25 tons/year, for a reduction of 10 tons/year. Although the FroSAM analysis (see Section 4.0) was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from roads may be occur through a variety of methods.

8.2.1.8.2 Culverts

There are five culverts in the Moose Creek watershed that are known to block or impede fish passage. From lowest to highest in the watershed, they are: (1) Moose Creek, Road 726; (2) Lick Creek, Road 432; (3) Lick Creek, Road 5771; (4) Reynolds Creek, Road 432 is a bridge project scheduled for 2005; and (5) Sign Creek, Road 432. The Road 726 culvert on Moose Creek was proposed for replacement as a bridge in the Burned Area Recovery FEIS, and survey and design has been completed. When funding becomes available, the Forest plans on removing the FDR 726 culvert on Moose Creek and replacing it with a new bridge. This is likely to occur in the next couple of years. BNF recommended that the forest replace the other four barrier culverts on Lick, Reynolds, and Sign Creeks (tributaries to Moose Creek), pending funding.

8.2.1.8.3 Stream Bank Instability

Stream banks in Moose Creek were generally stable, but 8.2% of the banks evaluated on the ground were in the extreme BEHI erosion risk category. It is uncertain, however, the extent to which the bank instability results from natural vs. anthropogenic impacts. As part of the restoration strategy for the Moose Creek Watershed, a more detailed assessment will be preformed, and, if necessary, restoration section will be implemented.

8.2.1.9 West Fork Bitterroot River

8.2.1.9.1 Roads

Because of the large size of the West Fork Watershed and the extensive road network, it was not possible to evaluate the sediment load from every road in the basin. Instead, all of the roads in the sediment-listed tributaries to the West Fork of the Bitterroot River were evaluated, and results were extrapolated to the non-listed tributaries to derive a total basin-wide sediment load from forest roads. GIS data layers obtained from the Forest Service show 1,787 potential stream crossings in the West Fork Watershed. Of these, 219 were visited on the ground, and those that were identified as restoration priorities are discussed the Buck, Ditch, and Hughes Creek restoration sections. An on-the-ground assessment of road sediment loading in non-listed tributaries is included in the monitoring plan in Section 9.0.

Roads in the West Fork Watershed accounted for an estimated 3,041 tons of sediment/year. Sediment delivery mitigation will reduce the sediment load from them to an estimated 1,308 tons/year, for a reduction of 1,733 tons/year. Although the FroSAM analysis (see Section 4.0) was used to estimate the potential for road sediment reduction in the watershed, achieving this reduction in sediment loading from roads may be occur through a variety of methods.

In addition, encroachment of the West Fork Road and private land development have resulted in a loss of riparian over story, stream shade, and woody debris recruitment along much of the West Fork below Deer Creek. The IT will work in cooperation with local land managers to determine the feasibility of reducing road encroachment in the area.

8.2.1.9.2 Culverts

There are no culverts on the West Fork of the Bitterroot River that block or impede fish passage. There are numerous culverts on tributaries to the West Fork that block or impede fish passage (e.g. Pierce, Baker, Lavene, Boulder, Ward, East Piquett, Castle, Britts, Beavertail, Ditch, Little Boulder, Elk, Coal, Johnson, and Sheep Creeks). About a third of these culverts have been proposed for replacement in current forest NEPA projects such as the Burned Area Recovery FEIS and Frazier Interface EA. Four of the culverts proposed in the Burned Area Recovery FEIS were replaced with new stream simulation culverts in July 2003 (Took Creek, Road 1303; Took Creek, Road 362; Magpie Creek, Road 362; Sand Creek, Road 362). BNF recommended that the forest replace as many of the remaining barrier culverts as possible, pending funding. The forest should also monitor the new replacements to ensure that fish passage is being adequately maintained.

8.2.1.9.3 Stream Bank Instability

Potential bank instability problems appeared to be concentrated in twelve reaches of the West Fork (Table 8-6). It is uncertain, however, the extent to which the bank instability results from natural vs. anthropogenic impacts. As part of the restoration strategy for the West Fork Watershed, a more detailed assessment of this reaches will be preformed, and, if necessary, restoration of the banks in this section will be implemented. The location of the unstable reaches is presented in the West Fork stream bank condition map in Appendix H.

Table 8-6. Reaches of the West Fork with Potentially Significant Bank Instability.

Reach #	Reach Length (miles)	% Unstable
1	4.29	60.3
4	1.23	20.7
5	1.76	17.4
13	0.54	11.7
14	1.14	16.7
18	14.14	25.3
23	1.03	12.6
36	1.86	13.6
39	1.33	10.3
42	1.10	40.4
47	5.95	29.5
48	0.84	43.0

8.2.1.9.4 Temperature

This plan recommends prioritization of the thermal sources identified in Section 5.0 and the restoration of those sources where feasible as outlined in Section 5.8.

8.2.1.10 Overwhich Creek

8.2.1.10.1 Culverts

There is only one culvert in the Overwhich Creek watershed that is known to impede or blocks fish passage, and that is the Road 5703 culvert on Kyke Creek, which is a small tributary to Overwhich Creek. The rest of the culverts in the Overwhich Creek watershed do not affect fish. BNF recommended that the forest replace the culvert on Kyke Creek when funding is available. It would be a low priority because suitable fish habitat above the culvert is very limited (< 0.2 miles) because of steep gradients. Low numbers of small westslope cutthroat trout are present in Kyke Creek near the Road 5703 culvert.

