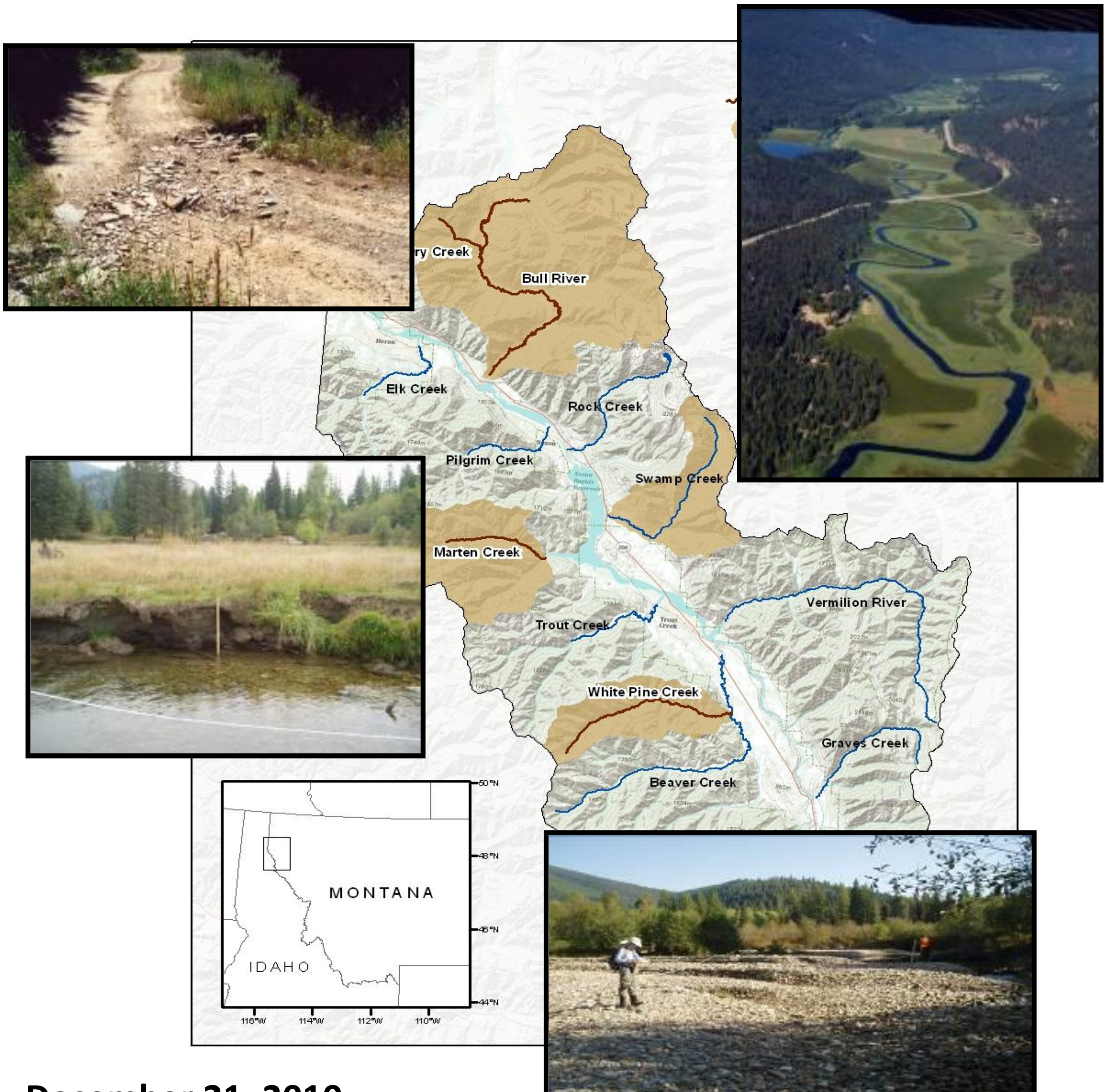
Montana Department of Environmental Quality

Lower Clark Fork Tributaries Sediment TMDLS and Framework For Water Quality Restoration



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ACRONYMS

AFO	Animal Feeding Operation
ARM	Administrative Rules of Montana
BEHI	Bank Erosion Hazard Index
BER	Board of Environmental Review, Montana
BMP	Best Management Practice
CAFO	Confined Animal Feeding Operation
cfs	Cubic Feet per Second
CNMP	Comprehensive Nutrient Management Plan
CWA	Clean Water Act
DEQ	Department of Environmental Quality, Montana
DLCD	Deer Lodge Conservation District
DNRC	Department of Natural Resources and Conservation, Montana
EMAP	Environmental Monitoring and Assessment Program
°F	Degrees Fahrenheit
ft	feet
FWP	Fish, Wildlife, and Parks, Montana Department of
HRU	Hydrologic Response Unit
HUC	Hydrologic Unit Code
in	inches
LA	Load Allocation
LANDSAT	Land Remote Sensing Sattelite
lbs/day	pounds per day
LCFT-TPA	Lower Clark Fork Tributaries TMDL Planning Area
LWD	Large Woody Debris
MCA	Montana Code Annotated
mg/L	Milligrams Per Liter
mi/sq mi	miles per square mile
MOS	Margin of Safety
MPDES	Montana Pollutant Discharge Elimination System
NBS	Near Bank Stress
NLCD	National Land Cover Dataset
NRCS	National Resource Conservation Service
NRDP	Natural Resource Damage Program
PFC	Proper Functioning Condition
SCD/BUD	Sufficient Credible Data / Beneficial Use Determination
SMZ	Streamside Management Zone
sq/mi	square miles
SSURGO	Soil Survey Geographic
STATSGO	State Soil Geographic [database]
SWAT	Soil and Water Assessment Tool [model]
SWPPP	Storm Water Pollution Prevention Plan
TMDL	Total Maximum Daily Load
TPA	TMDL Planning Area
UAA	Use Attainability Analysis
UCFRB	Upper Clark Fork River Basin

U.S. EPA	United States Environmental Protection Agency
USFS	United States National Forest Service
USGS	United States Geologic Survey
USLE	Universal Soil Loss Equation
USFWS	United States Fish & Wildlife Service
WARSEM	Washington Road Surface Erosion Model
WLA	Waste Load Allocation
WQA	Montana Water Quality Act
WRC	Watershed Restoration Coalition of the Upper Clark Fork
WRP	Watershed Restoration Plan

EXECUTIVE SUMMARY

This document presents a Total Maximum Daily Load (TMDL) and framework water quality restoration for sediment in five impaired tributaries in the Lower Clark Fork Tributaries TMDL Planning Area (TPA), located in northwest Montana and extending from the mouth of Prospect Creek near Thompson Falls, downstream to the Idaho-Montana state border. The following sections provide details related to the justification, development, and ultimate achievement of sediment TMDLs for Bull River, Dry Creek, Marten Creek, Swamp Creek, and White Pine Creek. DEQ has performed assessments determining that the above listed tributaries do not meet the applicable water quality standards. The scope of the TMDLs in this document address sediment related problems for Lower Clark Fork tributaries (See **Table E-1**). In addition, data for Elk Creek appears within this document to assist with future review of progress toward achieving the 1997 Elk Creek TMDL plan.

The Montana Water Quality Act requires DEQ to develop TMDLs for streams and lakes that do not meet, or are not expected to meet, Montana water quality standards. A TMDL is the maximum amount of a pollutant a waterbody can receive and still meet water quality standards. The goal of TMDLs is to eventually attain and maintain water quality standards in all of Montana's streams and lakes, and to improve water quality to levels that support all state-designated beneficial water uses.

The Lower Clark Fork Tributaries TMDL Planning Area is located entirely in Sanders County and within its boundaries exist the major tributaries of Beaver Creek, Elk Creek, Graves Creek, Pilgrim Creek, Rock Creek, Trout Creek and the Vermillion River, in addition to the tributaries for which TMDLs have been developed; however, it does not include the Lower Clark Fork River channel. Lower Clark Fork tributaries originate in the Cabinet Mountains to the northeast and the Coeur D'Alene Mountains to the southwest. The TPA includes portions of two national forests, the Lolo and Kootenai National Forests, and over half of the Cabinet Mountain Wilderness Area.

Sediment

Sediment was identified as a cause of impairment of aquatic life and coldwater fisheries in Bull River, Dry Creek, Marten Creek, Swamp Creek, and White Pine Creek. Sediment is impacting beneficial water uses in these streams by affecting habitat and other conditions necessary for the success of trout and other aquatic life. Water quality restoration goals for sediment in these stream segments were established on the basis of stream morphology, fine sediment levels in trout spawning areas, pool quality and riparian condition. DEQ believes that once these water quality goals are met, beneficial uses currently impacted by sediment will be restored.

Sediment loads were quantified for natural background conditions and for the following sources: bank erosion, upland/hillslope erosion, and sediment from road crossings. The Lower Clark Fork tributaries sediment TMDLs indicate that reductions in sediment loads ranging from 28% to 43% will result in meeting the water quality restoration goals.

Recommended strategies for achieving the pollutant reduction goals of the Lower Clark Fork Tributaries TMDLs are also presented in this plan. They include best management practices (BMPs) for agriculture, timber harvest, and roads, as well as expanding riparian buffer areas and using other land, soil, and water conservation practices that improve the condition of stream channels and associated riparian vegetation.

Implementation of most water quality improvement measures described in this plan is based on voluntary actions of watershed stakeholders. Ideally, the TMDL and associated information within this document will be used by a local watershed group and/or other watershed stakeholders as a tool to help guide and prioritize local water quality improvement activities. These improvement activities can be documented within a watershed restoration plan consistent with DEQ and EPA recommendations.

It is recognized that a flexible and adaptive approach to most TMDL implementation activities may become necessary as more knowledge is gained through implementation and future monitoring. The plan includes an effectiveness monitoring strategy that is designed to track future progress towards meeting TMDL objectives and goals, and to help refine the plan during its implementation.

Table E-1. Impaired Waterbodies, Impairment Causes, and Impaired Beneficial Uses in the Lower Clark Fork TPA for Which TMDLs Were Completed in 2010.

Waterbody & Location Description	Waterbody ID	Impairment Cause	TMDL Pollutant Category	Impaired Uses
Bull River, the North Fork to the mouth (Cabinet Gorge Reservoir)	MT76N003_040	**Sedimentation/ Siltation**	**Sediment**	Aquatic Life, Cold Water Fishery
Dry Creek, headwaters to the mouth (Bull River) T28N, R33W	MT76N003_180	**Sedimentation/ Siltation**	**Sediment**	Aquatic Life, Cold Water Fishery
Marten Creek, headwaters to the mouth (Noxon Reservoir)	MT76N003_090	**Sedimentation/ Siltation**	**Sediment**	Aquatic Life, Cold Water Fishery
Swamp Creek, Cabinet Mountains Wilderness boundary to the mouth (Noxon Reservoir)	MT76N003_140	**Sedimentation/ Siltation**	**Sediment**	Aquatic Life, Cold Water Fishery*
White Pine Creek, headwaters to the mouth (Beaver Creek)	MT76N003_120	**Sedimentation/ Siltation**	**Sediment**	Aquatic Life, Cold Water Fishery

* Swamp Creek was not listed on the 303d List for impairment however data suggests that sediment impairment may exist, and impaired uses are similar to other impaired streams in the TPA.

1.0 INTRODUCTION

1.1 BACKGROUND

This document, *The Lower Clark Fork Tributaries Sediment TMDLs and Framework Watershed Water Quality Improvement Plan*, describes the Montana Department of Environmental Quality's present understanding of sediment related water quality problems in rivers and streams of the Lower Clark Fork Tributaries TMDL Planning Area (TPA) and presents a general framework for resolving them. The Lower Clark Fork TPA encompasses the Clark Fork watershed from its confluence with Prospect Creek near Thompson Falls to the Montana-Idaho border; however this document focuses only on sediment TMDLs for Clark Fork tributaries, and excludes the Clark Fork River. **Figure A-1 found in Appendix A** shows a map of waterbodies in the TPA with sediment pollutant listings addressed in this document. Pollutants affecting the Clark Fork River and other pollutants in Lower Clark Fork tributaries will be addressed in future documents.

Congress passed the Water Pollution Control Act, more commonly known as the Clean Water Act, in 1972. The goal of this act is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The Clean Water Act requires each state to set water quality standards to protect designated beneficial water uses and to monitor the attainment of those uses. Fish and aquatic life, wildlife, recreation, agriculture, industrial, and drinking water are all types of beneficial uses designated in Montana. Streams and lakes (also referred to as waterbodies) not meeting the established standards are called *impaired waters*, and those not expected to meet the standards are called *threatened waters*.

The waterbodies with their associated impairment and threatened causes are identified within a biennial integrated water quality report developed by DEQ. Impairment causes fall within two main categories: pollutant and pollution. Both Montana state law (Section 75-5-701 of the Montana Water Quality Act) and section 303(d) of the federal Clean Water Act require the development of total maximum daily loads (TMDLs) for impaired and threatened waters where a measurable pollutant (for example, sediment, nutrients, metals or temperature) is the cause of the impairment. The waterbody segments with pollutant impairment causes in need of TMDL development are contained within the 303(d) List portion of the State's integrated water quality report. The integrated report identifies impaired waters by a Montana waterbody segment identification, which is indexed to the National Hydrography Dataset. **Table 1-1** identifies the waterbodies identified as impaired or threatened by pollutants and pollution in the Lower Clark Fork tributaries TPA.

Table 1-1. 2008 Impaired Waterbodies, Impairment Causes, and Impaired Beneficial Uses in the Lower Clark Fork Tributaries TPA.

Waterbody & Location Description	Waterbody ID	Impairment Cause	TMDL Pollutant Category	Impaired Uses
Beaver Creek, headwaters to the mouth (Confluence with the Clark Fork River)	MT76N003_030	Alteration in stream side or littoral vegetation covers	*Not a Pollutant*	Aquatic Life, Cold Water Fishery
Bull River, the North Fork to the mouth (Cabinet Gorge Reservoir)	MT76N003_040	**Sedimentation/ Siltation**	**Sediment**	Aquatic Life, Cold Water Fishery
		Physical substrate habitat alterations	*Not a pollutant*	Aquatic Life, Cold Water Fishery
Dry Creek, headwaters to the mouth (Bull River) T28N, R33W	MT76N003_180	**Sedimentation/ Siltation**	**Sediment**	Aquatic Life, Cold Water Fishery
Graves Creek, headwaters to the mouth (Clark Fork River)	MT76N003_080	Alteration in stream-side or littoral vegetative cover	*Not a Pollutant*	Aquatic Life, Cold Water Fishery
Marten Creek, headwaters to the mouth (Noxon Reservoir)	MT76N003_090	**Sedimentation/ Siltation**	**Sediment**	Aquatic Life, Cold Water Fishery
		Physical substrate habitat alterations	*Not a pollutant*	Aquatic Life, Cold Water Fishery
Pilgrim Creek, headwaters to the mouth (Cabinet Gorge Reservoir)	MT76N003_100	Physical substrate habitat alterations	*Not a pollutant*	Aquatic Life, Cold Water Fishery
Rock Creek, headwaters to mouth below the Noxon Dam	MT76N003_190	Alteration in stream-side or littoral vegetative cover	*Not a Pollutant*	Aquatic Life, Cold Water Fishery
Swamp Creek, Cabinet Mountains Wilderness Boundary to the mouth (Noxon Reservoir)	MT76N003_140	None listed	None listed	Insufficient data to assess
Vermillion River, headwaters to the mouth (Noxon Reservoir)	MT76N003_130	Alteration in stream-side or littoral vegetative cover	*Not a Pollutant*	Aquatic Life, Cold Water Fishery
White Pine Creek, headwaters to the mouth (Beaver Creek)	MT76N003_120	Alteration in stream-side or littoral vegetative cover	*Not a Pollutant*	Aquatic Life, Cold Water Fishery
		Sedimentation/ Siltation	**Sediment**	Aquatic Life, Cold Water Fishery
		Temperature, water	*Temperature	Aquatic Life, Cold Water Fishery

This document provides TMDLs for those pollutants identified by bold text.
* Temperature TMDL will be developed in a future document.

A TMDL refers to the maximum amount of a pollutant a stream or lake can receive and still meet water quality standards. The development of TMDLs and water quality improvement strategies in Montana includes several steps that must be completed for each impaired or threatened waterbody and for each contributing pollutant (or “pollutant/waterbody combination”). These steps include:

1. Characterizing the existing waterbody conditions and comparing these conditions to water quality standards. During this step, measurable target values are set to help evaluate the stream's condition in relation to the applicable standards.
2. Quantifying the magnitude of pollutant contribution from the pollutant sources
3. Determining the TMDL for each pollutant, based on the allowable loading limits (or loading capacity) for each pollutant/waterbody combination.
4. Allocating the total allowable load (TMDL) into individual loads for each source (referred to as the load allocations or waste load allocations).

In Montana, restoration strategies and recommendations are also incorporated in TMDL documents to help facilitate TMDL implementation.

The above four TMDL steps are further defined in **Section 4.0** of this document. Basically, TMDL development for an impaired waterbody is a problem solving exercise. The problem is excess pollutant loading negatively impacting a designated beneficial use. The solution is developed by identifying the total acceptable pollutant load to the waterbody (the TMDL), characterizing all the significant sources contributing to the total pollutant loading, and then identifying where pollutant loading reductions should be applied to one or more sources to achieve the acceptable load.

1.2 Water Quality Impairments and TMDLs Addressed By This Plan

As shown by **Table 1-1**, sediment in the predominant TMDL pollutant category in the Lower Clark Fork Tributaries TPA. For each impairment cause, the impaired beneficial uses are also identified and in the Lower Clark Fork include aquatic life and cold water fisheries. TMDL development for each pollutant category will follow a similar process as reflected by the organization of this document and discussed further in **Section 1.3** below.

In addition to those TMDLs identified in **Table 1-1**, data reviewed during this project justified the further development of sediment TMDLs for Swamp Creek, despite the fact that it is not currently listed for sediment impairment on the 2008 303d List. In total, this document addresses 5 sediment TMDLs for the Lower Clark Fork Tributaries TPA.

TMDLs are not required for impairment causes that are not pollutants, and in general, those streams listed solely for habitat alteration causes have not been investigated for TMDL development within the context of this document. However, the sediment targets, pollutant reduction strategies, and restoration principles described herein do apply throughout the TPA and are encouraged to be considered regardless of TMDL status and current water quality condition. Streams listed for impairment causes that are not pollutants are described in **Section 6.0** – **Other Problems and Concerns**.

1.3 Document Layout

The main body of the document provides a summary of the TMDL components. Additional technical details of these components are contained in the appendices of this report. In addition to this introductory section which includes the brief TMDL background and identification of TMDLs developed, this document has been organized into the following sections:

Section 2.0 - Lower Clark Fork Watershed Description:
Description of the physical and social characteristics of the watershed.

Section 3.0 - Montana Water Quality Standards:
Discusses the water quality standards that apply to the Lower Clark Fork watershed.

Section 4.0 - Description of TMDL Components:
Defines the components of a TMDL and the process by which they are developed.

Section 5.0 - Sediment TMDL Components, sequentially:
Discusses the pollutant category's impact to beneficial uses, the existing water quality conditions and the developed water quality targets, the quantified pollutant contributions from the identified sources, the determined TMDL, and the allocations.