8.2.1.10.2 Temperature

This plan recommends prioritization of the thermal sources identified in Section 5.0 and the restoration of those sources were feasible as outlined in Section 5.8.

8.2.1.11 Nez Perce Fork

8.2.1.11.1 Culverts

There are six culverts in the Nez Perce Fork watershed that are know to block or impede fish passage. From lowest to highest in the watershed, they are: (1) Gemmell Creek, Road 5633; (2) Two Creek, Road 5650; (3) Tough Creek, Road 5644; (4) Flat Creek, Road 468; (5) Nez Perce Fork, lower crossing of Road 468; and (6) Nez Perce Fork, upper crossing of Road 468. The rest of the culverts in the Nez Perce Fork watershed are either new stream simulation culverts that allow adequate fish passage (Nelson Creek, Road 468; Gemmell Creek, Road 468; and Sentimental Creek, Road 13482), or culverts that do not affect fish. BNF recommended that the forest replace as many of the seven barrier culverts as possible, and continue to monitor the three recent replacements to ensure adequate fish passage is maintained at those sites. The two upper culverts on the Nez Perce Fork are located on the paved portion of Road 468, and both contain very deep fills. Due to the expense and limited amount of suitable fish habitat upstream of those culverts, any replacements would probably have to occur in conjunction with major road reconstruction.

8.2.1.11.2 Temperature

This plan recommends prioritization of the thermal sources identified in Section 5.0 and the restoration of those sources were feasible as outlined in Section 5.8.

8.2.1.12 Martin Creek

8.2.1.12.1 Culverts

There are three culverts in the Martin Creek watershed that could potentially block or impede fish passage: the Road 726 culvert on Bush Creek and the Road 13318 and 13317 culverts on Paint Creek. Bush Creek and Paint Creek are tributaries to lower Martin Creek. BNF recommended that the forest replace these three barrier culverts, pending funding.

8.2.1.12.2 Shade/temperature

Martin Creek was found as not impaired for thermal modifications (See table 3-67). However, this plan proposes further study as outlined in Sections 5.5.3.2 and 9.11.

8.2.2 Agency and Stakeholder Coordination

8.2.2.1 Future Impacts

This plan recommends proper planning with all future activities in the BHTPA to help ensure that the goals of this WQRP are met as outlined in Sections 4.0 and 5.0.

Achieving the targets set forth in this TMDL will require a coordinated effort between land management agencies, the state and county governments and private landowners. A Water Quality Implementation Team (IT) will be formed with representatives invited from the entities listed below. It is expected that this IT would evolve from the already established Bitter Root Water Forum and existing BHTPA TAC.

- Bitterroot Conservation District
- Ravalli County Planning Office
- MFWP
- Bitter Root Water Forum
- Bitterroot National Forest
- MDEQ
- USEPA
- Tri-State Water Quality Council

Additionally, up to three community members unaffiliated with any group and up to three environmental group representatives will be invited. The group will be facilitated by MDEQ or their designated representative. The purpose of the group will be to track the implementation of this Water Quality Improvement Strategy and to address new threats to water quality as they arise. Specific tasks that will be undertaken by the IT are:

- Conduct annual watershed-wide road inventories in drainages that have experienced recent timber management activities.
- Compile, reports, and serve as a repository for data being collected throughout the Bitterroot Headwaters.
- Oversee the implementation of the specific source reduction tasks prescribed in this TMDL.
- Coordinate the restoration and monitoring efforts of agencies and stakeholders.
- Address new threats to water quality as they arise.
- Work with private landowners and land management agencies to address bank instability through grazing management, restoration, and other available methods.

8.2.3 Bitterroot National Forest

For a description of restoration activities planned by the Bitterroot National Forest other than those described elsewhere in this document, refer to the Burned Area Recovery Final EIS, September 2001 and to recent BNF Forest Management Plans.

8.2.4 Bitterroot Conservation District

Future involvement of the Bitterroot CD in the Bitterroot headwaters will primarily consist of technical assistance and review of any planned culvert replacements on perennial streams, as required under Montana’s Natural Streambed and Land Preservation Act (310 Law).

BCD will actively be involved in restoration planning for the Bitterroot Headwaters TMDL planning are, since coordination with numerous small private landowners will be required.

SECTION 9.0 MONITORING STRATEGY

9.1 Monitoring Plan

As part of the overall implementation strategy for this water quality protection plan, a water quality monitoring plan for the Bitterroot Headwaters is included to help meet the following seven objectives:

1. Document water quality trends associated with future implementation efforts.
2. Monitor progress toward meeting water quality targets.
3. Fill existing data gaps on both 303(d) listed streams and on streams that, while not formally listed, are thought to impact water quality in the basin.
4. Conduct an adaptive management strategy to fulfill requirements of this WQRP.
5. Conduct a phased hydrologic study to fulfill the requirements of this WQRP.
6. Address all assumptions and uncertainties identified in this WQRP.
7. Seek funding to implement monitoring and restoration recommendations.

This monitoring plan will address the need to evaluate the progress toward meeting or protecting water quality standards and associated beneficial uses (Montana State Law (75-5-703(7) and (9)). The monitoring will also address the tracking of specific implementation efforts. It is anticipated that the Stakeholders will help develop monitoring details and help pursue funding for monitoring and data evaluation. The Bitterroot Headwaters Water Quality Protection Monitoring Plan includes the following:

- Complete the collection of current condition data for targets and indicators. No current data is available for several of the targets and indicators. For example, no biological data are available for Hughes, Laird, and Gilbert Creeks.
- Conduct road sediment assessments for select watersheds in which recent forest management activities have taken place to identify potential new sources of road sediment.
- Conduct on-the-ground validation of modeling assumptions and results.
- Verify current model assumptions and estimate sediment load reductions related to BMP upgrades, road closures and obliterations.
- Monitor implementation of restoration action. Monitoring activities should include tracking the effectiveness of BMPs on forest roads in meeting targets, and summarizing the length of road upgrades to BMP standards, length of decommissioned roads, and fish passage barriers corrected.
- Monitor redds and/or populations of native salmonid species in listed streams.
- Collect new biological (macroinvertebrate and periphyton) data every five years.
- Continue temperature monitoring.
- Conduct new stream surveys at monitoring sites established by IT every 5 years.
- If funding allows, repeat the stream bank stability assessment, perhaps every 10 years, to document the effects of new disturbance that may occur.

9.2 Implementation and Restoration Monitoring

The Bitterroot National Forest land managers plan implementation and tracking of restoration activities. As feasible, Montana DEQ would periodically assist with the compilation of the implementation efforts of the various landowners described below.

Implementation and restoration monitoring tracking includes annual summaries of the length of road upgraded to BMP standards, length of decommissioned roads, and fish passage barriers corrected.

Should state BMP audits include harvest areas in Bitterroot Headwaters TPA, these will be compiled by land managers to serve as future reference in evaluating TMDL success.

Finally, efforts set forth in this WQRP are designed to dovetail with upcoming planning strategies for the Bitterroot main stem WQRP/TMDL that is due for completion in 2006.

9.3 Trend Monitoring of Target Variables

The Implementation Team plans to conduct trend monitoring throughout watershed. Target trend monitoring plans are summarized Table 9-1.

Table 9-1. Proposed Target Variable Monitoring Sites.

Stream	Parameter	Location	Timing	Responsible Party
West Fork Bitterroot Watershed				
Buck	Geomorphic	BUCK 0.5	every 5 years	IT
Ditch	Geomorphic	DITCH 0.4	every 5 years	IT
Overwhich	Geomorphic	OVERWHICH 1.5	every 5 years	IT
West Fork Bitterroot River	Geomorphic	WEST FORK BITTERROOT RIVER 30.3	every 5 years	IT
Hughes Creek	Geomorphic	HUGHES CREEK, 0.5	every 5 years	IT
	Geomorphic	HUGHES CREEK, RESTORATION SITE 9.0	every 5 years	IT
Blue Joint Creek (reference)	Geomorphic	BLUE JOINT 5.3	every 5 years	IT
Deer Creek (reference)	Geomorphic	DEER 0.3	every 5 years	IT
Rombo (reference)	Geomorphic	ROMBO 4.8	every 5 years	IT
Little Boulder Creek (reference)	Geomorphic	LITTLE BOULDER CREEK	every 5 years	IT
East Fork Bitterroot Watershed				
Gilbert Creek	Geomorphic	GILBERT 0.1	every 5 years	IT
Laird Creek	Geomorphic	LAIRD 1.4	every 5 years	IT
Martin Creek	Geomorphic	MARTIN 1.3	every 5 years	IT
Meadow Creek	Geomorphic	MEADOW 4.2	every 5 years	IT
	Geomorphic (reference site)	MEADOW 5.6	every 5 years	IT
Reimel Creek	Geomorphic	REIMEL 2.9	every 5 years	IT
	Geomorphic	REIMEL 3.8	every 5 years	IT

Table 9-1. Proposed Target Variable Monitoring Sites.

Stream	Parameter	Location	Timing	Responsible Party
East Fork Bitterroot River	Pebble Count	EF Bitterroot Pebble Count Sites 3.8 (At Medicine Tree)	every 5 years	IT
	Pebble Count	EF Bitterroot Pebble Count Sites 9.8 (At Spring Gulch)	every 5 years	IT
	Pebble Count	EF Bitterroot Pebble Count Sites (12.8 (At Sula Store)	every 5 years	IT
	Pebble Count	EF Bitterroot Pebble Count Sites 19.7 (At Mink Creek)	every 5 years	IT
	Pebble Count	EF Bitterroot Pebble Count Sites 25.1 (Below Meadow Creek)	every 5 years	IT
East Fork Bitterroot River (reference)	Geomorphic	EAST FORK BITTERROOT R 29.8	every 5 years	IT
Moose Creek (reference)	Geomorphic	MOOSE 4.1 - SULA	every 5 years	IT
Swift Creek (reference)	Geomorphic	SWIFT 0.6	every 5 years	IT
Tolan Creek (reference)	Geomorphic	TOLAN 5.1	every 5 years	IT
All	Biological, temperature, suspended sediment, turbidity, shade monitoring.	At all pre-established sties described above.	every 5 years	MDEQ