Section 6.0 - Other Problems/Concerns:
Describes other problems or issues that may potentially be contributing to water quality impairment and how the TMDLs in the plan may address some of these concerns. This section also provides recommendations for addressing these problems.

Section 7.0 - Restoration Objectives and Implementation Plan:
Discusses water quality restoration objectives and presents a framework implementation strategy for meeting the identified objectives and TMDLs.

Section 8.0 - Monitoring for Effectiveness:
Describes a water quality monitoring plan for evaluating the long term effectiveness of the Lower Clark Fork Tributaries TMDLs and Framework Watershed Water Quality Improvement Plan.

Section 9.0 - Public Participation and Response to Comments:
Describes the involvement of other agencies and stakeholder groups who were involved with the development of the plan, the public participation process used in review of the draft document, and presents and addresses comments received during the public review period.

2.0 LOWER CLARK FORK WATERSHED DESCRIPTION

This section of the Lower Clark Fork Tributaries TMDL and water quality restoration plan provides general background information about the watershed, and sets the stage for a later discussion of water quality problems, and the underlying historical, current and possible future causes of impairment. It is designed to put the subject waterbodies into context within the larger watershed. The characterization establishes a context for impaired waters, as background for total maximum daily load (TMDL) planning.

The Montana Department of Environmental Quality (DEQ) has identified 5 waterbodies for TMDL development within the Lower Clark Fork River watershed: Bull River, Dry Creek, Marten Creek, Swamp Creek, and White Pine Creek. The impairment listings are detailed in DEQ's Integrated 305(b)/303(d) Water Quality Report (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, 2009), and information pertaining to the current condition of these streams is located in **Section 5.0**. Impairment listings are summarized in **Section 1.0**.

2.1 PHYSICAL CHARACTERISTICS

2.1.1 Location

The Lower Clark Fork Tributaries TMDL Planning Area (LCFT-TPA) is located in northwest Montana. The planning area encompasses approximately 738 square miles (**Table 2-1**) and includes all tributaries to the Lower Clark Fork River from the mouth of Prospect Creek near Thompson Falls, Montana, downstream to the Idaho-Montana state border (**Figure A-1**). The LCFT-TPA does not include the Lower Clark Fork River channel. Lower Clark Fork tributaries originate in the Cabinet Mountains to the northeast and the Coeur d'Alene Mountains to the southwest. Located entirely within Sanders County, Montana, the LCFT-TPA includes portions of two national forests- the Lolo and Kootenai National Forests, and over half of the Cabinet Mountain Wilderness Area. The Clark Fork River is dammed twice in the LCFT-TPA, forming Cabinet Gorge Reservoir near the Montana-Idaho border and Noxon Reservoir several miles upstream.

Table 2-1. Drainage areas of the Lower Clark Fork Watershed TMDL Planning Area subwatersheds.

Subwatershed	Drainage Area (Square Miles)	Percent of TMDL Planning Area
Beaver Creek✧	90.5	12.3%
Bull River*	142.1	19.3%
Elk Creek†	57.6	7.8%
Graves Creek	28.7	3.9%
Marten Creek	46.1	6.2%
Pilgrim Creek	28.7	3.9%
Rock Creek	33.1	4.6%
Swamp Creek	35.8	4.9%
Vermilion River	105.9	14.4%
White Pine Creek	31.2	4.2%
All other watersheds	137.5	18.6%
Total	738.1	100%

✧Beaver Creek values do not include White Pine Creek watershed area.
*Dry Creek is included in values reported for the Bull River.
†Elk Creek values reported are for the whole watershed. The Montana 303(d) List definition for Elk Creek is for only that portion of the drainage in Montana.

Twelve tributaries in the LCFT-TPA are on the Montana 303(d) List: Graves Creek, Vermilion River, Swamp Creek, Rock Creek, Bull River, Dry Creek, Elk Creek, Pilgrim Creek, Marten Creek, White Pine Creek, and Beaver Creek; although only Bull River, Dry Creek, Marten Creek, and White Pine Creek are currently listed with Sediment as a cause for impairment (**Figure A-1**). In general, watershed characteristics throughout **Section 2.0** are stratified by the Montana 303(d) List of drainage boundaries with two exceptions: 1) Dry Creek, a tributary to the Bull River, is included in the values reported for the Bull River watershed. 2) Elk Creek watershed characteristics are reported for the entire watershed rather than only that portion of the drainage within Montana borders. In addition to these particulars, the Beaver Creek watershed is presented as two parts: White Pine Creek and Beaver Creek. White Pine Creek is the only tributary to Beaver Creek known to be inhabited by bull trout, Salvelinus confluentus, a federally listed threatened species (United States Department of Interior, Fish and Wildlife Service, 1998). Therefore, the White Pine Creek drainage has been separated from Beaver Creek for the purpose of presenting watershed information. Data specific to any 303(d) listed waterbody will be reported as necessary in the following sections.

2.1.2 Topography

Figure A-2 displays topographic relief and the distribution of elevations in the Lower Clark Fork Watershed TMDL Planning Area. Elevations in the LCFT-TPA average 4,270 feet and range from 2,170 feet to 8,690 feet (GEI Consultants, Inc., 2005). Tributaries within the TMDL planning area are characterized by a high percentage of steep terrain in their headwaters and mid-drainages. In the lower drainages, morphology transitions to low gradient alluvial valleys or alluvial fans as the tributaries flow into the Lower Clark Fork River or Noxon Rapids and Cabinet Gorge reservoirs.

2.1.3 Geology

The majority of the LCFT-TPA consists of metasedimentary rock, part of a series known as the Belt supergroup (U.S. Geological Survey, 1955). Deposited over 600 million years ago, rock formations of the Belt series consist generally of shale, sandstone and limestone layers that were deposited by shallow intercontinental seas and lightly metamorphosed during subsequent uplifting processes (GEI Consultants, Inc., 2005). **Figure A-3** displays surface geology of the LCFT-TPA, which includes Belt rocks, alluvial deposits, portions of the Idaho batholith, and isolated deposits from Glacial Lake Missoula. The Vermilion River and Cabinet Mountain Range are known to contain gold, silver and copper deposits.

Glacial Lake Missoula deposits date to the Pleistocene period, between 1.6 million and 10,000 years ago. According to flood deposits in Idaho, Oregon and Washington, the Purcell lobe of the Cordilleran ice sheet dammed the Clark Fork River near the Idaho-Montana border between 40-70 times over approximately 10,000 years (GEI Consultants, Inc., 2005). The ice dams were breached periodically by Lake Missoula, producing large magnitude catastrophic floods. These floods scoured the landscape of the Lower Clark Fork watershed, removing topsoil and exposing bedrock.

Continual advance and retreat of glaciers, in conjunction with the floods of Lake Missoula, have resulted in the shallow soils, compacted glacial tills, fine lacustrine deposits, and highly dissected/high stream density characteristics of Lower Clark Fork tributaries today (GEI Consultants, Inc., 2005). Large glacial till deposits, deep alluvial deposits and shallow soil depths effect perennial flows of Lower Clark Fork tributaries. Intermittent flows, in addition to waterfalls or other geological knick points, act as natural fish barriers in several 303(d) listed streams including Vermilion River, Graves Creek and Rock Creek (GEI Consultants, Inc., 2005).

Detailed Soil Survey Geographic (SSURGO) data are not available for the entire Lower Clark Fork Watershed (Natural Resources Conservation Service, 1995). Two SSURGO scale soil surveys, one each in Lincoln and Sanders Counties, cover the Clark Fork River Basin and most private land areas in the lower watersheds of tributaries to the Lower Clark Fork River. The county soil surveys do not, however, extend to the upper watersheds of several tributaries in the Lower Clark Fork. State Soil Geographic Data Base (STASTGO) data generalize more detailed (SSURGO) soil survey maps and use data on geology, topography, vegetation, climate and Land Remote Sensing Satellite (LANDSAT) images to assemble probable soil classifications for areas lacking SSURGO data (Natural Resource Information System, 2003).

The NRCS recommends using either SSURGO or STATSGO data, but not both, due to the incompatibility of the databases (Natural Resources Conservation Service, 1994). Therefore, soil characteristics presented in the watershed characterization are based on STATSGO data for the sake of continuity.

The Universal Soil Loss Equation (USLE) K-factor is a measure of a soil's inherent susceptibility to erosion by rainfall and runoff. Values of K range from 0 to 1 with higher numbers indicative of greater erodibility. The distribution of K values in the LCFT-TPA can be found in **Table 2-2** below. Almost 77 percent of the Lower Clark Fork TMDL Planning Area has a soil erosion factor between 0.2 and 0.5, which is considered moderate susceptibility to erosion. Soils more resistant to surface erosion (K-factor less than 0.20) constitute 21.6 percent of the LCFT-TPA and soils with high susceptibility to erosion comprise approximately 1.4 percent. **Figure A-4** displays the spatial distribution of K values throughout the Lower Clark Fork watershed.

Table 2-2. Distribution of soil K-factor values in the Lower Clark Fork TMDL planning area (square miles). Blank cells indicate 0 value.

Subwatershed	0.00 – 0.09	0.10 – 0.19	0.20 – 0.29	0.30 – 0.39	0.40 – 0.49	0.50 – 0.59	Total
Beaver Creek✧	---	5.8	32.7	48.0	3.7	---	90.2
Bull River*	---	64.5	7.5	70.1	0.1	---	142.1
Elk Creek†	---	11.7	12.9	19.0	---	8.1	51.7
Graves Creek	---	4.1	6.1	18.5	---	---	28.7
Marten Creek	---	5.9	23.4	16.8	---	---	46.1
Pilgrim Creek	---	3.8	21.2	3.0	0.8	---	28.7
Rock Creek	---	17.6	---	14.1	1.4	---	33.1
Swamp Creek	---	21.0	6.8	5.0	3.0	---	35.8
Vermilion River	---	0.3	34.0	71.7	---	---	105.9
White Pine Creek	---	2.1	10.3	18.8	---	---	31.2
All other watersheds	---	21.2	50.6	58.7	5.0	2.1	137.6
Total	---	158.0	205.4	343.6	13.9	10.2	731.1
Percent of TMDL Planning Area	---	21.6	28.1	47.0	1.9	1.4	100%

✧Beaver Creek values do not include White Pine Creek watershed area.
*Dry Creek is included in values reported for the Bull River.
†Elk Creek values reported are for the whole watershed.

2.1.4 Hydrology and Hydrography

The U.S. Geological Survey (USGS) has maintained seven gauging stations within the Lower Clark Fork periodically throughout the last 30 years. Five of the gauging stations are located on tributaries to the Lower Clark Fork River and two monitor discharge of the Lower Clark Fork River. **Table 2-3** summarizes the data and periods of record for Lower Clark Fork gauging stations. With the exception of two gauging stations on the main stem of the Lower Clark Fork River, there are no stream flow data currently being collected by the USGS within the TMDL planning area. The nearest gauge for which real-time daily discharge is available is Prospect Creek near Thompson Falls, Montana, approximately one-third of a mile upstream of the LCFT-TPA boundary.

Table 2-3. USGS stream gauges in the LCR-TPA
(U.S. Geological Survey, 2008)

Station Number	Station Name	Drainage Area (Square Miles)	Peak Streamflow Period of Record (Calendar Year)	Daily Streamflow Period of Record (Calendar Year)
12391000	Clark Fork River at Thompson Falls, MT	21,113 mi2		1952 – 1959
12391100	White Pine Creek near Trout Creek, MT	8.75 mi2	1974 – 1984	
12391200	Canyon Creek near Trout Creek, MT	8.64 mi2	1972 – 1991	
12391300	Noxon Rapids Reservoir near Noxon, MT	21,833mi2	1959 – Present	1959 - Present
12391400	Clark Fork River below Noxon Rapids Dam	21,833 mi2	1960 – Present	1960 – Present
12391430	Skeleton Creek at Noxon, MT	2.1 mi2	1972 – 1984	
12391525	Snake Creek near Noxon, MT	3.11 mi2	1972 – 1984	
12391550	Bull River near Noxon MT	139 mi2	1973 - 1984	1972 – 1982

The USGS has average daily discharge records in only one Montana 303(d) listed stream in the LCFT-TPA, the Bull River**. Figure 2-1** illustrates a hydrograph for the Bull River gauge and depicts the seasonality of peak flows in the Lower Clark Fork region (U.S. Geological Survey, 2008). During the winter months, the hydrograph rises and falls and various precipitation, rain-on-snow, and snowmelt events increase flows intermittently. In late March/early April, the hydrograph begins to rise as temperature increases causing rapid snowmelt runoff. Stream flows start to taper off in June when warm dry air moves in and the snow pack is depleted. By August, the flows reach their lowest, running near base level for a couple of months through late summer and early fall.

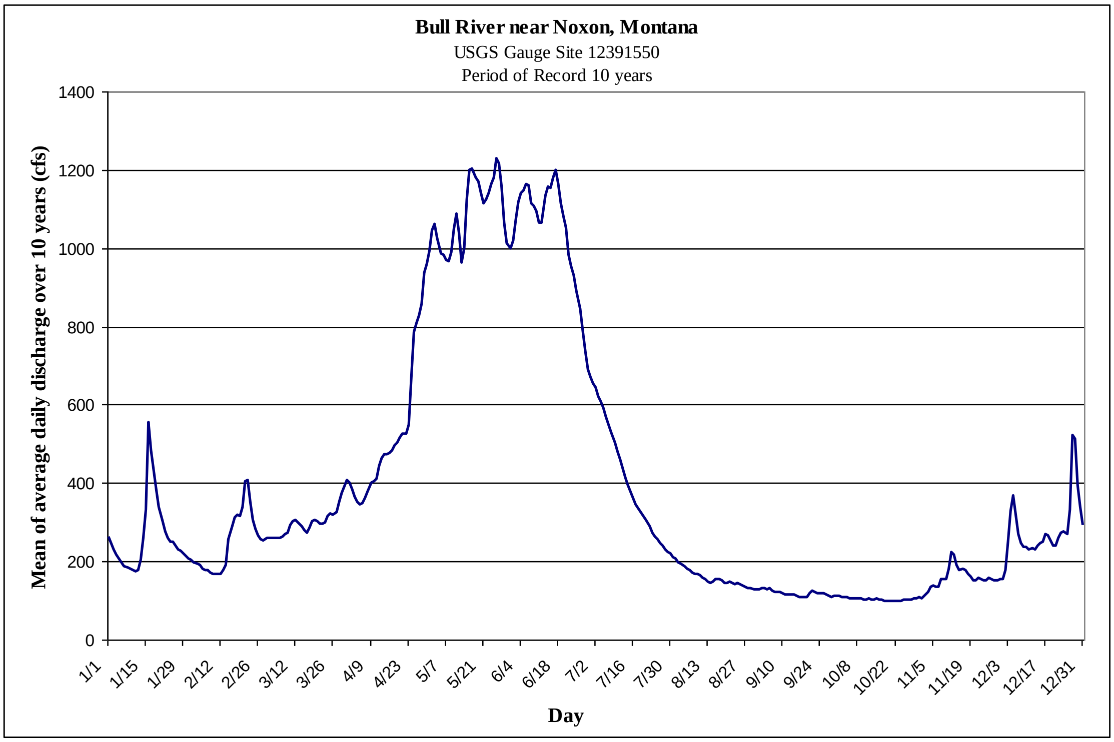

Figure 2-1. The hydrograph for the USGS stream gage stationed on the Bull River near Noxon, Montana displays the mean, in cubic feet per second, of mean daily discharge over a period of 10 years.

Table 2-4 presents predicted flood frequencies based on annual peak discharges through 1998 in White Pine Creek and the Bull River. The USGS stream gage in the Bull River is approximately 1.3 miles upstream of the mouth, representing 139 square miles of the 142 square mile watershed. Flood frequencies based on the Bull River gage data can be assumed to closely represent flows for the entire watershed area. The White Pine Creek Gage is approximately 9 stream miles upstream of the mouth and measures only 8.75 square miles of the 31.2 square mile watershed. Data and calculations based on the White Pine gage do not represent flows for the entire watershed, rather the gage provides information for less than one third of the drainage basin.

Table 2-4. The flood frequencies for White Pine Creek and Bull River USGS gauging stations. (U.S. Geological Survey, 2008).

Recurrence Interval (Years)	Discharge measured from peak flow record (cfs)	
	White Pine Creek #12391100	Bull River #12391550
Q1.25	137	1,530
Q2	212	2,100
Q5	340	2,900
Q10	442	3,340
Q25	591	4,120
Q50	717	4,630
Q100	858	5,160

For the greater part of the past two decades, the LCFT-TPA has experienced regional drought and below average precipitation, although recently 'wet' years have been recorded in 2008 and 2009 (United

States Geological Survey, 2010). Most notable periods of drought have been from 1992-1994 and 2000-2005. Both 1996 and 1997 were above average precipitation years (United States Geological Survey, 2010). In 1997, rain-on-snow events quickly released water in storage at higher elevations causing flood level flows throughout the Lower Clark Fork region and most of Montana.

The hydrography of tributaries in the LCFT-TPA is approximately a 2:1 ratio of intermittent to perennial channel lengths (**Table 2-5**). Intermittent flows are most likely the result of inherent factors such as climate, geology, and historical geomorphic processes (i.e. glaciations and catastrophic flooding events). With the exception of lower gradient channel sections in Beaver, Elk, Swamp and Trout Creeks, very little surface water is diverted for irrigation (see **Section 2.3.4** for assessment of water use in the LCFT-TPA). The timing, length, and location of intermittent stretches of stream have a direct impact on fisheries abundance throughout the Lower Clark Fork basin (see **Section 2.2.2**).

Table 2-5. Length of perennial and intermittent streams in the Lower Clark Fork TMDL Planning Area* (United States Department of Interior, Geological Survey, 2006)

Flow Regime	**Channel Length (Miles)**
Perennial	482.4
Intermittent	984.5
Canals, Ditches, or Artificial Pathways	No Designation

* Calculation does not include portion of Elk Creek drainage in the State of Idaho.

2.1.5 Stream Morphology

As part of an effort to consolidate stream channel data, a GIS reach break layer based on stream morphology was created by River Design Group in 2005. Data in this layer came from multiple sources including 1995 USGS aerial imagery assessment, topographic and spatial analysis, incorporation of data from previous studies (Washington Water Power Company, 1996); (Watershed Consulting LLC, 1999); (U.S. Department of Agriculture, Forest Service, Kootenai National Forest, 2000); (Land & Water Consulting, 2001a); (Land & Water Consulting, 2001b); (U.S. Department of Agriculture, Forest Service and River Design Group, 2004); (River Design Group and U.S. Department of Agriculture, Forest Service, Kootenai National Forest, Cabinet Ranger District, 2004); (River Design Group, 2005b); (GEI Consultants, Inc., 2005), and an aerial flight over the study area. The result is a comprehensive summary of Rosgen Level I stream types in the Lower Clark Fork Watershed TMDL Planning Area (**Figure A-5**).

In general, Rosgen type A and B channels dominate the higher elevations and steeper terrain of tributary watersheds (River Design Group, 2005b). At mid-elevations, tributaries typically transition between B, E, C, and D channel types. Rosgen C, E or D types occur primarily in the mid to lower elevations where more gradual terrain is found in the lower watershed areas. Immediately upstream of the mouths of many tributaries in the LCFT-TPA the channel will enter a steep canyon as it drops to the elevation of the Clark Fork River. These short sections are typified by B or F type channels.