Biological Data

Biological data (to include macroinvertebrate and periphyton sampling) will be collected every five years as a measure of aquatic life beneficial use support. Sampling will be conducted at the sites described in Section 4.0. In Hughes, Laird, and Gilbert Creeks where no biological data are currently available, and in Moose Creek where no periphyton data are currently available, sampling will be conducted by the Stakeholders as soon as a possible to provide a benchmark against which to compare future monitoring and gauge the success of TMDL restoration efforts.

In-Stream Temperatures

Data collection efforts will continue in the basin to help maintain the long-term temperature database currently maintained by MFWP. In addition, reference streams need to be identified and monitored in conjunction with the regularly scheduled monitoring in the Bitterroot basin. Reference temperature data is needed to address whether or not targets are being met or conducive to the Bitterroot basin.

Shade Monitoring

Since vegetation re-growth does not occur immediately, it is recommended that the air photo assessment conducted as part of the temperature assessment in this WQRP, be repeated during the 5-year review of this TMDL/WQRP. Additionally, it is recommended that as any streamside roads are removed or obliterated, that they be tracked via current databases.

9.4 Trend Monitoring of Supplemental Indicators

Pools/Mile, Residual Pool Depth, & LWD/Mile

MDEQ and the IT plan to periodically monitor trends in habitat condition (pools and LWD) in the sediment-impaired streams. At least one monitoring reach has been identified in each of the sediment-impaired streams. These monitoring reaches are listed below in Table 9-2. The variables monitored will include pools/mile, LWD/mile, and residual pool depth. The method used to monitor these variables will be the Region 1 Aquatic Ecological Unit Inventory (Draft 2004). This protocol is similar to the R1/R4 survey that has been used in the past and data will be comparable. Each of the reaches listed in Table 9-2 will be monitored at least once every 5 years. Information generated from this monitoring will be used in future evaluation of TMDL target attainment. MDEQ would work with all stakeholders on monitoring methods and protocols as necessary. Information generated from this monitoring will be used in future evaluation of TMDL target attainment.

Table 9-2. Monitoring Reaches for Pools/Mile, LWD/Mile, and Residual Pool Depth.

Stream	Reach #	Start of reach	End of reach	Distance	Dominant channel type(s)
East Fork	3	Robbins Gulch	Medicine Tree Creek	1.9 miles	B3/C3
East Fork	7	Cameron Creek	Tolan Creek	4.3 miles	C3
West Fork	2	Conner Cutoff Bridge	Trapper Creek	3.9 miles	B3/C3
West Fork	8	Painted Rocks Reservoir inlet	Hughes Creek	5.0 miles	C4
Ditch Creek	1	West Fork Highway	1000’ upstream from highway	1000 feet	B4
Buck Creek	2	Forest boundary	1000’ upstream from boundary	1000 feet	B4
Hughes Creek	3	Road 5685 bridge	Crandall Creek	2.6 miles	C4
Hughes Creek	4	Crandall Creek	FS Boundary 1 mile upstream of Crandall Creek	1.0 miles	C4
Laird Creek	2	Forest boundary	Gilbert Creek	0.4 miles	B4
Gilbert Creek	1	Mouth	Forks (S 9, NW ¼ of NE ¼)	0.4 miles 0.8 miles	B4
Reimel Creek	2	Forest boundary	Diggins Creek	1.9 miles	C4
Moose Creek	1	Mouth	Reynolds Creek	2.0 miles	B3
Meadow Creek	4	Unnamed trib (S 2, SW ¼ of NE ¼)	Spruce Creek	2 miles	C4

Suspended Solids and Turbidity

While suspended solids (TSS) and turbidity typically require long-term data set to help provide any reasonable inferences about the data, both are easy to measure and can prove valuable for future target attainment assessments. Therefore, it is *recommended* that annual measurements occur concurrent (and in addition to) with the surface fines monitoring. It is important to note that seasonality is an important factor when measuring suspended solids turbidity. Consequently, multiple data collection about the annual hydrograph would be necessary to adequately characterize trends over time.

Human-Caused Sediment Sources

The goal of this monitoring parameter would be to track any known human induced sediment sources that may arise following on going and future activities. This tracking system should employ a mitigation and subsequent feedback loop mechanism.

For example, the BNF monitors grazing allotments on Reimel and Meadow Creeks. The BNF also tracks road decommissioning efforts forest wide.

Culvert/Fish Passage

Continue to identify and upgrade or remove fish passage barriers where appropriate. Consultation with local fish biologists is recommended to ensure desired isolated populations wouldn't be put at risk for introgression. The 2003 fish passage culvert assessment was comprehensive and need not be repeated in the foreseeable future. However, the Implementation Team will document the progress made in removing fish passage barriers and in monitoring the installation of new culverts to prevent new barriers from being created.