Reservoirs in the Clark Fork River formed by the Cabinet Gorge Dam (1952) and Noxon Rapids Dam (1958) have elevated water levels at the mouths of Lower Clark Fork tributaries. An increase in base level elevations can affect an entire drainage profile depending on geology and sedimentation characteristics. To some extent, effects such as upstream migration of channel types, destabilization of banks, and reworking of channel scour and depositional areas can be expected.

2.1.6 Climate

The Lower Clark Fork watershed has an intercontinental/mountain climate, similar to that throughout the Rocky Mountains. Variability in elevation coincides with temperature and precipitation variability. Cumulative data of the subwatersheds in the LCFT-TPA indicates annual precipitation (rain and snowfall) ranges of 21 to 79 inches with an annual mean of 46 inches (GEI Consultants, Inc., 2005). According to monthly precipitation patterns in the towns of Noxon and Thompson Falls, the majority of precipitation falls between November and March as snow. In Noxon, snowfall averages 57 inches per year and rainfall averages 18 inches per year (GEI Consultants, Inc., 2005). Just upstream of the LCFT-TPA, Thompson Falls receives an average rainfall of 20 inches per year. Average monthly temperatures range from 23°F (January) to 64°F (July-August) in Noxon and 27°F (January) to 68°F (July) in Thompson Falls (GEI Consultants, Inc., 2005) (**Table 2-6**).

Table 2-6. Average annual air temperature (°F), average snowfall, and precipitation recorded at four locations in the Lower Clark Fork drainage
(GEI Consultants, Inc., 2005)

Weather Station Location	Years of Record	Average Annual Air Temperature (°F)			Ave. Snowfall (Inches)	Precipitation (Inches)
		Minimum	Mean	Maximum		
Belknap	43	34.7	47	60.6	41.3	23.5
Trout Creek	49	29.4	43	58.5	77.6	30.3
Noxon	104	31.1	45	59.4	57.8	17.9
Heron	87	31.8	44	56.4	85.4	33.7

The Lower Clark Fork drainage is part of a relatively low elevation region that opens onto the Columbia Plateau. As warm, moist air travels from the Pacific Ocean up the Columbia River basin, it can cause occasional rainfalls on existing snowcover, known as rain-on-snow events. The result of rain-on-snow events can be avalanches and rapid flooding. Rain-on-snow events are known to be responsible for some of the largest peak flows ever recorded in some Montana basins (GEI Consultants, Inc., 2005). Since 1974, three of the five largest peak flows on Prospect Creek (Jan. 1, 1974- 5,490 cfs; Feb. 9, 1996- 5,160 cfs; Dec. 26, 1980- 2,960 cfs) occurred between December and February, and were likely rain-on-snow events (United States Geological Survey, 2010). These events appear to occur on a near decadal timeframe on average.

2.2 Ecological Parameters

2.2.1 Vegetation

The Gap Analysis Program, sponsored and coordinated by the USGS Biological Resources Division (BRD), is a national- and state-level effort to provide regional assessments of the conservation status of native vertebrate species and natural land cover types (Wildlife Spatial Analysis Lab, 1998). The Montana GAP Analysis was completed in 1998 and has since been updated and standardized to enhance continuity throughout the state. **Table 2-7** summarizes vegetation and natural land cover within the Lower Clark Fork TMDL Planning Area.

Table 2-7. Vegetation classification (GAP) within the LCFT-TPA
(Wildlife Spatial Analysis Lab, 1998). Blank cells indicate a value less than 0.05 units.

Description	Acres	Square Miles	% of LCFT-TPA
Urban or Developed Lands	4	---	---
Low/Moderate Cover Grasslands	3,837	6.0	0.8
Moderate/High Cover Grasslands	1,289	2.0	0.3

Table 2-7. Vegetation classification (GAP) within the LCFT-TPA
(Wildlife Spatial Analysis Lab, 1998). Blank cells indicate a value less than 0.05 units.

Description	Acres	Square Miles	% of LCFT-TPA
Montane Parklands and Subalpine Meadows	4,063	6.3	0.9
Mixed Mesic Shrubs	30,796	48.1	6.6
Mixed Broadleaf Forest	516	0.8	0.1
Lodgepole Pine	23,965	37.4	5.1
Ponderosa Pine	13,232	20.7	2.8
Grand Fir	4,924	7.7	1.1
Western Red Cedar	2,784	4.4	0.6
Western Hemlock	23,632	36.9	5.0
Douglas-fir	50,617	79.1	10.8
Western Larch	8,603	13.4	1.8
Douglas-fir/Lodgepole Pine	8,615	13.5	1.8
Mixed Whitebark Pine Forest	2,730	4.3	0.6
Mixed Subalpine Forest	52,575	82.1	11.2
Mixed Mesic Forest	191,974	300.0	40.9
Mixed Xeric Forest	11,659	18.2	2.5
Mixed Broadleaf and Conifer Forest	2,428	3.8	0.5
Standing Burnt Forest	268	0.4	0.1
Water	386	0.6	0.1
Conifer Riparian	6,595	10.3	1.4
Broadleaf Riparian	300	0.5	0.1
Mixed Broadleaf and Conifer Riparian	242	0.4	0.1
Graminoid and Forb Riparian	164	0.3	---
Shrub Riparian	2,408	3.8	0.5
Mixed Riparian	4,115	6.4	0.9
Rocky Mountain Juniper	13,276	20.7	2.8
Mixed Barren Sites	2,706	4.2	0.6
Alpine Meadows	136	0.2	---
Total	468,840	732.6	100.0

Non-native plants such as spotted knapweed, reed canary grass, St. John's Wort and dalmatian toadflax are known to exist in the LCFT-TPA (GEI Consultants, Inc., 2005; Liermann, Brad, personal communication 2006b). Spotted knapweed grows well in shallow or dry soils, disturbed ground, and upland or riparian areas. Knapweed is often observed on gravel bars and steep channel banks where native plants take longer to become established. Reed canary grass out-competes native riparian species, decreasing species diversity, riparian and stream shade. Non-native plants promote homogeneous upland and riparian zones that may have increased transpiration and/or erosion rates.

2.2.2 Aquatic Life – Cold Water Fish

A recent study of fisheries and habitat in the Lower Clark Fork basin indicates the presence of several native and non-native fish species (**Figure A-6**). Native species known to occur in Lower Clark Fork tributaries include bull trout, westslope cutthroat trout, mountain whitefish, northern pikeminnow, redside shiner, longnose dace, peamouth, suckers, and sculpins (GEI Consultants, Inc., 2005). Nonnative species of concern include brook trout, brown trout and rainbow trout. **Table 2-8** identifies the presence of key native and non-native fish species in 303(d) listed tributaries of the LCFT-TPA.

Table 2-8. Known fish presence in subwatersheds of the Lower Clark Fork Watershed TMDL Planning Area
(GEI Consultants, Inc., 2005).

Subwatersheds	Native Fish Species				Non-native Fish Species		
	Bull Trout	Westslope Cutthroat Trout	Mountain Whitefish	Other fish species*	Brook Trout	Brown Trout	Rainbow Trout
Beaver Creek	x	x	x	x	x	x	x
Bull River	x	x	x	x			
Elk Creek	x		x		x	x	
Graves Creek	x	x	x		x	x	x
Marten Creek	x	x			x	x	
Pilgrim Creek	x	x		x	x	x	x
Rock Creek	x	x			x		x
Swamp Creek	x	x	x	x	x	x	
Vermilion River	x	x	x	x	x	x	x
White Pine Creek	x	x	x	x	x	x	x
All Other Watersheds	x	x	x	x	x	x	x

Bull trout, a federally listed threatened species (United States Department of Interior, Fish and Wildlife Service, 1998), and westslope cutthroat trout recognized by the State of Montana as a Species of Special Concern (Roedel, unpublished), are less numerous today than they were historically in the Lower Clark Fork River system (GEI Consultants, Inc., 2005).

There are several threats to beneficial use support of cold water fisheries (see **Table 2-15**). These include, but are not limited to human land management, presence of non-native fish and vegetation species, and various natural limiting factors (U.S. Department of Agriculture, Forest Service, Kootenai National Forest, 2000; GEI Consultants, Inc., 2005).

Geologic fish passage barriers and intermittent or insufficient channel flows are a barrier to fish movement and spawning activities. A recent assessment of habitat in the Lower Clark Fork basin found approximately 82 miles of stream with detrimentally low flows in streams used by bull trout, westslope cutthroat trout or mountain whitefish (GEI Consultants, Inc., 2005).

2.2.3 Fires

Wild fire has significantly affected natural land cover, runoff rates, and soil erosion in the Lower Clark Fork Watershed. Charred old growth cedar stumps and abundant instream bedload suggest the continued influence of the historic 1889 and 1910 fires, and floods of 1916 that are believed to have altered the stream corridors in the Lower Clark Fork Watershed (U.S. Department of Agriculture, Forest Service, Kootenai National Forest, 2000). **Table 2-9** summarizes wildfire activity in the Lower Clark Fork Watershed TMDL Planning Area.

Table 2-9. Fire history in the LCFT-TPA
(GEI Consultants, Inc., 2005). Blank cells indicate no data available.

Subwatershed		% Watershed Burned Pre-1910	% Watershed Burned 1910	% Watershed Burned Post-1910
303(d) listed	Beaver Creek	23	37	< 0.5
	Bull River	---	8	3
	Elk Creek	---	4	10
	Graves Creek	---	5	0
	Marten Creek	---	24	10
	Pilgrim Creek	---	37	8
	Rock Creek	53	2	5
	Swamp Creek	---	26	1
	Vermilion River	---	20	5
	White Pine Creek	---	16	0
All other tributaries	East Fork Blue Creek	100	41	---
	Dead Horse Creek	99	4	---
	McKay Creek	8	---	15
	Stevens Creek	---	20	---
	Tuscor Creek	---	17	---
	Deep Creek	---	25	2
	Mosquito Creek	---	13	0
	Squaw Creek	---	3	23
	Trout Creek	---	26	5

2.3 CULTURAL PARAMETERS

2.3.1 Population

As of the 2000 Montana census, the population of Sanders County totaled 10,227 people (Natural Resource Information System, 2000; Census and Economic Information Center, 2002). The largest town in the county, Thompson Falls (population 1,319), is southeast of the Lower Clark Fork TMDL Planning Area.

The majority of residences, businesses, and populace are in the low elevation/lower gradient valleys of the LCFT-TPA and along the Lower Clark Fork River corridor (**Figure A-7**). The concentration of population within lower drainage areas of the LCFT-TPA is in stark contrast to virtually uninhabited expanses of land in the middle and upper watershed areas. Approximately 80% of the Lower Clark Fork TMDL Planning Area has less than 2 persons per square mile (**Table 2-10**).

Table 2-10. Distribution of 2000 population density in the Lower Clark Fork Watershed TMDL Planning Area
(Census and Economic Information Center, 2002).*

Population Density (persons / square mile)	2000 (Square Miles)	2000 Percent of LCFT-TPA
0 – 1	327.1	44.7
1 – 2	261.5	35.7
2 – 5	68.0	9.3
5 – 10	34.6	4.7
10 – 25	30.1	4.1
25 – 50	7.2	1.0
50 – 100	2.6	0.4
100 – 150	1.0	0.1
150 – 250	0.3	< 0.05
250 – 350	0.1	< 0.05
Total	732.4	100.0

* Values presented do not include that portion of Elk Creek in the State of Idaho.

Between 1990 and 2000, population in the Lower Clark Fork TMDL Planning Area and the Clark Fork River valley increased 12%, rising from 439 to 490 individuals. In contrast, population increased 21% in the LCFT-TPA tributaries alone, rising from 227 to 274 individuals. While there is an overall increase in population in the Lower Clark Fork Watershed, census data indicates that a greater portion of that growth is occurring in the tributaries to the Clark Fork River than in the main valley.

2.3.2 Land Ownership

The majority of land in the Lower Clark Fork TMDL Planning Area is managed by the U.S. Forest Service (Lolo and Kootenai National Forests) comprising 89.3% or 660 square miles of mostly steep, higher elevation uplands (Natural Resource Information System, 2005). Private lands account for 9.7% (71 square miles) and are located predominantly in the lower watershed areas where wide, low-gradient valleys are conducive to agriculture and development. The Plum Creek Timber Company owns 0.6% (4.6 square miles) of the LCFT-TPA, most of which forms a “checkerboard” pattern with National Forest Lands in the upper Vermillion River drainage. Montana State Trust Lands comprise the least proportion of the basin, accounting for only 0.4% (2.9 square miles) interspersed evenly among private and National Forest lands. For the distribution of land ownership within each 303(d) listed tributary see **Table 2-11** and **Figure A-8**.

Table 2-11. Distribution of land ownership in the Lower Clark Fork TMDL Planning Area
(GEI Consultants, Inc., 2005).

Subwatershed	Percent U.S. Forest Service (USFS)	Percent Private Lands	Percent Plum Creek Timber Company	Percent Montana State Trust (DNRC)
Beaver Creek✧	81.4	17.9	0	0.7
Bull River*	94.0	4.9	1.1	0
Elk Creek†	80.9	18.6	0	0.5
Graves Creek	95.2	4.8	0	0
Marten Creek	99.5	0.5	0	0
Pilgrim Creek	90.7	8.9	0	0.4
Rock Creek	93.0	6.6	0	0.4

Table 2-11. Distribution of land ownership in the Lower Clark Fork TMDL Planning Area (GEI Consultants, Inc., 2005).

Subwatershed	Percent U.S. Forest Service (USFS)	Percent Private Lands	Percent Plum Creek Timber Company	Percent Montana State Trust (DNRC)
Swamp Creek	87.6	12.4	0	0
Vermilion River	85.4	11.8	2.8	0
White Pine Creek	96.8	3.2	0	0
All other watersheds	89.1	9.7	0	1.2
Total	89.3	9.7	0.6	0.4

✧Beaver Creek values do not include White Pine Creek watershed area.
*Dry Creek is included in values reported for the Bull River.
† Elk Creek values reported are for the whole watershed.

Historically, U.S. Forest Service lands were harvested for timber and minerals. Many roads were built in conjunction with these activities. Currently, forest lands in the LCFT-TPA are used for recreational purposes as well as for resource extraction. Most of the historical roads system is maintained to some degree to supply access for recreation, resource extraction and fire suppression. Other roads are either decommissioned or left in place. Private lands tend to be a mix of agricultural and residential uses. Several tracts of land that were historically grazed or farmed are now subdivided into smaller parcels and have been developed into residential units. Those lands and roads owned by the Plum Creek Timber Co. are maintained for timber harvest as are, generally, the lands managed by the State of Montana's Department of Natural Resources.

2.3.3 Land Cover

In 1992, the USGS and the U.S. Environmental Protection Agency (USEPA) published the National Land Cover Dataset (NLCD), an up-to-date source of intermediate scale land cover data. The information is based primarily on 30 meter resolution Landsat thematic mapper data and provides a coarse outline of land cover and land uses within the conterminous United States (**Figure A-9**). **Table 2-12** presents land uses/land cover in the LCFT-TPA.

Table 2-12. Land uses/land cover in the Lower Clark Fork TMDL Planning Area (United States Geological Survey, 2000). Blank cells indicate a value of less than 0.05 units.

Land Use / Land Cover	Acres	Square Miles	Percent of LCFT-TPA
Open Water	699	1.1	0.1
Perennial Ice/Snow	122	0.2	---
Low Intensity Residential	1	---	---
Commercial/Industrial/Transportation	382	0.6	0.1
Bare Rock/Sand/Clay	4,588	7.2	1.0
Transitional	4,564	7.0	1.0
Deciduous Forest	584	0.9	0.1
Evergreen Forest	392,534	613.3	83.2
Mixed Forest	2,197	3.4	0.5
Shrubland	29,992	46.9	6.4
Grasslands/Herbaceous	28,902	45.2	6.1
Pasture/Hay	5,792	9.0	1.2
Row Crops	1	---	---
Small Grains	782	0.2	0.2
Fallow	4	---	---

Table 2-12. Land uses/land cover in the Lower Clark Fork TMDL Planning Area
(United States Geological Survey, 2000). Blank cells indicate a value of less than 0.05 units.

Land Use / Land Cover	Acres	Square Miles	Percent of LCFT-TPA
Urban/Recreational Grasses	0	---	---
Woody Wetlands	711	1.1	0.2
Emergent Herbaceous Wetlands	29	---	---
Total	471,856	737.3	100

2.3.4 Water Resources

The Lower Clark Fork River Drainage Habitat Problem Assessment (GEI Consultants, Inc., 2005) identified dewatering of Beaver Creek for irrigation as a potential threat to native fisheries. There are several points of surface water diversion in the TMDL Planning Area (see **Figure A-10**) (Montana Department of Fish, Wildlife and Parks, 2003). The majority of diversions are located in White Pine Creek, Big Beaver Creek and Little Beaver Creek. Elk Creek, Pilgrim Creek, Swamp Creek and the Bull River also have several points of diversion along their tributaries and main stem (Montana Department of Natural Resources and Conservation Water Resources Division, 2003). **Table 2-13** summarizes the means of surface water diversion in the LCFT-TPA.

Table 2-13. Distribution and means of diversion for water rights in the LCFT-TPA
(Montana Department of Natural Resources and Conservation Water Resources Division, 2003).

Subwatershed	Dam	Flowing	Headgate	Livestock Watering Direct From Source	Pipeline	Pump	Other ‡	Total Points of Diversion
Beaver Creek✧	6	1	2	17	1	23	5	55
Bull River*	0	5	5	3	9	6	3	31
Elk Creek†	8	0	12	8	1	13	12	54
Graves Creek	1	0	6	3	0	0	17	27
Marten Creek	1	0	0	0	0	1	0	2
Pilgrim Creek	1	0	4	8	0	6	0	19
Rock Creek	0	0	0	0	4	1	2	7
Swamp Creek	4	6	15	2	3	1	2	33
Vermilion River	0	0	0	0	0	1	2	3
White Pine Creek	1	0	2	10	1	2	0	16
All other watersheds	7	18	19	6	1	6	7	64
Total	29	30	65	57	20	60	50	311

✧Beaver Creek values do not include White Pine Creek watershed area.
*Dry Creek is included in values reported for the Bull River.
† Elk Creek values reported are for the whole watershed.
‡Other category includes the following: gravity flow/direct, dike, diversion dam, fueled pump, instream, multiple, other diversion, pit, pump/flood and dike, pump/gravity flow, pump/headgate with ditch or pipeline.

The **Section 7** Consultation Watershed Baseline: Lower Clark Fork River, Montana report prepared by USFS- Kootenai National Forest in 2000 cites a water right held by the Green Mountain Irrigation District that could potentially divert the entire flow of Swamp Creek into their irrigation system at a diversion upstream of Galena Creek. No mention is made as to how often this diversion has occurred in the past (U.S. Department of Agriculture, Forest Service, Kootenai National Forest, 2000). Currently, no tributaries in the Lower Clark Fork Watershed are active municipal water suppliers ((Montana State Library, 2002); (U.S.Environmental Protection Agency, 2006)) or host wastewater permits (Montana

Department of Environmental Quality, 2000). Ground water is the primary source of municipal drinking water for communities in Sanders County and the Lower Clark Fork Watershed.