Fish Population Monitoring

Data collection efforts will continue in the basin to help maintain the long-term population database currently maintained by MFWP. In addition, it is recommended that a more aggressive approach to understanding and identifying bull trout migration in the Bitterroot basin take place. While it is currently believed that only low numbers of large migratory bull trout reside in the East and West Forks of the Bitterroot, efforts to identify Bull Trout spawning areas would help with restoration priorities. It is believed that many bull trout migrate out of Painted Rocks reservoir and spawn in the upper West Fork tributaries.

9.5 Condition Monitoring

For a stream channel to again become stable, it needs to be able to properly distribute its flow and sediment supply in order to maintain its dimension, pattern and profile without degrading or aggrading. Adjustments occur partially as a result of a change in the stream flow magnitude and/or timing, sediment supply and/or size, direct channel disturbance, and riparian vegetation changes (Rosgen, 1996). Management strategies and additional mitigations outlined in the restoration plan portion of this document would assist in the geomorphic recovery of these segments. It is important to note that "recovery" is defined as "potential for recovery" based on the reference conditions applicable to the streams within the Bitterroot Headwaters TPA. Once this recovery is met, sediment loads are expected to reach their expected norm due to efficiency of the system. Putting a time limit on geomorphic recovery can be rather difficult. However, routine measurements of entrenchment ratios, sinuosity and width/depth ratios can show trends over time. These trends can be used to make inferences towards the expected and desired evolutionary stage of the stream channel.

9.6 Reference Monitoring

As discussed in Sections 9.3 and 9.4, continued monitoring surrounding the water quality targets and supplemental indicators is needed to further verify impairment status and achievement of full beneficial use support. In addition to monitoring and data collection of the target/indicator parameters, continued monitoring of those same parameters in reference (minimally managed) streams is needed to help increase confidence that the targets and supplemental indicator values chosen best represent the narrative water quality standards.

MDEQ uses the reference condition to determine if narrative water quality standards are being achieved. The term "reference condition" is defined as the condition of a waterbody capable of supporting its present and future beneficial uses when all reasonable land, soil, and water conservation practices have been applied. In other words, reference condition reflects a waterbody's greatest potential for water quality given historic land use activities.

MDEQ applies the reference condition approach for making beneficial use-support determinations for certain pollutants (such as sediment) that have specific narrative standards. All classes of waters are subject to the provision that there can be no increase above naturally occurring concentrations of sediment and settleable solids, oils, or floating solids sufficient to create a nuisance or render the water harmful, detrimental or injurious. These levels depend on site-specific factors, so the reference conditions approach is used.

Also, Montana water quality standards do not contain specific provisions addressing nutrients (nitrogen and phosphorous), or detrimental modifications of habitat or flow. However, these factors are known to adversely affect beneficial uses under certain conditions or combination of conditions. The reference conditions approach is used to determine if beneficial uses are supported when nutrients, flow or habitat modifications are present.

Waterbodies used to determine reference condition are not necessarily pristine or perfectly suited to giving the best possible support to all possible beneficial uses. Reference condition also does not reflect an effort to turn the clock back to conditions that may have existed before human settlement, but is intended to accommodate natural variations in biological communities, water chemistry, etc. due to climate, bedrock, soils, hydrology and other natural physiochemical differences. The intention is to differentiate between natural conditions and widespread or significant alterations of biology, chemistry or hydrogeomorphology due to human activity. Therefore, reference conditions should reflect minimum impacts from human activities. It attempts to identify the potential condition that could be attained (given historical land use) by the application of reasonable land, soil and water conservation practices. MDEQ realizes that presettlement water quality conditions usually are not attainable.

Comparison of conditions in a waterbody to reference waterbody conditions must be made during similar season and/or hydrologic conditions for both waters. For example, the concentration of TSS of a stream at base flow during the summer should not be compared to the TSS of reference condition that would occur during a runoff event in the spring. In addition, a comparison should not be made to the lowest or highest TSS values of a reference site, which represent the outer boundaries of reference conditions.

The following methods may be used to determine reference conditions:

Primary Approach

- Comparing conditions in a waterbody to baseline data from minimally impaired waterbodies that are in a nearby watershed or in the same region having similar geology, hydrology, morphology, and/or riparian habitat.
- Evaluating historical data relating to condition of the waterbody in the past.
- Comparing conditions in a waterbody to conditions in another portion of the same waterbody, such as an unimpaired segment of the same stream.

Secondary Approach

- Reviewing literature (e.g. a review of studies of fish populations, etc.) that was conducted on similar waterbodies that are least impaired.
- Seeking expert opinion (e.g. expert opinion from a regional fisheries biologist who has a good understanding of the waterbody's fisheries health or potential).
- Applying quantitative modeling (e.g. applying sediment transport models to determine how much sediment is entering a stream based on land use information, etc.).

MDEQ uses the primary approach for determining reference condition if adequate regional reference data are available and uses the secondary approach to estimate reference condition when there are no regional data. MDEQ often uses more than one approach to determine reference condition, especially when regional reference condition data are sparse or nonexistent.