2.3.5 Recreational Use

Recreational activities take place on public lands in the Lower Clark Fork Watershed year-round, making use of the road network originally built to meet timber and mineral harvest needs. Popular recreational activities include hunting and fishing, foraging (mushrooms and berries), hiking in upper watershed/headwater areas, snowmobiling and ATV use (Liermann, Brad, personal communication 2006a). The distribution of recreational use is likely to mimic the road network, which facilitates access to public lands. Reservoirs in the Clark Fork River corridor are also popular recreational areas in Lower Clark Fork Watershed.

2.3.6 Harvest History

The majority of timber harvest in the Lower Clark Fork TMDL Planning Area occurred during the latter half of the twentieth century (GEI Consultants, Inc., 2005). Small amounts of timber were extracted between 1910 and 1940 in the Vermilion River and Trout Creek watersheds. Harvest activity began to increase during the 1950s, peaking between 1960 and 1990. All tributaries in the LCFT-TPA have experienced some harvest activity (GEI Consultants, Inc., 2005). **Table 2-14** summarizes the distribution of timber harvest in the Lower Clark Fork basin since 1970. In some watersheds, however, the effect of timber harvest activities prior to 1970 could still be impacting existing stream conditions (e.g. Graves Creek harvest from 1967-1975) (River Design Group, 2005a).

Table 2-14. Harvest history in the LCFT-TPA from 1970 to 2000.
Blank cells indicate incomplete data (U.S. Department of Agriculture, Forest Service, Kootenai National Forest, 2000; GEI Consultants, Inc., 2005).

Subwatershed		Percent Harvested Since 1970	Regeneration Harvest (Acres)*
303(d) listed	Beaver Creek	2.9	
	Bull River	5.5	4,671
	Elk Creek	2.9	
	Graves Creek	0	
	Marten Creek	12.1*	3,707
	Pilgrim Creek	7.2*	1,115
	Rock Creek	12.7*	2,484
	Swamp Creek	2.8*	571
	Vermilion River	6.7*	4,376
	White Pine Creek	15.9*	3,073
All other tributaries	East Fork Blue Creek	3.6	
	Dead Horse Creek	7.5	
	McKay Creek	1.1	
	Stevens Creek	5.1	
	Tuscor Creek	4.3	
	Deep Creek	0	
	Mosquito Creek	12	
	Squaw Creek	0.76	
	Trout Creek	0.4	

* Values reported for USFS managed lands and may not reflect total harvest activity in the watershed.

2.3.7 Natural and Anthropogenic Impacts

Several studies have been done that identify land uses and features that affect fish habitat in the Lower Clark Fork TMDL Planning Area. **Table 2-15** summarizes those land uses and features.

Table 2-15. Distribution of impacts that affect fish habitat in the Lower Clark Fork Watershed TMDL Planning Area
(U.S. Department of Agriculture, Forest Service, Kootenai National Forest, 2000; GEI Consultants, Inc., 2005).

Feature	Subwatersheds										
	Beaver Creek	**Bull River**	**Elk Creek**	**Graves Creek**	**Marten Creek**	**Pilgrim Creek**	**Rock Creek**	**Swamp Creek**	**Vermilion River**	**White Pine Creek**	**All Other Watersheds**
Dam											x
Presence of non-native fish	x	x	x	x			x	x	x	x	x
Myxobolus cerebralis	x									x	
Noxious weeds in riparian		x	x			x				x	x
Fire	x		x		x	x	x				
Bridge and road construction			x						x	x	
Upland logging	x		x	x		x					x
Riparian logging	x	x		x		x	x		x	x	x
Riparian vegetation removal						x				x	x
Haying in riparian		x				x					
Floodplain modification	x									x	x
Channel modification	x	x				x					x
Streambank modification									x	x	
Seasonally dry	x				x	x	x	x		x	x
Grazing	x	x				x				x	x
Dewatered for irrigation	x										
Development in the watershed		x	x	x	x						
Mining				x					x		x
Anthropogenic Fish Barrier				x		x	x				x
Natural Fish Barrier (i.e. waterfall)				x			x		x		x

3.0 TMDL Regulatory Framework

3.1 TMDL Development Requirements

Section 303(d) of the Federal Clean Water Act (CWA) requires states to identify waterbodies within its boundaries that do not meet water quality standards. States track these impaired or threatened waterbodies with a 303(d) List. The 303(d) List for Montana's waterbodies is within Montana's Water Quality Integrated Report. State law identifies that a methodology for determining the impairment status of each waterbody is used for consistency and the actual methodology is identified in **Appendix A** of Montana's Water Quality Integrated Report (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2009).

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

A TMDL is a pollutant budget for a waterbody identifying the maximum amount of the pollutant that a waterbody can assimilate without causing applicable water quality standards to be exceeded. TMDLs are often expressed in terms of an amount, or load, of a particular pollutant (expressed in units of mass per time such as pounds per day). TMDLs must account for loads/impacts from point and nonpoint sources in addition to natural background sources, and need to incorporate a margin of safety and consider seasonality. In Montana, TMDL development is often accomplished in the context of an overall water quality plan. The water quality plan includes not only the actual TMDL, but also includes information that can be used to effectively restore beneficial water uses that have only been affected by pollution, such as habitat degradation or flow modification that are not covered by the TMDL program.

To satisfy the Federal Clean Water Act and Montana State Law, TMDLs are developed for each waterbody-pollutant combination identified on the states list of impaired or threatened waters and are often presented within the context of a water quality restoration or protection plan. State Law (MCA 75-5-703)8)) also directs DEQ to "support a voluntary program of reasonable land, soil, and water conservation practices to achieve compliance with water quality standards for nonpoint source activities for waterbodies that are subject to a TMDL ……." This is an important directive that is reflected in the overall TMDL development and implementation strategy within this plan. It is important to note that water quality protection measures are not considered voluntary where such measures are already a requirement under existing Federal, State, or Local regulations. Montana TMDL laws provide a 5-year review process to allow for an adaptive management approach to update the TMDL and water quality restoration plan.

3.2 Waterbodies and Pollutants of Concern

Recently, a court ruling and subsequent settlements have obligated the U.S. EPA and the State of Montana to use pollutant/waterbody combinations from the Montana's 1996 List of impaired waters. State and federal guidance indicates that the most recent list be used for determining the need for TMDLs. Sediment pollutants that have appeared on the 2008 list are addressed in the impairment status review, TMDLs, or watershed restoration plans presented in this document. Most pollutants identified on the 2008 list are addressed, however the 2008 temperature listing for White Pine Creek is not addressed at this time due to project budget and time constraints. This listing will be identified in a follow up monitoring strategy and addressed within a timeframe identified in Montana's law (MCA 75-5-703). **Table 3-1** provides a summary of waterbody listings and their beneficial use support status for the 2008 303(d) Lists for the Lower Clark Fork tributaries TPA. Specific probable causes of impairment for each of the impaired waterbodies is found in **Table 1-1,** in **Section 1**.

Table 3-1. Lower Clark Fork impaired waterbody segments and beneficial use support status for which TMDLs were developed

Waterbody & Stream Description	Waterbody #	Use Class	Aquatic Life	Fisheries - Cold	Drinking Water	Primary Contact (Recreation)	Agriculture	Industry
Bull River, the North Fork to the mouth (Cabinet Gorge Reservoir)	MT76N003_040	B-1	P	P	X	F	F	F
Dry Creek, Minnesota Gulch to mouth (German Gulch)	MT76N003_180	B-1	P	P	F	F	F	F
Marten Creek, headwaters to mouth (Clark Fork River)	MT76N003_090	B-1	P	P	X	X	F	F
Swamp Creek, the headwaters to the mouth (Warm Springs Creek)	MT76N003_140	A-1	X	X	X	X	X	X
White Pine Creek, the national forest boundary to the mouth (Clark Fork River)	MT76N003_120	B-1	P	P	F	F	F	F

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

Impairment status and impairment list reviews are provided for each of the above waterbodies in **Sections 5.0**.

3.3 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 nondegradation 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 5**. Sediment is the only pollutant addressed in this Water Quality Restoration Plan. This section provides a summary of the applicable water quality standards for sediment.

3.3.1 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 (ARM 17.30.607-616), and to adopt standards to protect those uses (ARM 17.30.620-670).

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

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

All tributaries included in this document have been designated as B-1, except Swamp Creek, which is designated as A-1. A description of Montana's applicable surface water classifications and designated beneficial uses for Lower Clark Fork tributaries are presented in **Table 3-2**.

Table 3-2. Montana Surface Water Classifications and Designated Beneficial Uses Applicable to the Upper Clark Fork Tributaries.

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

3.3.2 Standards

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

<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 (Montana Department of Environmental Quality, 2008). The numeric human health standards have been developed for parameters determined to be toxic, carcinogenic, or harmful and have been established at levels to be

protective of long-term (i.e., life long) exposure by water consumption, as well as through direct contact such as swimming.

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

High quality waters are afforded an additional level of protection by the nondegradation rules (ARM 17.30.701) and in statute (MCA 75-5-303). 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 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 Lower Clark Fork TPA are summarized below.

Sediment

Sediment (i.e., coarse and fine bed sediment) and suspended sediment are addressed via the narrative criteria identified in **Table 3-3**. 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 3-3**).

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

Rule(s)	Standard
17.30.622(3)	No person may violate the following specific water quality standards for waters classified A-1.
17.30.622(3)(d)	No increase above naturally occurring turbidity or suspended sediment is allowed except as permitted in 75-5-318, MCA.
17.30.622(3)(f)	No increases are allowed above naturally occurring concentrations of sediment or suspended sediment (except as permitted in 75-5-318, MCA), settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.
17.30.623(2)	No person may violate the following specific water quality standards for waters classified B-1.
17.30.623(2)(d)	The maximum allowable increase above naturally occurring turbidity is five nephelometric turbidity units except as permitted in 75-5-318, MCA.
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.
17.30.602(19)	"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(25)	"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.

4.0 DESCRIPTION OF TMDL COMPONENTS

A TMDL is the pollutant loading capacity for a particular waterbody and refers to the maximum amount of a pollutant a stream or lake can receive and still meet water quality standards. Therefore, when a TMDL is exceeded, the waterbody will be impaired.

More specifically, a TMDL is the sum of the allowable loading from all sources to the waterbody. These loads are applied to individual sources or categories of sources as a logical method to allocate water quality protection responsibilities and overall loading limits within the contributing watershed(s). The allocated loads are referred to as waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources. Natural background loading is considered a type of nonpoint source and therefore represents a specific load allocation. In addition, the TMDL includes a Margin of Safety (MOS) that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving stream. The inclusion of a MOS results in less load allocated to one or more WLAs or LAs to help ensure attainment of water quality standards.

TMDLs are expressed by the following equation which incorporates the above components:

$$\text{TMDL} = \Sigma\text{WLA} + \Sigma\text{LA} + \text{MOS}$$

The allowable pollutant load must ensure that the waterbody being addressed by the TMDL will be able to attain and maintain water quality standards for all applicable seasonal variations in streamflow, and pollutant loading. **Figure 4-1** is a schematic diagram illustrating how numerous sources contribute to the existing load and how the TMDL is defined. The existing load can be compared to the allowable load to determine the amount of pollutant reduction needed.

The major components that go into TMDL development are target development, source quantification, establishing the total allowable load, and allocating the total allowable load to sources. Although the way a TMDL is expressed may vary by pollutant, these components are common to all TMDLs, regardless of pollutant. Each component is described in further detail below.

The following section of the document (**Sections 5**) describes the analysis of sediment in the Lower Clark Fork Tributaries TPA. **Section 5** includes a discussion on the waterbody segments of concern, how sediment is impacting beneficial uses, the information sources and assessment methods to evaluate stream health and pollutant source contributions, water quality target development along with a comparison of existing conditions to targets, quantification of loading from identified sources, the determination of the allowable loading (TMDL) for each waterbody, and the allocations of the allowable loading to sources.

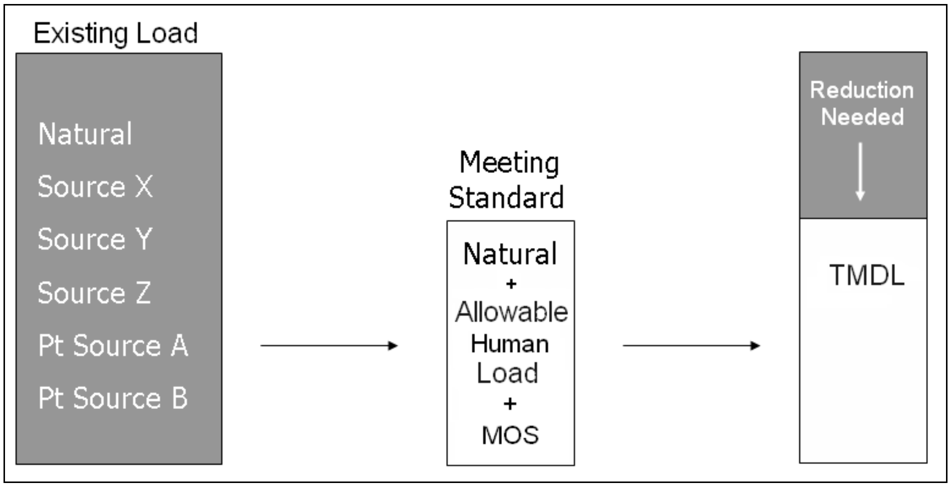

Figure 4-1. Schematic example of TMDL development

4.1 Target Development

Because loading capacity is evaluated in terms of meeting water quality standards, quantitative water quality targets are developed to help assess the condition of the waterbody relative to the applicable standard(s) and to help determine successful TMDL implementation. This document outlines water quality targets for sediment in the Lower Clark Fork Tributaries TPA. TMDL water quality targets help translate the applicable numeric or narrative water quality standards for the pollutant of concern. For pollutants with established numeric water quality standards, the numeric value(s) within the standard(s) are used as TMDL water quality targets. For pollutants with only narrative standards, such as sediment, the water quality targets provide a site-specific interpretation of the narrative standard(s), along with an improved understanding of impairment conditions. Water quality targets typically include a suite of in-stream measures that link directly to the impacted beneficial use(s) and applicable water quality standard(s). The water quality targets help define the desired stream conditions and are used to provide benchmarks to evaluate overall success of restoration activities. By comparing existing stream conditions to target values, there will be a better understanding of the extent and severity of the problem.

4.2 Quantifying Pollutant Sources

All significant pollutant sources, including natural background loading, are quantified so that the relative pollutant contributions can be determined. Source assessments often have to evaluate the seasonal nature and ultimate fate of the pollutant loading since water quality impacts can vary throughout the year. The source assessment usually helps to further define the extent of the problem by putting human caused loading into context with natural background loading.

A pollutant load is usually quantified for each point source of the pollutant permitted under the Montana Pollutant Discharge Elimination System (MPDES) program. Most other pollutant sources, typically referred to as nonpoint sources, are quantified by source categories such as unpaved roads and/or by land uses such as crop production or forestry. These source categories or land uses can be further divided by ownership such as Federal, State, or private. Alternatively, a sub-watersheds or tributaries approach can be used, whereby most or all sources in a sub-watershed or tributary are combined for quantification purposes.

The source assessments are performed at a watershed scale because all potentially significant sources of the water quality problems must be evaluated. The source quantification approaches may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading (40 CFR Section 130.2(I)). Montana TMDL development often includes a combination of approaches depending on the level of desired certainty for setting allocations and guiding implementation activities.

4.3 Establishing the Total Allowable Load

Identifying the TMDL requires a determination of the total allowable load over the appropriate and sensible time period necessary to comply with the applicable water quality standard(s). Although the concept of allowable daily load is incorporated into the TMDL term, a daily loading period may not be consistent with the applicable water quality standard(s) or may not be practical from a water quality management perspective. Therefore, the TMDL will ultimately be defined as the total allowable loading using a time period consistent with the application of the water quality standard(s) and consistent with established approaches to properly characterize, quantify, and manage pollutant sources in the watershed. For example, sediment TMDLs may be expressed as an allowable yearly load whereas the TMDL to address acute toxicity criteria for metals will include a near-instantaneous loading requirement calculated over a time period of one second (based on standard methods for evaluation flow in cubic feet per second).

Where numeric water quality standards exist for a stream, the TMDL or allowable loading, typically represents the allowable concentration multiplied by the flow of water over the time period of interest. This same approach can be applied for situations where a numeric target is developed to interpret a narrative standard and the numeric value is based on an in-stream concentration of the pollutant of concern.

For some narrative standards such as those relating to sediment, there is often a suite of targets based on stream substrate conditions and other similar indicators. In many of these situations, it is difficult to link the desired target values to highly variable and often episodic in-stream loading conditions. In these situations, the TMDL is often expressed as a percent reduction in total loading based on source quantification results and an evaluation of load reduction potential (**Figure 4-1**). The degree by which existing conditions exceed desired target values can also be used to justify a percent reduction value for a TMDL.

Even if the TMDL is preferably expressed using a time period other than daily, an allowable daily loading rate will also be calculated to meet specific requirements of the Clean Water Act. Where this occurs, TMDL implementation and the development of allocations will still be based on the preferred time period as discussed above.

4.4 Determining Allocations

Once the loading capacity (i.e. TMDL) is determined, that total must be partitioned, or allocated, among the contributing sources. In addition to basic technical and environmental considerations, this step introduces economic, social, and political considerations. The allocations are often determined by quantifying feasible and achievable load reductions associated with the application of reasonable land, soil, and water conservation practices. Reasonable land, soil, and water conservation practices generally include Best Management Practices (BMPs), but additional conservation practices may be required to achieve compliance with water quality standards and restore beneficial uses. It is important to note that implementation of the TMDL does not conflict with water rights or private property rights. **Figure 4-2** contains a schematic diagram of how TMDLs are allocated to different sources using WLAs for point sources and LAs for natural and nonpoint sources. Although some flexibility in allocations is possible, the sum of all allocations must meet the water quality standards in all segments of the waterbody.

Under the current regulatory framework for development of TMDLs, flexibility is allowed in the expression of allocations in that *"TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure."* Allocations are typically expressed as a number, a percent reduction from the current load), or as a surrogate measure, such as a percent increase in canopy density for temperature TMDLs.

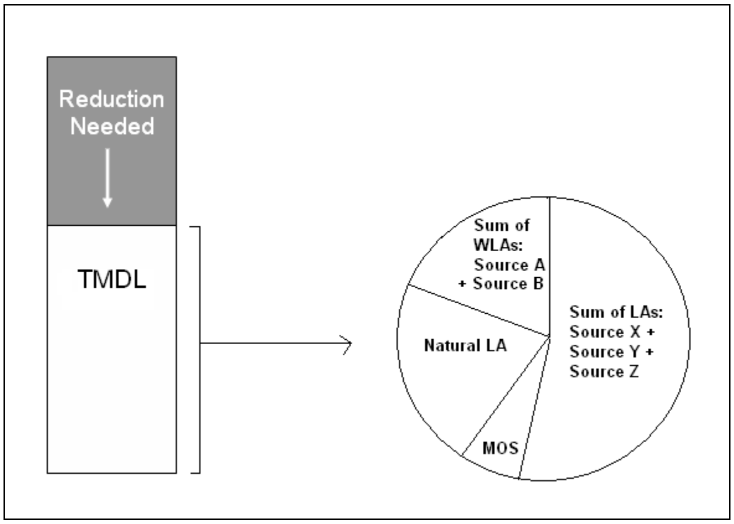

Figure 4-2. Schematic diagram of TMDL and allocations

Incorporating a margin of safety (MOS) is a required component of TMDL development. The MOS accounts for the uncertainty between pollutant loading and water quality and is intended to ensure that load reductions and allocations are sufficient to sustain conditions that will support beneficial uses. 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 (U.S.Environmental Protection Agency, 1999).

5.0 Sediment TMDL Components

This portion of the document focuses on sediment as an identified cause of water quality impairment in the Lower Clark Fork TPA. It describes: 1) the mechanisms by which sediment impair beneficial uses of those streams, 2) the specific stream segments of concern, 3) the presently available data pertaining to sediment impairments in the watershed, 4) the various contributing sources of sediment based on recent data and studies, and 5) the sediment TMDLs and allocations.

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

5.1 Mechanisms of Effects of Excess Sediment to Beneficial Uses

Sediment is a naturally occurring component of healthy and stable stream and lake ecosystems. Streams in particular are dynamic systems that are dependent on a balance between stream flow and sediment input for their natural function. However, human influence may alter or prohibit the ability of a stream to achieve equilibrium between flow and sediment, which in turn may lead to detrimental effects to the proper form and function of the stream, and may change habitat and water quality conditions.

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

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

Excess sediment may also impair biological processes of individual aquatic organisms. When present in high levels, sediment may clog the gills of fish and cause other abrasive damage. Abrasion of gill tissues triggers excess mucous secretion, decreased resistance to disease, and a reduction or complete cessation of feeding (Wilber, 1983); (McCabe and Sandretto, 1985); (Newcombe and MacDonald, 1991). High levels of benthic fine sediment can also impair reproductive success of fish. Fine sediment deposition reduces availability of suitable spawning habitat for salmonid fishes and can smother eggs or hatchlings. An accumulation of benthic fine sediment reduces the flow of water through gravels harboring salmonid eggs, hindering emergence of newly hatched fish, depleting oxygen supply to embryos, and causing metabolic wastes to accumulate around embryos, resulting in higher mortality rates (Armour et al., 1991).

As described in **Section 3**, sediment as a pollutant is addressed via narrative criteria that do not allow for harmful or other undesirable conditions related to increases in sediment above naturally occurring levels. 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.

5.2 Stream Segments of Concern

The **Table 5-1** presents streams and stream segments that have been listed for sediment impairment on the 2008 303(d) List.

Table 5-1. Waterbody segments in the Lower Clark Fork TPA with sediment related pollutant and pollution listings on the 2008 303(d) List

Waterbody ID	Stream Segment	2008 Probable Causes of Impairment
MT76N003_040	**BULL RIVER**, the North Fork to the mouth (Cabinet Gorge Reservoir)	**Sedimentation/siltation,** *Physical Substrate Habitat Alterations*
MT76N003_180	**DRY CREEK,** headwaters to the mouth (Bull River) T28N, R33W	**Sedimentation/siltation**
MT76N003_090	**MARTEN CREEK**, headwaters to the mouth (Noxon Reservoir)	**Sedimentation/siltation**, *Physical Substrate Habitat Alterations*
MT76N003_120	**WHITE PINE CREEK**, headwaters to the mouth (Beaver Creek)	**Sedimentation/siltation***, Alteration in stream-side or littoral vegetation covers*

Pollution listings are presented in *italics*

At the time of the 2008 field investigation, two additional Lower Clark Fork TPA streams were included for data collection and analysis as a result of their appearance on earlier 303(d) Impaired Waters Lists or due to pollution listings that are frequently associated with sediment. This inclusion of additional sites within the Lower Clark Fork TPA helped provide the foundation for target development, and give a broader representation of sediment issues throughout the watershed. In the case of Swamp Creek, which at the time of the field effort had not undergone an impairment determination, the data collected helped further characterize the condition in that stream which led to its inclusion in TMDL development. In the case of Elk Creek, a TMDL had been completed in 1997 and significant work has been completed since that time to improve its conditions and address TMDL requirements. In addition to supporting overall target development in the TPA, the inclusion of Elk Creek in the 2008 field effort provides data to local resource managers to evaluate the stream condition since the time of the TMDL. Streams not listed for sediment, but included in this report are listed in **Table 5-2**.

Table 5-2. Additional waterbody segments in the Lower Clark Fork TPA included for TMDL related investigation

Waterbody ID	Stream Segment	Previous Probable Causes of Impairment Listings
MT76N003_140	**SWAMP CREEK,** Cabinet Mountains Wilderness boundary to the mouth (Noxon Reservoir)	*Insufficient information to assess*
MT76N003_060	**ELK CREEK**, headwaters to the mouth (Cabinet Gorge Reservoir)	**Sedimentation/Siltation**

5.3 Information Sources and Assessment Methods

Existing data specifically related to sediment conditions for listed tributaries is mixed in the Lower Clark Fork. Where data may exist, varying methods in data collection between agencies and across the watershed, as well as qualitative assessment rather than quantitative data, make sediment impacts difficult to define and compare throughout the planning area. The main information source used to assess sediment and habitat conditions for the Lower Clark Fork tributaries of interest are from the DEQ 2008 field effort (subsequent report included as **Appendix B**), and where available and applicable, data from land management agencies such as the US Forest Service, US Natural Resource & Conservation Service, Green Mountain Conservation District, and various reports related to the Lower Clark Fork and its tributaries, along with field notes, “windshield surveys” from DEQ personnel, and information contained within DEQ Sufficient Credible Data/Beneficial Use Determination (SCD/BUD) files were used to supplement the 2008 DEQ field data.

5.3.1 DEQ Longitudinal Field Method for Sediment and Habitat Impairment

In the summer of 2008, 22 sites on six streams throughout the Lower Clark Fork TPA were selected for sediment and habitat data collection. (**Appendix C**). Initially, all streams of interest underwent an aerial assessment procedure by which reaches were characterized by four main attributes: stream order, valley gradient, valley confinement, and ecoregion. These four categories represent the main factors that are not influenced by the presence of human activity, and thereby allow for comparisons among those reaches of the same characteristics. However land management practices as a result of the presence of man may have an impact on the way a stream responds, and because of this, reaches were stratified further based on anthropogenic influence, to allow for the observance of natural versus anthropogenic effects. Reaches were then chosen for assessment to allow for a representation of various reach characteristics and anthropogenic influence.

Sediment and habitat related information that was collected includes: width/depth ratio, entrenchment ratio, riffle cross section, riffle pebble count, riffle grid toss, grid toss in pool tails, pool frequency, residual pool depth, riparian green line, and eroding bank analysis. Detailed methodology and procedure for reach classification and field methods can be found in Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments (DEQ, 2010) and data from the field effort is presented in **Appendix B**.

5.3.2 United States Forest Service – Pacfish/Infish Biological Opinion Effectiveness Monitoring Program (PIBO)

PIBO was initiated in 1998 to provide a consistent framework for monitoring aquatic and riparian resources on most Forest Service and Bureau of Land Management land within the upper Columbia River basin. The goal of PIBO is to implement a monitoring program with the capability of determining whether the aquatic conservation strategies within PACFISH and INFISH (USFS Fisheries management units), or revised land management plans, are effective in maintaining or restoring the structure and function of riparian and aquatic systems. As such, each PIBO site has a suite of data collected to characterize stream morphology, substrate composition, pool and habitat quality, riparian condition and more.

PIBO data comparable to DEQ targets and relatable to DEQ data and methods includes width/depth ratios, percent fines less than 6mm, percent fines less than 2mm, residual pool depths, pool frequency, and large woody debris counts.

Where it occurred, PIBO data from the streams of interest was used for comparison to DEQ targets. In addition, PIBO data from 46 sites within the Cabinet ranger district in the Kootenai National Forest, and the Plains-Thompson Falls ranger district in the Lolo National Forest was analyzed for target value development.

5.4 WATER QUALITY TARGETS

5.4.1 Targets

In order to ascertain the relative impact of sediment on a stream and its beneficial uses, comparison of stream conditions to a suite of numeric water quality targets is used. One single water quality target is often not sufficient for determining the condition of a stream, however, when viewed in combination measures of instream siltation; morphological characteristics that contribute to loading, storage, and transport of sediment or that demonstrate those effects; and biological response to increased sediment provide a good representation of current condition as it relates to sediment. The linkages between sediment, habitat, and fish and aquatic life is well documented in scientific studies, examples of which are (Cover et al., 2008; Bryce et al., 2010)

In developing these targets, consideration must be made to account for natural variation throughout the river continuum. Specifically, some reaches will have a natural tendency for storage of sediment and others will be more efficient at sediment transport. Therefore, targets follow stratifications employed in the data analysis, such that they can be applied appropriately.

The water quality targets presented in this section (see **Tables 5-3, 5-4**) are based on the best available science and information available at the time this document was written. However, targets will be addressed during future TMDL reviews for their applicability and may be modified under situations such as a better understanding of reference conditions or procedure improvements including new or modified field methods. In some situations, new targets may be added in the future to better characterize sediment conditions.

Furthermore, the exceedence of one target value does not necessarily equate to a determination of impairment. The degree to which one or more targets are exceeded is taken into account, and the combination of target analysis, qualitative observations, and sound, scientific professional judgment is crucial when assessing stream condition. A brief description and justification of the target parameters used in the analysis is included in the sections that follow, and rationale and development of target values is included in **Appendix D**.

Table 5-3. Lower Clark Fork Tributaries TPA Sediment and Habitat Targets; Does NOT include Bull River

Sediment and Habitat Water Quality Target	**High Gradient Reaches***		**Low Gradient Reaches***
Morphology			
Width/Depth Ratio	≤20		≤25
Entrenchment	Rosgen literature values		
Substrate Composition			
Pebble Count, % <2mm	≤5		≤5
Pebble Count, % <6mm	≤5		≤10
Pool Habitat			
Pool Frequency (per 1000 feet of stream)	>9		>9
Residual Pool Depth	**Bankfull Width 20-29 feet**	**Bankfull Width 30-39 feet**	**Bankfull Width 40-49 feet**
	≥1.2	≥1.6	≥1.7

* In general, high gradient reaches for these purposes refer to the equivalent of Rosgen A and B stream categories. Low gradient reaches refer to the equivalent of Rosgen C stream types. These types classify the majority of conditions that would be encountered in the Lower Clark Fork. For stream types outside of this range (such as Rosgen E), analysis may need to be conducted on a site by site basis using literature values and counsel with local resource management professionals.

Table 5-4. Lower Clark Fork Tributaries TPA Sediment and Habitat Targets; Bull River*

Sediment and Habitat Water Quality Target			
Morphology			
Width/Depth Ratio	Within expected values for appropriate Rosgen stream type; (Width/Depth guidelines: C types <30, B types <25, E < 12)		
Entrenchment			
Substrate Composition			
Pebble Count, % <2mm	≤20		
Pebble Count, % <6mm	≤20		
Pool Habitat			
Pool Frequency (per mile)	>20		
Residual Pool Depth	**Bankfull Width 30-39 feet**	**Bankfull Width 40-49 feet**	**Bankfull Width >50 feet**
	≥1.6	≥1.7	≥1.9

*It was deemed that the size and character of the Bull River, in comparison to the other tributaries in the planning area, warrants targets specific to the Bull River to be developed independent of the other tributary targets. Details are included in **Appendix D**.

5.4.1.1 Morphology

Parameters related to stream morphology describe channel shape and dimension, and thereby indicate the ability of the stream to store and transport sediment. Stream gradient and valley confinement are two significant controlling factors that determine stream form and function, however alterations to the landscape, and sediment input beyond naturally occurring amounts can affect stream morphology. Numerous scientific studies have found trends and common relationships between channel dimensions in properly functioning stream systems. Two of those relationships are used as targets in the Lower Clark Fork TPA and are described below.

Width Depth Ratio

Width/depth ratio is defined as the channel width at bankfull height divided by the mean bankfull depth (Rosgen, 1996). Bankfull is a concept used by hydrologists to define a regularly occurring channel-forming high flow. One of the first generally accepted definitions of bankfull was provided by Dunne and Leopold in 1978:

> ***"The bankfull stage corresponds to the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels."***

Width/depth ratio is one of several standard measurements used to classify stream channels (Rosgen, 1996), making it a useful variable for comparing conditions on reaches within the same stream type. Comparison of observed and expected width/depth ratio is a useful indicator of channel overwidening and aggradation, which are often linked to excess streambank erosion or acute or chronic erosion from sources upstream of the study reach. Higher width/depth ratios than those expected indicate streams that may not be properly functioning or have higher sediment loads. Channels that are overwidened often are associated with excess sediment deposition and streambank erosion, contain shallower, warmer water, and provide fewer deepwater habitat refugia for fish.

Entrenchment Ratio

Stream entrenchment ratio is equal to the floodprone width divided by the bankfull width (Rosgen 1996). Entrenchment ratio is used to help determine if a stream shows departure from its natural stream type. It is an indicator of stream incisement, and therefore indicates how easily a stream can access its floodplain. Streams are often incised due to detrimental land management or may be naturally incised due to landscape characteristics. A stream that is overly entrenched (entrenchment ratio <1.4) generally is more prone to streambank erosion due to greater energy exerted on the banks during high flow periods. Greater scouring energy in incised channels results in higher sediment loads derived from eroding banks. If the stream is not actively degrading (downcutting), the sources of human caused incisement are historic in nature and may not currently be present, although sediment loading may continue to occur. Entrenchment ratio is an important measure of channel condition as it relates to sediment loading and habitat condition, due to the long-lasting impacts of incisement and large potential for sediment loading in incised channels.

5.4.1.2 Substrate Composition

Percent surface fines provide a good measure of the siltation occurring in a river system and serve as an indicator of stream bottom aquatic habitat and its ability to support aquatic life. Although it is difficult to correlate percent surface fines with loading in mass per time directly, the Clean Water Act allows "other applicable measures" for the development of TMDL water quality restoration plans. Percent surface fines and their effect on biological communities has been quantitatively shown in a number of studies (Suttle et al., 2004; Irving and Bjornn, 1984; Kondolf, 2000) and applied successfully in other TMDLs in western Montana addressing sediment related to stream bottom deposits, siltation, and aquatic life uses.

Percent Fines <2mm

Surface fine sediment measured in the Wolman pebble count is one indicator of aquatic habitat condition and can indicate excessive sediment loading. Studies have shown that increased substrate fine materials less than 2mm can adversely affect embryo development success by limiting the amount of oxygen needed for development (Meehan, 1991). As well, the TMDL for the Flathead Headwaters TMDL (Environmental Research Laboratory-Duluth et al., 2004) describes work completed in the Boise

National Forest in Idaho, which showed a strong correlation between the health of macroinvertebrate communities and percent surface fines defined as all particles less than two millimeters.

Percent Fines <6mm

As with surface fine sediment smaller than 2mm diameter, an accumulation of surface fine sediment less than 6mm diameter may indicate excess sedimentation. The size distribution of substrate material in the streambed is also indicative of habitat quality for salmonid spawning and incubation. Excess surface fine substrate smaller than 6.35 mm may have detrimental impacts on aquatic habitat. Weaver and Fraley observed a significant inverse relationship between the percentage of material less than 6.35 mm and the emergence success of west slope cutthroat trout and bull trout (Weaver and Fraley, 1991).

5.4.1.3 Pool Features

Pools are morphological features that are characterized by slow moving, deep sections of the stream. These important components aid in the balance between flow and sediment load by reducing stream velocity and storing water and sediment. Pool features also play an important role for the aquatic life and fisheries by providing refuge from warm water, high velocity, and terrestrial predators. However, when sediment loads are excessive, pool habitat quality and frequency is often diminished as pools fill with sediment. As this happens, velocities increase, stream channels widen, and sediment is transported to other areas of the stream where it is sometimes deposited in areas that have an additional impact on fisheries and aquatic life. The measure and comparison of pool features can have direct links to sediment load increases and its affect on stream form and function, as well as biological integrity.(Kershner et al., 2004; Riggers et al., 1998)

Residual Pool Depth

Residual pool depth, defined as the difference between pool maximum depth and crest depth, (end of the pool depth), is a discharge-independent measure of pool depth and an indicator of the quality of pool habitat. Essentially it represents the depth of water that would remain in a pool if water ceased to flow through the channel, and only where pools occur remained filled. Deep pools are important resting and hiding habitat for fish, and provide refuge during temperature extremes and high flow periods. Pool residual depth is also 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.

Pool Frequency

Pool frequency is a measure of the availability of pool habitat to provide rearing habitat, cover, and refuge for fish. Pool frequency is related to channel complexity, availability of stable obstacles, and sediment supply. Excessive erosion and sediment deposition can reduce pool frequency by filling in smaller pools. Pool frequency can also be affected adversely by riparian habitat degradation resulting in a reduced supply of large woody debris or scouring from stable root masses in streambanks.

5.4.2 Supporting Information/Supplemental Water Quality Parameters

Although the following categories are not a direct measure of sediment, they do provide insight into the condition of the stream and streambanks, and of the overall riparian quality which is often associated with factors that may be leading to increased sediment loads and the reduction of habitat. (Castelle and Johnson, 2000; Ellis, 2008)

During the 2008 DEQ sediment and habitat data collection, a riparian assessment method (ie, Greenline) (DEQ, 2010) was used to conduct a coarse survey of the riparian corridor and its general vegetation composition. The results of which can be used to infer riparian corridor health and bank stability.

Understory Shrub Cover along Green Line

Riparian shrub cover is one of the most important influences on streambank stability. Removal of riparian shrub cover can dramatically increase streambank erosion and increase channel width/depth ratios. Shrubs stabilize streambanks by holding soil and armoring lower banks with their roots, and reduce scouring energy of water by slowing flows with their branches.

Good riparian shrub cover is also important for fish habitat. Riparian shrubs provide shade, reducing solar inputs and increases in water temperature. The dense network of fibrous roots of riparian shrubs allows streambanks to remain intact while water scours the lowest portion of streambanks, creating important fish habitat in the form of overhanging banks and lateral scour pools. Overhanging branches of riparian shrubs provide important cover for aquatic species. In addition, riparian shrubs provide critical inputs of food for fish and their feed species. Terrestrial insects falling from riparian shrubs provide one main food source for fish. Organic inputs from shrubs, such as leaves and small twigs, provide food for aquatic macroinvertebrates, which are an important food source for fish.

Based on a general review of riparian shrub cover results from Greenline studies conducted during the 2008 DEQ field efforts, a goal of 90% or greater shrub cover for high gradient reaches, and 60% or better shrub cover for low gradient reaches should be considered under most conditions for streams in the Lower Clark Fork watershed.

Bare ground along Green Line

Percent bare ground is an important indicator of erosion potential, as well as an indicator of land management influences on riparian habitat. Bare ground was noted in the greenline inventory in cases where recent ground disturbance was observed, leaving bare soil exposed. Bare ground is often caused by trampling from livestock or wildlife, fallen trees, recent bank failure, new sediment deposits from overland or overbank flow, or severe disturbance in the riparian area, such as from past mining, road-building, or fire. Ground cover on streambanks is important to prevent sediment recruitment to stream channels. Sediment can wash in from unprotected areas due to snowmelt, storm runoff, or flooding. Bare areas are also much more susceptible to erosion from hoof shear. Most stream reaches have a small amount of naturally-occurring bare ground. As conditions are highly variable, this measurement is most useful when compared to reference values from best available conditions within the study area or literature values.