9.7 Data Gaps

The following data gaps have been identified during the TMDL development process and will be addressed by the Implementation Team:

- ***Biological Data:*** Biological data should be collected in those streams where it is currently lacking: Hughes Creek, Laird Creek, and Gilbert Creek.
- ***Lead in Overwhich Creek:*** Lead concentrations should be monitored at a frequency to be determined by MDEQ to ensure the decision to de-list Overwhich was valid and that lead no longer affects beneficial uses in this stream.
- ***Metals in Moose Creek:*** Macroinvertebrate samples collected in 2001 provided evidence of possibly elevated metals concentrations in Moose Creek (see Section 3.4.9). Moose Creek has never been listed for metals and no metals data were located for this stream.

The Implementation Team will oversee metals sampling in Moose Creek to investigate the macroinvertebrate findings.

9.8 Phased Study Approach for Flow Alterations

It is not possible at this time to specifically quantify the relative importance flow has on the East Fork Bitterroot River. In order to adequately describe the flow issues in the East Fork, a comprehensive basin-scale hydrologic investigation must occur. This investigation would be conducted as a phased approach to this WQRP. The investigation would address decreased (dewatering) flows as suggested in Section 6.0 in order to help identify any potential thermal impairments associated with dewatering.

Dewatering

The East Fork of the Bitterroot River is currently listed as impaired for flow alterations resulting from agriculture. Decreased in-stream flows often result in adverse affects to aquatic life and cold-water fisheries that result from decreased sediment transport, increased nutrient concentrations and increased temperatures (Meehan, 1991). In the Bitterroot Headwaters Planning Area, this de-watering effect typically appears to result from impoundments and water diversions used for the irrigation of hay and other crops.

As previously described (Section 6.2.1) the large size of this watershed and the long history of water-use practices in the basin requires a phased-approach that will consist of a comprehensive basin-scale hydrologic investigation which will answer the following questions:

1. What is the natural hydrologic regime of the East Fork and what are their expected mean annual natural flows?
2. What is the extent of surface water-use in the basin and how is it used?
3. What is the extent of groundwater-use in the basin?
4. How efficient are the water use mechanisms in the basin?
5. What is the fate of all diverted water in the basin?
6. Given all the water-use in the basin and the need for full support of all beneficial uses, what is the minimum and maximum flows that can be expected in the basin?
7. What is the effect of the timing, magnitude, duration and location of irrigation return flows?

In order to sufficiently answer the above questions, the study would include, but not be limited to the following:

- Map and categorize all irrigated lands and major water supply ditches using Geographic Information System (GIS). Orthophoto quadrangles would be scanned and irrigation lands would be delineated from these base photos. The irrigated lands will be categorized and the water supply for each irrigated parcel identified. Potential stream flow sites and monitoring locations would be selected and prioritized. Much of this work has already been completed in Ravalli County.

- Estimate seasonal surface water inflows and outflows from the basin by measuring and monitoring the flows of the principal streams both upstream and downstream of the major irrigation diversions.
- Establishing multiple stations that are yet to be determined would monitor losses from stream channels and evaporation by riparian vegetation.
- Where possible, monitoring of existing groundwater levels using existing wells. As resources permit, additional wells may need to be identified and drilled to provide adequate coverage.
- Estimations of net irrigation water requirements (the amount of applied irrigation water that is actually consumed by a crop) can be done using two methods. One method would be to calculate the theoretical crop evapotranspiration using standard equations and climatic data. The second method would estimate crop water requirements based on hay yields. The effective rainfall will be subtracted from the measured effective crop-water requirement to determine net irrigation water requirements.
- Gross irrigation water requirements (the total amount of water diverted) will be estimated by measuring diversion rates at representative flood, center pivot, and side-roll sprinkler irrigated fields. Delivery system efficiency would be determined by dividing the net irrigation requirement by the gross irrigation requirement.
- In the event that inefficiencies are found, mitigation measures would be developed and prioritized.

Once the water budget/irrigation study is complete, a determination of the impairment status could be made and a corrective action plan put in place. In the event irrigation is noted as potentially dewatering the East Fork, spatial analysis combined with calculated irrigation water requirements would be applied to generate “what if” scenarios. For example, stream flows and water availability estimates could be provided for different water management scenarios using modeling techniques to be defined. Additionally, allocations could be developed to help meet the needs of both the resource and the water users.

9.9 Temperature Monitoring

In-stream temperature thermographs have been employed in all of the BHTPA impaired streams for as long as 10 years by MFWP. This data was evaluated based on bull trout requirements. Data indicate that many of the originally thermally impaired streams are still impaired today.

As discussed in Sections 3.3 and 5.5, both in-stream temperature targets and shade supplemental indicators are used to assess the impairment status of the BHTPA streams. In order to measure success of implementation efforts outlined in Section 8.0 and to better define the true temperature potential of the BHTPA streams, a temperature monitoring strategy is proposed below.

Conceptually, this study would address the following questions:

1. What is the expected natural thermal regime of the BHTPA streams?
2. What are appropriate reference streams for comparison to the BHTPA streams?