Based on a general review of riparian shrub cover results from Greenline studies conducted during the 2008 DEQ field efforts, a goal of 0% bare ground should be considered under most conditions for streams in the Lower Clark Fork watershed.

Large Woody Debris

Large woody debris in the form of branches, trunks, rootwad, and other manner of downed wood within the active stream channel is a vital component of most western Montana stream ecosystems. Large wood in the channel provides multiple benefits for fish and other aquatic life by creating cover and habitat, encouraging scour resulting in pool development and sediment transport, and being a component in the overall foodweb for the various lifeforms in and around the stream. In addition, large woody debris may also be an indicator of riparian community health and maturity, which also has impacts on the overall form and function of a stream ecosystem (Hauer et al., 1999).

Although large woody debris does not, by itself, suggest impairment from sediment, because of the common linkages that large woody debris has on stream health, it is commonly reviewed in combination with other sediment parameters to provide a better picture of the overall issues affecting a stream. Large woody debris discussion within the context of this document is used for that purpose and is not suggested as a target value per say; but simply to provide a stronger weight of evidence when discussing the condition of streams in the Lower Clark Fork. A value of 40 large wood pieces per 1000' is suggested as an appropriate indicator of a health system for Lower Clark Fork tributary systems.

5.4.3 Comparison of Listed Waters to Targets (by stream segment)

5.4.3.1 Bull River, the North Fork to the mouth (Cabinet Gorge Reservoir); MT76N003_040

Review of the DEQ assessment files for Bull River indicates moderate impairment to the Bull River, with fisheries being limited by low habitat complexity, limited spawning areas, and low large woody debris, partially as a result of land management activities along the river. Macroinvertebrate communities indicate 'fair' conditions. High fines were also identified in some parts of the lower river.

Although reaches from the Bull River were included in the 2008 DEQ sampling effort, it was found that in general, the character of the sites sampled on the Bull River, were considerably different from the sites in the rest of the data set, and therefore the data included from the Bull River sites was not included when developing targets for the Lower Clark Fork tributaries. Instead, TMDL targets from other, nearby, larger stream systems such as the St. Regis River and Prospect Creek were reviewed, and targets specific to the Bull River were developed to assess its condition; these targets are described further in **Table 5-4** and **Section D.3** of **Appendix D**.

General stream morphology parameters (see **Table 5-5**) such as width/depth and entrenchment for all three DEQ sites appear to be within the range of what might be expected for this system. Substrate composition in reach 3-2 is very much within the range of the overall Lower Clark Fork tributary targets; however reach 3-3 has very high percent fines, and reach 5-1 also displays elevated fines **(Table 5-6**). Although designated as Rosgen C stream types in BULL 3-3 and BULL 5-1, these reaches may be borderline E reaches, which typically have higher percent fines, and therefore comparison to the C reach based targets may be misleading, (although percent fine values in 3-3 are considerably high, even for an E type system). Pool frequency for all reaches (**Table 5-6**) is somewhat low however the residual pool depths are very well defined in all three reaches. Large woody debris appear to be acceptable throughout the sampled reaches in the Bull River.

The PIBO site occurs on the East Fork Bull River (see **Table 5-7**), which is more akin to the other tributaries in the Lower Clark Fork in terms of size and Rosgen stream type, and therefore is compatible with the designated targets described in **Section 5.4.1**. Percent fines <6mm are slightly elevated and pool frequency is not meeting the target at this site.

Table 5-5. Bull River – DEQ 2008 Morphology Data

Reach	Ecoregion	Reach Type	Bankfull Width	Rosgen Stream Type	Width/Depth Ratio	Entrenchment
BULL 3-2	15q	3-U-0	61.5	C4/E4	28	4.20
BULL 3-3	15q	3-U-0	61.3	C5/E5	19.3	5.90
BULL 5-1	15q	3-U-0	62.7	E5	**14.1**	7.10

Values in **BOLD** indicate an exceedence of the target value.

Table 5-6. Bull River – DEQ 2008 Habitat Data

Reach	Wolman Pebble Count		Grid Toss	Residual Pool Depth	Pools #/1000'	Large Wood #/1000'
	Percent Fines <2mm	Percent Fines <6mm	Percent Fines <6mm			
BULL 3-2	1	6	4.0	2.8	8.0	**19.0**
BULL 3-3	**30**	**55**	**61.0**	3.5	**4.0**	**11.0**
BULL 5-1	14	**24**	12.0	3.5	**3.0**	22.0

Values in **BOLD** indicate an exceedence of the target value.

Table 5-7. Bull River - PIBO Data

Stream	Reach ID	Gradient	W/D	%<2mm	%<6mm	Pool D	Pool Frq	LWD
East F. Bull	2152	5.0	16.8	4	**13**	1.7	**2**	139

Values in **BOLD** indicate an exceedence of the target value.

Field notes from the 2008 field assessment describe the conditions of the DEQ Bull River reaches further:

BULL 3-2 – There was moderate bank erosion occurring within the reach. Streambanks on outside meanders with poor vegetation and rooting conditions typically experienced the greatest erosion. Streambanks are comprised of sandy, gravelly unconsolidated materials lending to its erosive nature. The understory is dominated by reed canary grass, alder, and some willow and grass/forbs. Overstory consists of patchy conifers with spruce and cedars along the channel margins. The entire riparian zone is still recovering from 1990s stand replacement wildfire. Riparian zone likely logged prior to 1990 wildfire as evidenced by cedar and spruce stumps. This reach was historically used for log drives when western red cedars were logged. No current active human impacts to the reach, although there are private residences upstream and downstream of survey reach. Throughout the reach, mid-channel and transverse bars present alluding to high sediment (coarse) supply from North Fork and South Fork Bull River. This is a transitional reach between the upper watershed transport reaches (typically B), and downstream depositional E stream type reaches. Abundant sediment deposits occur downstream of the surveyed reach where the gradient is lower, and sinuosity and bed material fines are higher.

BULL 3-3 – Streambanks were mostly stable. The silt-clay bank material is cohesive and seemingly more resistant to scour although some sloughing of upper bank occurs. Reed canary grass dominates the riparian zone with drier grasses intermixed, and willow and red osier dogwood forming narrow bands adjacent to streambanks with some debris inputs. Human impacts in this reach related to the historic clearing and conversion of riparian vegetation (woody shrub community conversion to reed canary grass). Stream channel with plane bed, dune-ripple bedforms indicating increased sediment deposition. Channel bed sediment is mostly sand/silt with some small gravel content.

BULL 5-1 – Streambanks are primarily composed of sands and other fine materials, overlain by extensive vegetative cover of reed canary grass, and sparse shrubs and scattered cedar roots, but root mats are moderately undercut and slumping on several banks, with the underlying materials eroded. The riparian zone may have been historically affected by agricultural operations (conversion of valley land), but does not appear to have any current and active anthropogenic influences throughout this reach. Slow-moving water, low gradient riffles and few, long pools characterize the habitat in this reach.

As a result of the high fines in BULL 3-3 and BULL 5-1, reduced pool frequency and historic human impacts witnessed in the Bull River reaches, a TMDL will be developed.

5.4.3.2 Dry Creek, headwaters to the mouth (Bull River) T28N, R33W; MT76N003_180

Review of the DEQ assessment files for Dry Creek indicates a lack of macroinvertebrates and significant sources of sediment present including roads and sensitive land types. 100% pure resident westslope cutthroat are present, however the stream also displays intermittency which may limit connectivity to the Bull River. Sediment produced from landslides and road fill have provided a significant sources of mostly course gravel to cobble size material. Logging in the riparian areas coupled with the fire of 1910 have exacerbated channel instability in the transitional areas causing significant braiding and bank erosion potential. Comparison of recent photos with pre-management photos shows dramatic increases in the number of slope failures throughout the watershed, although most roads are now closed and USFS initiated a basin-wide road reclamation project in 2001. Based on the available data, the severe impairment indicated by the macroinvertebrates and identification of sources of sediment (non-natural) has lead to the impairment listing.

Only one reach was assessed in the Dry Creek watershed and of the parameters reviewed only pool frequency was below the target value, and only slightly (**Tables 5-8 and 5-9**). Two sites were assessed through the USFS PIBO data (**Table 5-10**) however both of those sites had an incomplete suite of data with information pertaining only to large wood and width/depth. For the PIBO data, only one of the two sites had w/d data, and that site was well above the w/d target for B streams. Large wood was meeting the target at one site, and slightly below the target at the other.

Table 5-8. Dry Creek – DEQ 2008 Morphology Data

Reach	Ecoregion	Reach Type	Bankfull Width	Rosgen Stream Type	Width/Depth Ratio	Entrenchment
DRY 9-2	15q	2-U-0	36	B3	12.4	6.10

Values in **BOLD** indicate an exceedence of the target value.

Table 5-9. Dry Creek – DEQ 2008 Habitat Data

Reach	Wolman Pebble Count		Grid Toss	Residual Pool Depth	Pools #/1000’	Large Wood #/1000’
	Percent Fines <2mm	Percent Fines <6mm	Percent Fines <6mm			
DRY 9-2	1	2	3.0	1.7	**8.0**	116.0

Values in **BOLD** indicate an exceedence of the target value.

Table 5-10. Dry Creek – PIBO Data

Stream	Reach ID	Gradient	W/D	%<2mm	%<6mm	Pool D	Pool Frq	LWD
Dry	4802	3.8	**-**	-	-	-	-	**35**
Dry	142	3.8	**41.9**	-	-	-	-	53

Values in **BOLD** indicate an exceedence of the target value.

Field notes from the 2008 field assessment describe the conditions of the DEQ Dry Creek reaches further:

<u>DRY 9-2</u> – Streambank material is dominated by course cobbles and boulders in this reach, covered with a mat of forest roots and associated understory shrubs. However, high bank height ratios, shallow rooting depths, and high near bank stress values lead to high erodibility. Although the reach was dry when assessed, this reach and channel corridor are subject to major debris torrents in addition to active channel headcuts and avulsions; fresh coarse sediment lag deposits with material up to 4' in diameter were observed. Channel headcuts and avulsions are common. No current anthropogenic activities appear to be actively influencing the channel however there is evidence of historic logging practices such as an abandoned road along the north side of the valley that was relocated mid-slope due to chronic road failures. Erosion and sediment production is also influenced by the alluvial fan that forms the bed geomorphic surface. Conifer species dominate the riparian area, and extensive large woody debris jams are prevalent, resulting in gradient increases and knickpoints, which lead to frequent channel shifts and destabilized banks.

Although meeting most targets at the assessment site, the unstable banks as a result of historic anthropogenic activities and actively eroding nature of this reach undoubtedly is contributing significant sediment loads in low gradient reaches and to the receiving Bull River. As such, a TMDL will be developed for Dry Creek.

5.4.3.3 Marten Creek, headwaters to the mouth (Noxon Reservoir); MT76N003_090

Review of DEQ assessment files for Marten Creek described slight to moderate impairment with high levels of percent fines in spawning gravels; values of 29% and 41%; and Riffle Stability Index values indicating an unstable streambed. The assessment file also referenced a 1998 USFWS document – *ESA Determination for Bull Trout*, that states >17% fines in spawning gravels is considered to be 'Functioning at Unacceptable Risk for bull trout'.

Multiple sites were assessed in the Marten Creek watershed as part of the 2008 DEQ field study (**Tables 5-11 and 5-12**). In the two branches that eventually join to make Marten Creek (South Branch and North Branch); the North Branch site NBMC 8-1 was not meeting the target for residual pool depth and large wood. The South Branch site SBMC 3-1 was slightly above the target for width/depth, but met all other targets. Both sites on the mainstem of Marten Creek saw values for pool quality and quantity, and large wood slightly outside of the target, and site MC 9-1 also was well outside of the expected target value for width/depth ratio.

In addition, two PIBO sites in the Marten Creek watershed were also reviewed (see **Table 5-13**). Similar to Dry Creek, both sites had incomplete data sets and only a few parameters were able to be compared to targets. One site occurred on the South Fork of Marten Creek; only width/depth and large wood were measured; width/depth somewhat exceeded the target, and large wood was well below the target value. The second site occurred on the mainstem of Marten Creek; and again only width/depth and large wood were reviewable. Width/depth values at the mainstem PIBO site were just slightly above the target, and large wood numbers were well below.

Table 5-11. Marten Creek – DEQ 2008 Morphology Data

Reach	Ecoregion	Reach Type	Bankfull Width	Rosgen Stream Type	Width/Depth Ratio	Entrenchment
NBMC 8-1	15o	2-U-4	21.4	B3	12.5	1.70
SBMC 3-1	15o	2-C-4	31.4	B4	**26.6**	1.70
MC 6-2	15o	3-U-2	30.7	C3	16.2	5.00
MC 9-1	15k	3-U-0	48.9	C3	**41**	7.40

Values in **BOLD** indicate an exceedence of the target value.

Table 5-12. Marten Creek – DEQ 2008 Habitat Data

Reach	Wolman Pebble Count		Grid Toss	Residual Pool Depth	Pools #/1000’	Large Wood #/1000’
	Percent Fines <2mm	Percent Fines <6mm	Percent Fines <6mm			
NBMC 8-1	1	4	2.0	**1**	16.0	**30.0**
SBMC 3-1	3	5	5.0	1.3	28.0	149.0
MC 6-2	6	8	5.0	**1.5**	**6.0**	**26.0**
MC 9-1	7	8	4.0	**1.4**	**8.0**	**20.0**

Values in **BOLD** indicate an exceedence of the target value.

Table 5-13. Marten Creek – PIBO Data

Stream	Reach ID	Gradient	W/D	%<2mm	%<6mm	Pool D	Pool Frq	LWD
South F. Marten	1801	1.4	**31.5**	-	-	-	-	**12**
Marten	1805	1.6	**26.7**	-	-	-	-	**29**

Values in **BOLD** indicate an exceedence of the target value.

Field notes from the 2008 field assessment describe the conditions of the DEQ Marten Creek reaches further:

<u>NBMC 8-1</u> – Streambanks are generally stable with some discrete eroding banks located along meander outcurves and constrictions. Bank substrate contains a large cobble-boulder matrix which provides some natural bank protection. Overall, there is low supply from eroding streambanks, and high vegetative cover prevents erosion of the thin forest topsoil and provides moderate potential for large wood recruitment, although there is evidence of past logging activities within the channel migration zone. The stream interacts with USFS road hillslope in part of the reach, but the fillslope appears stable with grasses/shrubs and there is low sediment delivery potential. The channel is characterized as having a plane bed, riffle/step (forced) pool morphology. There is limited pool development and depths due to armored bed and lack of coarse large wood.

<u>SBMC 3-1</u> – Dense vegetation, a rocky hillslope and coarse bank materials result in minimal to moderate bank erosion. Numerous large woody debris jams and boulder deposits dissipate energy and prevent scouring, as well as influencing channel morphology and habitat. There does not appear to be any recent impacts in the reach other than a fire. The riparian zone is intact with no signs of logging. Series of log steps store sediment and provide upstream deposition and downstream scour. There is a multi-story riparian zone with a mature conifer canopy dominated by hemlock.

MC 6-2 – In the lower reach, there is a bedrock outcrop on the southern bank and forms much of the southern channel margin. There is minor bank erosion on the north bank and bank erosion occurs on most streambanks lacking bedrock. Eroding banks are commonly 3-4 feet high where they occur. No obvious current human impacts. Downstream end of reach has intermittent conditions partially caused by large sediment deposits in the channel, influenced by large wood. Water flows upstream and downstream of the intermittent reach. Steeper reaches have coarser bed material including boulders that are unlikely to move except in uncommon flood events. Large trees including cedars and mature cottonwoods provide the in-channel debris.

MC 9-1 – Bank erosion is pervasive with most outside banks affected by scour. Flood-deposited coarse material on channel margins is semi-colonized by shrubs and weeds and most of these surfaces are not stable enough to resist erosion. Eroding banks range from 2ft to 4ft in height. Loose sediment suggests a dynamic system with a mobile bed and lack of larger material and large woody debris for channel stability. Channel changes may be relatively frequent based on overflow channels, moderately fresh deposition, and bank erosion. Stream habitat is generally homogeneous with limited pools and long riffles. The canopy is less contiguous compared to upstream reaches and consists of cottonwoods as the primary overstory species, with infrequent conifers. No current anthropogenic influences were identified at this site.

Current anthropogenic impacts are rare in the Marten Creek sites selected for assessment. In general, pool depths and pool frequency are only slightly lower than target values. Although not a direct indicator of sediment itself, large woody debris was consistently below the target which may indicate more of an issue with riparian community development and historic disturbance than any present activity. Additionally, the bank instability and high width/depth ratio at the lower reach (MC 9-1) indicates a disturbed floodplain and stream corridor that will likely require active channel restoration to stem the pervasive bank erosion. Because of this, a TMDL will be pursued despite the marginal and limited exceedence of sediment targets in the other reaches.

5.4.3.4 Swamp Creek, Cabinet Mountains Wilderness Boundary to the mouth (Noxon Reservoir); MT76N003_140

Four reaches were assessed on Swamp Creek during the 2008 Lower Clark Fork field assessment (**Tables 5-14 and 5-15**). Data throughout the reaches was variable in relation to meeting the various targets. Two reaches had width/depth ratios well above the target for that parameter indicating some reaches with unstable channel form. In addition, while not well above the targets for percent fines, three of the four sites were in some slight exceedence of the target values for both size classes. Residual pool depths in SWP 18-1 was also considerably below the target for residual pool depth, while SWP 22-3 was also somewhat below the target. Large wood was also well under the target in reach SWP 18-1, and slightly below in reaches SWP 21-1 and SWP 22-3.

Additionally, one site on West Fork Swamp Creek was included in the PIBO dataset (**Table 5-16**). This site met all targets except pool frequency. Large wood data did not exist for this site.

Table 5-14. Swamp Creek – DEQ 2008 Morphology Data

Reach	Ecoregion	Reach Type	Bankfull Width	Rosgen Stream Type	Width/Depth Ratio	Entrenchment
SWP 18-1	15q	2-U-2	33.5	C3	18.7	4.50
SWP 20-1	15q	3-U-0	47.7	C4	**43.4**	6.20
SWP 21-1	15k	3-U-0	45	C4	**47.8**	9.50
SWP 22-3	15q	3-U-0	40.1	C4	19.8	2.90

Values in **BOLD** indicate an exceedence of the target value.

Table 5-15. Swamp Creek – DEQ 2008 Habitat Data

Reach	Wolman Pebble Count		Grid Toss	Residual Pool Depth	Pools #/1000'	Large Wood #/1000'
	Percent Fines <2mm	Percent Fines <6mm	Percent Fines <6mm			
SWP 18-1	4	7	1.0	**0.6**	13.0	**20.0**
SWP 20-1	**11**	**14**	5.0	1.7	14.0	71.0
SWP 21-1	**11**	**14**	1.0	1.8	11.0	48.0
SWP 22-3	**12**	**15**	4.0	**1.3**	11.0	40.0

Values in **BOLD** indicate an exceedence of the target value.