3. How do the current sources identified in Section 5.5 affect in-stream temperatures and subsequently effective shade?

In order to help answer questions 1 and 2 above, continued in-stream temperature monitoring is proposed annually in all thermally impaired streams within the BHTPA. Additionally, it is proposed that adequate reference streams be identified and monitored in the same manner.

In order to help answer question 3 above, it is important to have a general understanding of the "potential" sources that may be attributing to a temperature problem. Known land-use activities in the BHTPA that are thought to be influencing temperature are agriculture, mining, timber harvest, development, and road construction. These activities may result in decreases in riparian shade.

It is therefore suggested that a study be developed that would reanalyze the "effective shade study" that was conducted as part of this WQRP (see Section 5.0) every 5 years. This study in combination with the restoration activities outlined in Section 8.0, would help measure success of restoration efforts and help identify increases in effective shade in the BHTPA.

9.10 Adaptive Management Strategy

As monitoring data is obtained and evaluated, MDEQ in partnership with the stakeholders will adjust load allocations as necessary to meet targets, especially those targets associated with in-stream conditions. Additionally, targets could also be adjusted. These adjustments would take into account new technologies and information as they arise.

The adaptive management strategies are outlined below:

- **Impairment Status:** As discussed in Section 3.7, uncertainties with the current impairment status exist. Therefore, further review and analysis needs to occur in order to adequately address the water quality impairments in the Bitterroot Headwaters TPA. Utilization of the approaches discussed in Section 3.3 would further assist in this effort. An assessment of the impairment status will occur during the 5-year review period of this WQPR.

- **Targets:** In order to set the supplemental indicators (TSS and Turbidity) outlined in Section 3.3, data from multiple monitoring stations must be collected. These data would be collected at existing sites already established by the Bitterroot National Forest as well as reference sites.

  Additionally, percent fines and in-stream temperature data would be collected at reference sites. This information would be used to draw better conclusions on the conditions of the reference streams and used for comparison on streams in the Bitterroot Headwater TPA as well as assist with future downstream TMDL/WQRP development. Percent fines data for Rosgen "E" channel types would be a priority, as the dataset used for the analysis in this WQRP did not contain any "E" channels. It is important to note that very few if any Rosgen E channels exist that would adequately represent the BHPA streams within the Bitterroot National Forest. Therefore such references would have to be obtained off of from private lands or other suitable streams within the region. Furthermore, a Geographical Information System (GIS) mapping exercise would be conducted to identify Rosgen channel classes within the Bitterroot Headwaters TPA. This data could largely be built from existing U.S. Forest Service, DNRC, and MDEQ data.

- **Temperature/Effective Shade**: The data collection of the temperature in-stream targets (Table 3-8) would aid in an adequate impairment determination. The targets are designed to represent conditions needed for salmonid reproductive success and full beneficial use support. While adequate reference data for some of the parameters in Table 3-8 do not exist, standard in-stream temperature collection methodologies thermographs would be used within the BHPA to collect in-stream temperature. Collection would occur at both existing monitoring sites and potential reference reaches within the Bitterroot Headwaters planning area. These sites may be identified as more data and knowledge of the area becomes available. It is expected that collection of reference temperature data would help decipher temperature potential in the BHTPA and thus not require the complete removal of all thermal sources as outlined in Section 5.0.

  As discussed in Section 5.5 and Section 5.8, a phased allocation for road and mining thermal sources was proposed. Following the suggested feasibility analysis, it may be recognized that these sources are in fact *irretrievable commitments of resources* and therefore cannot be restored to another condition. At that time it would be appropriate to conclude that the allocations for timber harvest and fire outline in Section 5.5, are the best possible measures land managers can do in the BHTPA. However, if the feasibility analysis concludes that there are thermal sources that can in fact be removed, this strategy proposes that they are prioritized and the mitigation implemented. Following implementation of restoration activities, the shade analysis outlined in Section 5.0, could be re-visited to help articulate the actual loading and effective shade potential following these activities.

- **Nutrient Monitoring:** As discussed in Section 3.8, additional “nutrient” monitoring is proposed as a safety measure to ensure that both Moose Creek and the West Fork Bitterroot River continue to support their beneficial uses and ensure that a nutrient problem does not exist. This monitoring would be designed to replicate the monitoring efforts discussed in Section 3.3. Monitoring for all proposed nutrient targets/indicators would be collected and analyzed at the same locations and utilizing the same protocols as discussed in Section 3.3. These activities would occur as feasible and correspond with the 5-year review of this WQRP.

- **Unstable Stream Banks:** Performance based allocations for unstable banks were developed in Section 4.0. The primary sources identified as contributing to unstable banks were mining and agricultural (grazing). This adaptive management strategy outlines two options for achieving the performance-based allocations.

<u>Option 1</u>

The first option is to utilize Table 4-6, presented earlier in this WQRP. This table identifies 6 streams within the BHTPA and summarizes the linear feet of unstable banks in six different categories. For purposes of this WQRP, the following categories were considered the highest priority for improvement: *extreme, very high, high, and moderate*. Therefore this option recommends utilizing Table 4-6 to prioritize restoration efforts. Restoration activities outlined in Section 8.0 could be used to help restore these areas and achieve reductions in sediment loading from unstable banks.