Table 5-16. Swamp Creek – PIBO Data

Stream	Reach ID	Gradient	W/D	%<2mm	%<6mm	Pool D	Pool Frq	LWD
West F. Swamp	1812	3.4	19.8	0	3	1.3	**3**	-

Values in **BOLD** indicate an exceedence of the target value.

Field notes from the 2008 field assessment describe the conditions of the DEQ Swamp Creek reaches further:

<u>SWP 18-1</u> – Some erosion of floodplain areas and minimal streambank erosion has occurred as a result of flood scour but dense shrub cover including willow communities and forest understory anchors most of the streambanks while scattered cedar groves provide additional root cover. Some signs of livestock grazing exist but no other identifiable current anthropogenic impacts. Minimal habitat exists in the form of shallow pocket pools in channel margins. The channel is dynamic with floodplain overflow channels and coarse alluvium deposits and large woody debris scattered throughout. Bed material is limiting in spawning habitat and is comprised of coarse material and minimal gravels. Beavers are active on the floodplain and influence the vegetation community, especially along the channel and broader floodplain areas, but riparian vegetation is dense and diverse, consisting of a cedar, cottonwood, aspen, and spruce overstory, and willow, dogwood, snowberry, and alder in the understory.

<u>SWP 20-1</u> – The channel appears to be unstable and actively shifting in the upstream portions, with relic point-bars, lack of vegetative cover and abandoned channels. Considerable bank erosion is contributing sediment to the channel and most of the fine sediment (remnant of glacial Lake Missoula silts) is in the lower portion of the reach, especially downstream of a floodplain channel that joins the creek in toward the head of the reach. Swamp Creek Reach 20-1 currently exhibits a Rosgen D4 channel morphology. Based on the valley morphology, floodplain, and vegetation characteristics, the probable historical stream type was likely a Rosgen C4. Grazing has significantly contributed to stream erosion and may be furthering the system's susceptibility to periodic disturbance, as evidenced by hoof shear and vegetation cropping. Past and present beaver activity also appears to play an important role influencing channel

morphology, sediment storage, water storage and the vegetation community. Riparian community is described as a diffuse overstory with infrequent spruce, larch and cedar.

SWP 21-1 – Bank erosion is common at this site. Accelerated erosion is related to livestock grazing, hoof shear, vegetation removal and attempts at bank stabilization through riprap. The most severe erosion was due to bank toe failure and bank slumping. The channel morphology was characterized by long pools/glides and short riffles. Alder clumps and large wood from upstream influence pool scour and habitat. The channel appears to be over-widened through much of the reach due to grazing impacts and the upstream end of the reach is split into two channels.

SWP 22-3 – Erosion is moderate at this site. Failing banks, dominated by reed canarygrass are fairly common. However, a good and diverse off-channel riparian shrub community limits the extent of lateral bank retreat and bedrock limits erosion in the upper portion of the reach. Bedrock is either exposed at the channel surface or is covered by a thin veneer of sediment ranging from sand to boulders. Historic anthropogenic influence is apparent from the previously logged uplands and the current irrigation withdrawls and reservoir operations affecting flows. The channel is relatively homogeneous with few moderate to large pools. Numerous fish were stranded in the remaining pools. A narrow floodplain separates the channel from adjacent hillslopes.

Swamp Creek will undergo sediment TMDL development, largely as a result of the known historic influences of stream and landscape disturbance in the watershed, and the resultant affects, as seen in width/depth ratios and higher than average percent fines. The present day anthropogenic influences on bank stability and sediment load in the lower reaches also support the pursuit of TMDL for this stream.

5.4.3.5 White Pine Creek, headwaters to the mouth (Beaver Creek); MT76N003_120

Review of the DEQ assessment files indicates that upper White Pine Creek supports a pure, small yet viable westslope cutthroat fishery but it may be threatened from competition and genetic introgression from non-native species. Bull trout are also though to have been distributed throughout the drainage historically, but only 1 fish has been captured in 2000. Subpopulation size, growth and survival, life history diversity and connectivity all “functioning at risk” for bull trout. Persistence and genetic integrity “functioning at unacceptable risk.” Macroinvertebrates indicate that habitats are mostly intact, but demonstrate disturbance, and index scores suggest partial support of aquatic life. Much of the sediment issues in White Pine Creek appear to be a result of habitat instabilities; historic, natural catastrophes such as the large, landscape fires in 1889 and 1910, and the large flood of 1916, along with past and present detrimental land use practices including road construction, riparian and upland timber harvest, and stream modifications. The increased sediment loads resulted in accumulation of sediments, increased bank instability, erosion, and stream braiding, which are still visible on the landscape. Comparison of White Pine Creek to Kootenai National Forest reference data sets shows large, high quality pools with good habitat complexity are lacking and reduce the quality of overwintering habitat for fish. In addition, Wolman pebble counts and McNeil core sampling have demonstrated that there are areas that have excess fines, and are most likely affecting fish spawning success.

Three sites on White Pine Creek were included during the 2008 field assessment (**Tables 5-17 and 5-18**). Percent fines less than 2mm exceeded the target at all three sites, and was either at the target or barely above for percent fines less than 6mm. Residual pool depths were also below the target at two of the three reaches, as was pool frequency. Width/depth ratio and large wood did not meet the target at WPC 9-2.

In addition, one PIBO site on White Pine Creek was included for review (**Table 5-19**). This site did not meet the target for width/depth, both classes of percent fines, and residual pool depth. Large wood data was not available for this site.

Table 5-17. White Pine Creek – DEQ 2008 Morphology Data

Reach	Ecoregion	Reach Type	Bankfull Width	Rosgen Stream Type	Width/Depth Ratio	Entrenchment
WPC 8-3	15k	2-U-2	31.9	C3	21.3	7.70
WPC 9-2	15k	2-U-0	35.3	C4	**32.4**	5.20
WPC 9-5	15k	2-U-0	37.7	C4	24.8	5.50

Values in **BOLD** indicate an exceedence of the target value.

Table 5-18. White Pin Creek – DEQ 2008 Habitat Data

Reach	Wolman Pebble Count		Grid Toss	Residual Pool Depth	Pools #/1000’	Large Wood #/1000’
	Percent Fines <2mm	Percent Fines <6mm	Percent Fines <6mm			
WPC 8-3	**9**	10	1.0	**1**	**6.0**	56.0
WPC 9-2	**7**	**11**	3.0	**1.5**	12.0	**33.0**
WPC 9-5	**6**	10	1.0	1.7	**8.0**	57.0

Values in **BOLD** indicate an exceedence of the target value.

Table 5-19. White Pine Creek – PIBO Data

Stream	Reach ID	Gradient	W/D	%<2mm	%<6mm	Pool D	Pool Frq	LWD
White Pine	1810	0.5	**29.7**	**9**	**23**	**1.1**	11	**-**

Values in **BOLD** indicate an exceedence of the target value.

Field notes from the 2008 field assessment describe the conditions of the DEQ White Pine Creek reaches further:

WPC 8-3 - Most streambanks exhibit erosion. There is considerable sediment, generally coarser substrate, generated within the reach from streambank and floodplain erosion. There are signs of large material mobilized by larger flood events indicating strong forces during high flow events. Multiple braided channels show evidence of scouring during floods and subsequent abandonment. Portions of the reach have multiple channels and an intermittent reach with substantial bedload. The reach resembles fan morphology with poor habitat conditions and limited pools. Large wood present but infrequently influences channel morphology. Most of the large wood is in the form of single pieces with a few aggregates. No obvious current anthropogenic impacts to the site however a road does intersect the stream at the top and bottom of the reach. The riparian zone is characterized by a multi-species canopy of fir and cottonwood. There are limited shrubs, mainly small conifers.

WPC 9-2 - Considerable streambank erosion contributes sediment ranging from silts to medium cobble. Most erosion is occurring on outside streambanks with extreme bank heights. Alders provide some streambank stability but most eroding banks are dominated by grasses and knapweed. Inside banks are characterized by point bar deposits and sparse vegetative cover. Reaches upstream and downstream are influenced by a forest road, active evulsions and shifting channel braids. Most observable impacts are related to historical logging, past grazing, agriculture and on-going road maintenance. Large stumps suggest historical canopy and past logging. Algae is common throughout channel which may suggest high nutrient levels. The channel is actively migrating with an abundant sediment load as evidenced through meander cut-offs, floodplain scrolls, and extensive depositional bars. Shallow pools are located where the stream interacts with large wood and alder bunches. The channel profile includes pools, long glides and abrupt riffles. The vegetation community is characterized by an alder overstory with an understory including grasses, knapweed, and willows. Other shrubs include alder which are regenerating throughout the site. Sedges are common on depositional features parallel to channel. Areas of significant weed infestation include knapweed, oxeye daisy, purple loosestrife, and Canada thistle.

WPC 9-5 - Bank erosion is relatively common at outside streambanks with excessive bank heights. The entrenched channel has a relatively low sinuosity planform characterized by short riffles and long pools and glides. Some large wood and numerous alder thickets promote channel scour and pool diversity where they interact with the stream. Fine to medium gravels predominate the channel bed material and fine sediment and flocculant cover the channel bed in most slow water areas. Current anthropogenic impacts are easily seen throughout this reach; the streambank has been anthropogenically altered (bulldozed and graded) on river-left near the downstream end of the reach. Haying is a dominant influence on river-left, which extends from the floodplain to the channel margin. There is a recent subdivision on surrounding uplands. Riparian vegetation has been mowed to the top of bank. A newer bridge and low water ford have introduced fine sediment to the stream. Tractor tracks are apparent on the floodplain and equipment was used to manipulate the channel, potentially resulting in an active avulsion. Alder dominate the overstory and reed canary grass dominates the understory. Alders are located on the floodplain as well as on the streambanks of the entrenched bankfull channel. No mature overstory canopy exists above the alders. Reed canary grass is common, displacing sedges and rushes from low depositional areas and witnessed on failed streambank blocks and point bars. Limited other shrubs are present in the reach, including spirea.

Current and historic anthropogenic activity in the watershed, and exceedence of targets in each of the assessed reaches supports the development of TMDLs for this stream.

5.4.4 Data Review for Elk Creek

In 1998, a TMDL was developed for the Elk Creek watershed. Since that time, numerous improvement efforts have been completed, and more are in development, to try to achieve the recommendations in that TMDL and meet water quality standards. Elk Creek was included in the sampling and analysis plan for the 2008 Lower Clark Fork study to broaden the representativeness of data from tributaries within the TPA, and to provide additional information for the benefit of those who wish to review current conditions in Elk Creek, and assess progress since the 1998 TMDL was completed.

Seven sites in all were included from the Elk Creek watershed; one from West Fork Elk Creek, four from East Fork Elk Creek, and two from the mainstem of Elk Creek (**Tables 5-20 and 5-21**). The West Fork reach, WFELK 8-1 met the targets for stream morphology, and were barely exceeding the targets for both classes of percent fines. Additionally, residual pool depths were somewhat low in comparison to the target. The East Fork reaches saw some exceedence of target values for 3 of 4 width/depth ratios, with the most significant exceedence at EFELK 10-3. Residual pool depths and pool frequency targets were also not met in 3 of 4 reaches, as was large woody debris. Mainstem Elk Creek met most targets however a slight exceedence in width/depth ratio at ELK 11-3 was observed, as well as a deficiency in large wood at ELK 11-6. Although the target for percent fines was based on the wolman pebble count results, the target value of <10% less than 6mm showed slight exceedence via the grid toss method. These values are likely within the range of acceptability and are compatible with the percent fines as determined through the pebble count.

Three PIBO sites in the Elk Creek watershed were also identified; two on East Fork Elk Creek and one on West Fork Elk Creek (**Table 5-22**). The West Fork Elk Creek site had incomplete data; however, it was slightly below the target for large woody debris. Of the two East Fork Elk Creek sites only one had percent fines data, which was well above the target values for both classes. In addition, large wood and pool frequency was not meeting the target values at both sites. The residual pool depth target was met at one site, but not the second site.

Table 5-20. Elk Creek – DEQ 2008 Morphology Data

Reach	Ecoregion	Reach Type	Bankfull Width	Rosgen Stream Type	Width/Depth Ratio	Entrenchment
WFELK 8-1	15o	2-U-0	20.3	C3	23.5	7.40
EFELK 7-2	15k	2-U-4	28.5	B3	16.6	2.60
EFELK 8-1	15k	2-U-2	24.8	B4	**21.4**	4.60
EFELK 9-1	15k	2-U-0	27.5	B4	**26.9**	3.00
EFELK 10-3	15k	3-U-0	36.7	C4	**38.7**	3.30
ELK 11-3	15k	4-U-0	43.8	C4	**26.4**	7.00
ELK 11-6	15k	4-U-0	39.4	C4	17.4	2.60

Values in **BOLD** indicate an exceedence of the target value.

Table 5-21. Elk Creek – DEQ 2008 Habitat Data

Reach	Wolman Pebble Count		Grid Toss	Residual Pool Depth	Pools #/1000’	Large Wood #/1000’
	Percent Fines <2mm	Percent Fines <6mm	Percent Fines <6mm			
WFELK 8-1	**6**	**11**	7.0	**1.3**	10.0	43.0
EFELK 7-2	1	5	5.0	**1.1**	**7.0**	**26.0**
EFELK 8-1	2	5	3.0	1.3	**3.0**	**20.0**
EFELK 9-1	5	7	10.0	**1.1**	**4.0**	**37.0**
EFELK 10-3	5	9	8.0	**1**	9.0	56.0
ELK 11-3	3	7	**12.0**	2.7	9.0	62.0
ELK 11-6	4	8	**18.0**	3.2	9.0	**31.0**

Values in **BOLD** indicate an exceedence of the target value.

Table 5-22. Elk Creek – PIBO Data

Stream	Reach ID	Gradient	W/D	%<2mm	%<6mm	Pool D	Pool Frq	LWD
East F. Elk	145	0.6	24.1	-	-	**1.2**	**5**	**46**
East F. Elk	2149	0.7	**35.1**	**19**	**29**	1.6	**2**	**16**
West F. Elk	2156	2.9	19.1	-	-	-	-	**41**

Values in **BOLD** indicate an exceedence of the target value.

Field notes from the 2008 field assessment describe the conditions of the DEQ Elk Creek reaches further:

<u>WFELK 8-1</u> – Limited bank erosion occurs primarily near cedar stumps, roots, trunks, or large woody debris knick points. The stream is intermittent in this reach. Where and when water exists, there are deep pools and runs, with smaller sections of riffle throughout. Deep, curving, and pool forming bends also result in limited erosion at corners. Small material gravel dominant at pool crests and depositional sections of stream with large size cobble (90-128 mm) frequent in stream bottom with some embeddedness of larger cobble from finer material. Evidence of historical logging includes cedar stumps throughout the reach however, stream channel and riparian zone appear to be relatively stable and no recent anthropogenic influences exist. Past logging may have been limited and there is no sign of recent

activity, this reach occurs in a predominantly natural setting. Large diameter wood interspersed along stream channel helping to create pools and redirect flow. Some large cedars exist throughout and vegetation including small woody shrubs comprise the understory. Although old stumps are visible, a sparse but mixed age class in cedar composition with interspersed deciduous trees indicates a recovering riparian community. Good vegetation cover for the shaded, cedar sections of the reach.

EFELK 7-2 – The armored channel exhibits minimal erosion, and no current anthropogenic influences are present at this reach, although there is some logging approximately 2-3 miles upstream. Despite this, the logged area is small, and there is not much noticeable logging effect. Vegetation along the reach extends to the channel margin, completely covering the mixed sizes of substrate material that comprise the streambank. Intermittent flow through the reach appears to be due to high sediment bedload. Pool habitat is lacking with low wood frequency with marginal quality pools. The riparian zone is characterized by a grass, forbs and shrub understory with an overstory of conifers and patchy cottonwoods. Riparian condition looks good with stable vegetation and multiple age classes.

EFELK 8-1 – Naturally occurring eroding banks, very limited in size and frequency are usually at outside meanders. The streambanks are armored with large cobble, with a mat of shrub and tree cover on top with moderate rooting density. One large eroding hillslope with a stable toe is eroding about 8 feet up the bank. Previous increased sediment loads are evident by mature cottonwoods buried up to 3 feet and flood lag deposits intercepted by the channel, possibly deposited during the 1964 flood. The reach is intermittent. A homogeneous mixture of sediment size, dominated by coarse particles, is the primary source of material to the channel and armors the channel bed. Pools lack complexity and cover and are not well developed. The few pools that exist typically occur at meanders and are small in size. There is a limited amount of in-channel coarse large woody debris possibly reflecting riparian age class and past disturbance regimes. The stream is intermittent in the reach. Similar to EFELK 7-2, there is very little evidence of current human impacts in the reach. Limited logging occurred a number of years ago about 3 miles upstream, but no evidence of logging in the study reach. A forest fire approximately 20 years ago affected the vegetation community. There are relatively young age classes, 12-16” max diameter at breast height on floodplain and limited large wood recruitment potential. However, young riparian zone is diverse and dominated by conifer with some interspersed deciduous trees.

EFELK 9-1 – Some areas of sand and small fines dominated substrate, easily eroding where channel shape shifts due to large in-stream wood or at bends, however not much bank erosion witnessed outside of these erosive soil type areas. Extensive vegetation cover appears to be successfully mitigating erosion and providing cover. Long riffles and few pools, with pools typically influenced by large woody debris. The stream bed is elevated with deep channels along the edge of stream bottom. Excessive bedload and a shifting thalweg with channel bars forming midstream in some areas near large wood or upstream of bends suggests the reach is aggrading. Minimal evidence of human impacts near the stream however barbed wire was found along streambanks and within the channel suggesting previous fencing, possibly for livestock. Gabion basket was also found in the streambank in part of the reach. Conifer-dominated forest although size class is uniform indicating past disturbance. Good riparian buffer width although vegetation density and diversity are average.

EFELK 10-3 – Most streambanks in this reach are actively eroding. High stream energy and bedload deposits occur at meanders, influencing channel morphology. The riparian vegetation is dominated by reed canary grass and alder rather than historically dense species such as willow and dogwood, and limited root density coupled with sandy soils results in streambank instability. Large woody debris redirects flow into streambanks which is also affecting stability. Stream habitat consists of moderately deep pools and interspersed riffles. In general, there is limited trout habitat, mainly provided by pools formed by alders slumping from eroding banks. The bedload material is very mobile (smaller cobbles dominate) with abundant fine sediment in pool bottoms, slow areas and at meanders. Historically, valley bottoms similar to EFELK 10-3 in the Lower Clark Fork tributaries were dominated by western red cedar. Channel and floodplain instability is largely due to vegetation changes from cedar to alder. Other vegetation changes include shifts from stable cedar to reed canary grass. Past agricultural practices and livestock grazing have also affected vegetation conditions. The current landowner fences livestock from the stream and maintains a buffer, but woody vegetation is sparse and relatively ineffective for bank stabilization. Some streambank stabilization projects have been installed in this reach including two engineered log jams and one rip-rap bank. The narrow riparian zone includes reed canary grass and alder and virtually no conifers.