Option 2

A second option would be to take option 1, and carry it a step further. This option would utilize quantitative measurements to calculate the actual loads from each source and in turn allow land managers to measure actual reductions in load following restoration activities. This loading calculation would include, but is not limited to the following procedure:

Bank Erosion Hazard Index (BEHI) assessments were conducted on a sample of reaches to assess the potential for bank erosion in the BHTPA. However, these assessments did not quantify loads. Rather this assessment measured linear distances of bank erosion and categorized them by severity. To carry this analysis one step further and ultimately quantify loads, BEHI assessment could be conducted using a modified version of the Rosgen (1996) method to characterize stream bank conditions into numerical indices of bank erosion potential.

The modified BEHI methodology evaluated a stream bank's inherent susceptibility to erosion as a function of six factors, including:

1. The ratio of stream bank height to bank full stage.
2. The ratio of riparian vegetation rooting depth to stream bank height.
3. The degree of rooting density.
4. The composition of stream bank materials.
5. Stream bank angle (i.e., slope).
6. Bank surface protection afforded by debris and vegetation.

To determine a yearly sediment load from eroding stream banks in each BEHI category within the sampled reaches, bank retreat rates developed by Rosgen (2001) could be utilized. The rate of erosion would then be multiplied by the area of eroding bank (in square feet) to obtain a volume of sediment per year, and then multiplied by the sediment density to obtain a mass of sediment per year.

To derive a total sediment load from eroding stream banks for each of the listed streams in the BHTPA, results of the BEHI analysis could then be extrapolated from the sampled reaches to the remainder of the channel length.

The intent of this analysis is to provide an estimate of the sediment load from stream bank instability that was produced by human-induced impacts to the streams and was thus in excess of the natural sediment load that could be expected from stream banks even under pristine conditions. That natural component of the stream bank sediment load is included in the modeling estimate of background sediment described in Section 4.0 previously in this document.

To facilitate the allocation of the sediment load from stream banks to the proper pollutant source categories, the dominant land use in closest proximity to each eroding bank could be recorded during the BEHI inventories.

Adaptive Management Strategy Summary

At the end of 5 years, an evaluation of BMP implementation, target compliance and beneficial use determinations would be made. At this time, recommendations would be made by MDEQ to ensure that the goals of this restoration plan are being met. If, at that time, any one goal or target is not being met, an evaluation would be made that would determine one or more of the following:

- Adjustments to land-use activities;
- Make changes to original targets;
- Collect additional data and reevaluate next cycle.

To ensure reasonable and equitable decisions are made regarding future target and/or management adjustments, MDEQ would evaluate and compare both reference and TPA stream data collected under this WQRP with the data collected prior to the development of this plan.

Additionally, if at the 5-year evaluation period it is found that any or all of the streams within the Bitterroot Headwaters TPA are fully supporting beneficial uses, steps would be taken to ensure that management practices and mitigation measures outlined in this WQRP would continue. While favorable management practices would be expected to continue, the level of monitoring outlined in this WQRP could be revised. At this time, the monitoring strategy could be scaled back in both the frequency and intensity. While a downsizing of the monitoring program may or may not take place under these circumstances, enough monitoring would occur to ensure that trends could still be observed. Therefore, ensuring that full beneficial use support remains in place.

Water Quality Restoration Plan and Total Maximum Daily Loads for the Bitterroot Headwaters Planning Area

VOLUME IV
PUBLIC INVOLVEMENT AND REFERENCES

Preface

The final volume of this WQRP contains Sections 10.0 and 11.0. These sections contain a public involvement discussion that fulfills a requirement of this plan and a bibliography of references cited in the text of this document.

Following Volume IV, are the appendices as cited throughout the text of this document.

SECTION 10.0
PUBLIC INVOLVEMENT

Montana DEQ signed a 319-funded grant with the Tri-State Water Quality Council for implementation of this project in February of 2002. The first organizational meeting of the Technical Advisory Committee (TAC) was on March 26, 2002. The Tri-State Water Quality Council subcontracted Land & Water Consulting to execute the technical analysis starting in June 2002. The Bitter Root Water Forum signed a subcontract with the Council to manage public participation activities associated with the project.

The TAC included key public stakeholders to include the US Forest Service, the Montana DNRC, the Ravalli County Planning Office, the Bitterroot Conservation District, Montana Fish, Wildlife and Parks, the University of Montana. The TAC met formally in March, April, June and August of 2002 and in February, June and August of 2003. There were several other “informal” meetings of TAC members in 2003. A public meeting was held in Darby in January 2003 and February 2004, where the public in general was invited to hear presentations on the project and participate in a question and answer session.

As for this water quality restoration plan, a 5-week stakeholder comment period followed by a one-month public comment period was started on December 15, 2003 – January 12, 2004, & November 14, 2004-December 13, 2004, respectively. A formal public meeting was held on December 9, 2004. MDEQ reviewed and responded to comments and attempted to incorporate them where possible. Any future significant revisions to this plan or identification of water quality impairment conditions on future 303(d) lists will also undergo public review.

This final document reflects modifications made in response to the written and verbal comments received throughout the public comment period. The written comments and respective responses to those comments are provided in Appendix K.

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