ELK 11-3 – Large, long sandy streambanks are unstable due to lack of good riparian vegetation. Minimal riparian vegetation remains on eroding banks aside from reed canary grass and small patches of alder. Historically, valley bottoms like this were dominated by western red cedar. Channel and floodplain instability is due to vegetation changes from cedar to alder, or cedar to reed canary grass via human influence of agricultural practices and livestock grazing. Channel substrate and depositional bar substrate are dominated by similar small cobble substrate indicating very mobile, shifting materials. Mid-channel bars and long depositional benches occur throughout the reach. As a result, riffles are uncommon and the channel appears to be relatively unstable and aggrading, however deep pools are located through some meanders. Nearby, local haying and agricultural practices occur but does not seem to be affecting the streambanks themselves. The current adjacent landowner fences livestock from the stream and maintains a buffer of approximately 5 feet on average, but woody vegetation is sparse and relatively ineffective for bank stabilization. Some deciduous species, but mainly alders with a reed canarygrass understory. River right (opposite streambank from the hayfield) has more established riparian vegetation, but again limited in vegetation quality and diversity.

ELK 11-6 – Streambanks are generally comprised of fine gravel and lacustrine silt and clays. The rooting depth is relatively shallow and knapweed dominates several droughty terraces resulting in high erosion potential. The outside streambanks are characterized by a low and middle terrace, and are prone to erosion. Streambank heights are approximately 2 ft to 3 ft above the bankfull stage. The channel bed sediment distribution is bi-modal with coarse gravel surface material and high embeddedness with interstitial fines in the sub-surface bed material. The stream has a pool-riffle morphology, with the bed coarsening in a downstream direction. Riffles are underdeveloped with long glide features and associated pools generally lacking in cover, complexity and depth however, some deep lateral scour pools exist associated with large wood, mature alders, or the natural channel morphology. Undercut streambanks provide the primary cover through the reach. The 1997 flood appears to have affected the channel morphology. Past grazing and other land uses may have also affected channel stability. The channel generally downcut into the valley fill by as much as 2 feet relative to the low terrace which is the abandoned floodplain surface. The channel has limited meander belt width and is actively expanding the floodplain through erosion and accretion. Channel over-widening appears to be mainly from channel mobility and the confluence of two channel threads. Some residences and horses located near the stream, but livestock fenced from channel. At the upper end of the reach, the left floodplain and streambank is mowed and outdoor furniture is present. Floodplain riparian vegetation primarily consists of grass and forbs, reed canary grass, and pole-sized alders which replaced the historical western red cedar cover type. The cedars were most likely logged in the early 1900s similar to practices in other tributaries. The understory vegetation, from 5 ft to 15 ft in height, is comprised of mature and decadent alder. No overstory canopy exists with the exception of mature alders. Past and present vegetation conversion is due primarily to channel instability and resultant increased sediment loading to the channel.

Based on the data reviewed, it appears that past disturbance to the riparian corridor continues to affect the Elk Creek watershed. Slightly elevated fines, active bank erosion, and increased width/depth ratios in the lower reaches, as well as low numbers of large woody debris indicate the affects of a disturbed riparian area. However, it is noted that current land use practices witnessed along the stream in some stretches of the lower Elk Creek valley have fenced off the riparian corridor in an attempt to allow stabilization of banks. It will likely take more time, and potentially additional stream restoration BMPs, before true riparian recovery is witnessed.

5.4.5 TMDL Development Summary

Based upon the results of **Sections 5.4.3**, the following streams will be included for TMDL development for sediment (**Table 5-23**). Sediment sources and estimates of sediment loads from those sources are investigated in **Section 5.5**, and the TMDLs and allocations of sediment load are presented in **Section 5.6**.

Table 5-23. Lower Clark Fork TPA waterbodies included in sediment TMDL development

Waterbody ID	Stream Segment	2008 Probable Causes of Impairment
MT76N003_040	**BULL RIVER,** the North Fork to the mouth (Cabinet Gorge Reservoir)	**Sedimentation/Siltation**; *Physical Substrate Habitat Alterations*
MT76N003_180	**DRY CREEK**, headwaters to the mouth (Bull River) T28N, R33W	**Sedimentation/siltation**
MT76N003_090	**MARTEN CREEK**, headwaters to the mouth (Noxon Reservoir)	**Sedimentation/siltation,** *Physical Substrate Habitat Alterations*
MT76N003_140	**SWAMP CREEK**, Cabinet Mountains Wilderness boundary to the mouth (Noxon Reservoir)	*Insufficient data to assess*
MT76N003_120	**WHITE PINE CREEK**, headwaters to mouth (Beaver Creek)	**Sedimentation/siltation**, *Alteration in stream-side or littoral vegetation covers*

5.5 Source Quantification for all Waterbodies

Three major source categories of sediment have been identified in the Lower Clark Fork TPA. When developing TMDLs, sediment loads must be quantified for each significant source category, and where appropriate, strategies for reducing those loads from human caused sources must be developed such that streams meet all applicable water quality standards. This section describes the methodology, rationale, and assumptions in sediment load quantification and load reduction that is used as the basis for TMDLs for the tributaries of concern in the Lower Clark Fork.

5.5.1 Bank Erosion

Rivers and streams are dynamic, ever changing systems that are constantly seeking equilibrium with its surrounding environment. The size, force, and shape of these flowing waters fluctuate throughout the seasons, and over the years. As streams shift across the landscape, they inevitably cut a new path by which to flow, sometimes very slowly and subtly, and sometimes very dramatic and obvious. The resultant sediment load from the erosion enters the stream and becomes a component of the equation by which the stream tries to find its balance. Sediment from eroding banks may alter channel shape, alter the erosive properties of the stream itself, prohibit or encourage aquatic life and fisheries, and affect water chemistry and quality.

Bank erosion as a result of these shifts in direction and energy is a natural and necessary function of an active stream channel. However, in some cases bank erosion can be exacerbated or accelerated by human activities that result in altered bank stability or stream morphology. In investigating bank erosion as one source of the total watershed sediment load to derive the TMDL, methods were used to quantify sediment loads from eroding banks, identify the cause and effects of the eroding banks and therefore differentiate between existing and desired conditions (under all applicable land, water, and soil best management practices), and apply loads across the landscape to derive appropriate bank erosion loads at the watershed scale.

5.5.1.1 Quantifying Pollutant Sources

In 2008, a field study was conducted throughout the Lower Clark Fork watershed that investigated the sediment and habitat conditions in selected reaches for the streams of interest. In preparation for that study, an aerial assessment and GIS exercise was conducted to characterize the streams into representative reaches categorized by geomorphologic constraints independent of the influence of man, and sub-categorized further by the apparent influences land use, land cover, and local activities may have on an individual reach. From this assessment, sites were chosen for study to represent the variability in natural and anthropogenic influences throughout the watershed. For each site that was selected as part of the 2008 field study, an assessment of eroding banks was conducted for the entire length of the study site (generally 1000’ in length). The data from this effort forms the basis for quantifying loads from individual banks and their associated conditions, and the extrapolated bank erosion load as a component of the Total Maximum Daily Load for sediment.

5.5.1.2 Bank Erosion Assessment

For each monitoring reach selected in the aerial photo assessment, measurements were collected to calculate the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS), in accordance with the Watershed Assessment of River Stability and Sediment Supply guidelines (Rosgen, 2006). BEHI evaluates the susceptibility to erosion for multiple erosional processes. The process integrates multiple variables that relate to “combined” erosional processes leading to annual erosion rates. Erosion risk is then established for a variety of BEHI variables and is eventually used to establish corresponding streambank erosion rates. (Rosgen, 2006)

As part of the field analysis, in addition to the information recorded for the physical character of the eroding bank and the near bank stress, each bank is categorized as either actively/visually eroding or slowly eroding/vegetated. Each bank is also assigned percent influence contributing to the erosion of the bank and distributed among natural and anthropogenic causes such as transportation, grazing, timber harvest, etc. Once sediment loading is generated for each analyzed bank in a given site, the sum of the bank loads is calculated to derive the total load for the sampled site.

5.5.1.3 Bank Erosion Sediment Loading

In order to determine sediment loading from bank erosion, information from the sites assessed in the field is used and a process developed to provide reasonable estimates to represent the total sediment loads from bank erosion for each watershed.

In the Lower Clark Fork, the sediment load for each eroding bank in a sampled reach was calculated, and then the total sediment load for that reach was summed. Sampled reaches were sorted by their Level IV ecoregion and stream order, and the average sediment loads (tons/1000’) from these representative groupings determined. Sediment loads were then applied to each of the delineated reaches in a given stream, according to its associated reach Level IV ecoregion and stream order, and normalized by the distance of the reach. For individual reaches where the sampled data existed, those loads were applied instead of the average reach category load. For reaches with a stream order of one, or a gradient greater than 4%, no sediment load was applied as it was assumed that these reaches, in most cases, were very steep, head water reaches that typically exhibited little to no bank erosion. All reach loads were then summed for each stream to produce the estimated existing sediment load based on field data.

The Bull River provided a challenge during this analysis and extrapolation effort. The stratification of reaches was based on ecoregion, stream order, valley confinement, and valley gradient. In general, these four categories provide enough information by which to group reaches, and provide reasonable assurance that similarly characterized reaches will exhibit a similar sediment loading character. In large part, this appears to hold true with many of the tributaries in the Lower Clark Fork. However, this method does not account for additional differences in stream character as described through the Rosgen stream classification system. Namely, the differences in character between Rosgen C and E types, which take into account meander patters (sinuosity) and width/depth ratios. Upon review of the data and through observations in the field, it was determined that E type reaches generally seemed to show higher bank erosion trends than B or C reaches in the Bull River watershed, and therefore should be distinguished with a different loading rate. Of the three reaches on the Bull River surveyed, one reach was considered an E channel, and two others were considered borderline C/E channels. None of the three reaches were deemed appropriate to represent a true Bull River B/C channel. As a result, it was determined that the average bank erosion load from the sampled Bull River reaches would represent the load associated with E type reaches, and the average load from the Swamp Creek sites exhibiting the associated reach grouping would represent B/C stream types. But, as the original stratification did not include Rosgen stream classification, another source of information was necessary to extrapolate the bank erosion sediment loads. A watershed characterization completed in 2004 by RDG contained information on Rosgen types for the Bull River, and was therefore used as the reference by which to apply the existing sediment loading rates (River Design Group, 2006).

Table 5-24 provides the average reach load information that was used to develop existing bank erosion sediment loads in the Lower Clark Fork tributaries.

Table 5-24. Average Streambank Erosion Sediment Load by Reach Grouping

Reach Grouping (Level IV ecoregion-stream order)	Sampled Reaches	Average Streambank Erosion Sediment Load per 1000' (tons/year)
15k-2	ELK 7-2, EFELK 8-1, EFELK 9-1, WPC 8-3, WPC 9-2, WPC 9-5	15.1
15k-3	EFELK 10-3, MC 9-1, SWP 21-2	10.6
15k-4	ELK 11-3, ELK 11-6	17.9
15o-2	NBMC 8-1, SBMC 3-1, WFELK 8-1	16.2
15o-3	MC 6-2	40.2
15q-2	SWP 18-1, DRY 9-2	8.3
15q-3	SWP 22-3, SWP 20-1, BULL 3-2, BULL 3-3, BULL 5-1	16.5/40.9*

* 16.5 tons/year is the average sediment load from the Swamp Creek sites (22-3, 20-1) which are used to represent B/C stream type loads in the Swamp and Bull River subwatersheds. 40.9 tons/year is the average sediment load from only the three Bull River sites (3-2, 3-3, 5-1) which are used to represent loads from E stream types in the Bull River system.

5.5.1.4 Establishing the Total Allowable Load

Once the existing bank erosion sediment load has been derived, the allowable load must be established by which to determine the target conditions and allocation of sediment reductions.

In some cases, establishing the total allowable load is done by simply comparing the results from those areas clearly influenced by human activities to those areas where conditions are in a more natural or properly managed 'reference' condition. In the Lower Clark Fork, a legacy of historic forest fires and widespread timber harvest had at one time significantly altered the landscape and in particular, changed the riparian character and bank stability such that these affects are still evident today, despite there being relatively limited current anthropogenic influence in most drainages. Although as many as 100 years have passed since some of these activities have occurred, the soils, geology, climate and hydrology of the region have made recovery from these impacts a very slow process, and as a result, the historic anthropogenic influences, particularly the logging and riparian harvest of cedars throughout the watershed, are the focus of the sediment reduction strategy from bank erosion.

Due to the widespread nature of the riparian harvest and historic anthropogenic affects, as well as the historic forest fires of the region, simple designation between anthropogenic influence, and natural or 'reference' conditions proved difficult. As such, in order to determine the allowable load and target condition for bank erosion, the overall length of bank erosion occurring within the sampled reaches was investigated. For each reach sampled, the percent of eroding streambanks was calculated, and the median percent eroding banks of all reaches determined to be 9%. The median was chosen because the sample set included a mix regarding the severity of bank erosion impact, and represents reaches both which were stable and functioning, and those obviously unstable and contributing to increased 'unnatural' sediment loading. Since in any stream environment, the dynamic nature of stream migration inherently is erosive and creates both slowly eroding and actively eroding banks, some bank erosion is expected, and indeed necessary for the balance and health of the overall system. As such, the 9% eroding banks was deemed an appropriate, allowable, and expected degree of bank erosion for stream systems in the Lower Clark Fork.

For each individual stream of interest, the average percent eroding banks for the sampled reaches of that stream was determined. The average percent eroding banks of the stream was then compared to the median percent eroding banks (9%) of the total sample population. For each stream, the existing load was then reduced by the percent reduction necessary for that stream to achieve an equivalent of 9% eroding banks, the result of which is the desired sediment load from eroding banks, or the allowable load. **Table 5-25** shows the results for each stream.

Table 5-25. Extrapolated Bank Erosion Loads and Reductions

Stream	Existing Bank Erosion Load	Average % Eroding Bank per sampled reach	Percent Reduction to Achieve Equivalent of 9% Eroding Bank	Resultant Load
Bull River	4689	29.1	69	1454
Dry Creek	93	16.7	46	50
Marten Creek	870	18.5	51	426
Swamp Creek	534	19.6	54	299
White Pine Creek	818	32	72	229
Elk Creek	1375	10	10	1238

5.5.1.5 Allocations and achievement

Since the sediment loading from bank erosion is a gross estimate based on limited data, the allocation is simply described as the percent reduction necessary to achieve the 9% eroding bank equivalent. This allocation thereby encompasses all adjacent land use categories and land management practices, and expects all land owners in the Lower Clark Fork TPA to manage their land with all applicable and reasonable land, water, and soil conservation practices that will protect, improve, and restore stable and healthy streambanks and riparian corridors. Also, because much of the instability in banks, and therefore the resultant sediment loads, is presumed to be due to historic land management practices, it is not anticipated that current land owners bear the full responsibility for immediate recovery to the desired conditions. Rather, it is acknowledged that recovery to stable banks and improved and established riparian vegetation communities may take many decades to achieve. It is encouraged that, in addition to managing current activities with all reasonable land, soil, and water conservation practices, management decisions to promote floodplain functionality and native vegetation establishment throughout the riparian corridor will be reviewed and implemented wherever and whenever possible.

Historic influences on current bank erosion may be a large factor in the current condition of stream banks throughout the Lower Clark Fork TPA; however it is certainly not the only factor. Although it may be difficult to use aerial photography and GIS methodology to discern between bank erosion influenced from historic practices, and bank erosion as a result of natural processes, it is possible to identify potential present-day influencing factors with these methods. Through the stratification process used as part of the Lower Clark Fork assessment method, information on adjacent land use and potential current influences on bank erosion was collected. This data can be used to help assist land managers with prioritizing areas, or focusing on issues to be addressed to expedite sediment load reduction and eventually achieve the TMDL. This data is presented in **Table 5-26** below. It is acknowledged that the developed sediment loads and the method by which to attribute anthropogenic and historic influence are estimates based on aerial photography, best professional judgment, and limited access to each stream reach. The assignment of bank erosion loads to the various causes is not definitive; however it does provide helpful guides for directing focus and efforts at reducing the loads from those causes which are likely having the biggest impacts on the investigated streams. Complete TMDLs and allocations are presented in **Section 5.6**.

Table 5-26. Percent Adjacent Land Uses as Identified through GIS/Aerial Imagery with Potential Influence on Bank Erosion

Watershed	Natural/Historic	Transportation	Grazing	Cropland	Mining	Timber Harvest
Bull	35	18	40	-	-	7
Dry	87	9	-	-	-	4
Marten	60	22	6	-	-	12
Swamp	74	8	16	2	-	-
White Pine	73	-	9	-	1	1
Elk	56	12	31	-	-	2

5.5.1.6 Assumptions and Considerations

- The annual streambank erosion rates used to develop the sediment loading numbers were based on Rosgen BEHI studies developed in Colorado. While the predominant geologies between the Colorado research sites and the Lower Clark Fork are different, they are similar enough in character to warrant their application.

- The bank erosion data collected during the 2008 field effort is representative of conditions throughout the Lower Clark Fork watershed.
- The present day erosion has been, and continues to be, affected by the historic clearing of cedars and other past riparian harvest activities, in addition to other disturbances to the riparian corridor (both anthropogenic and natural, in the case of fires).
- Most tributaries in the LCF-TPA typically exhibit A, B, or C Rosgen stream types, however the Bull River is the only stream that exhibits a significant amount of E channel character to warrant a specific loading extrapolation scenario to account for this.
- The target of 9% eroding bank is a reasonable expectation of normal, natural conditions assuming riparian corridor vegetation was mature and stable.

5.5.2 Sediment from Roads

Roads located near stream channels can impact stream function through a degradation of riparian vegetation, channel encroachment, and sediment loading. The degree of impact is determined by a number of factors including road type, construction specifications, drainage, soil type, topography, precipitation, and the use of Best Management Practices (BMPs). In the Lower Clark Fork watershed, sediment from roads has been identified as one of three major source categories potentially affecting sediment loads in impaired tributary streams.

In 2009, DEQ estimated sediment loads for unpaved road crossings and parallel segments in the Lower Clark Fork through a combination of GIS analysis, field assessment, and computer modeling. The results of that effort were used to develop load calculations and load reduction allocations for sediment listed streams. The report from that effort is presented here as **Attachment 1**.

5.5.2.1 Quantifying Sediment From Roads

In order to determine the amount of sediment from roads, computer models are often used that simulate road surface erosion response to the hydrology and climate for a given area. These models take into account weather, road condition, road shape, road orientation, topography, buffering vegetation, and other factors. Most models require a certain amount of known field evaluation to use as input parameters to derive the loads from discrete locations, however depending on the size of the watershed, a subset of the sediment load from roads may be based on real data, with the results of the model extrapolated to the remaining roads.

In 2009, using road information provided by the Kootenai National Forest (KNF), crossings and parallel segments in the road network were identified and classified relative to 6th code subwatershed (with the separation of Dry Creek from Upper Bull River), land ownership, soil erosion hazard class, and road type. Then, a total of 43 unpaved crossings and 19 parallel segments were evaluated in the field to provide a subset of data related to these road attributes. **Table 5-27** provides a summary of road statistics for each assessed 6th code subwatershed.

Assessment of data from the field evaluation was conducted using the WEPP:Road forest road erosion prediction model (http://forest.moscowfsl.wsu.edu/fswepp/). WEPP:Road is an interface to the Water Erosion Prediction Project (WEPP) model (Flanagan and Livingston, 1995), developed by the USDA Forest Service and other agencies, and is used to predict runoff, erosion, and sediment delivery from forest roads. The model predicts sediment yields based on specific soil, climate, ground cover, and topographic conditions. Specifically, the following model input data was collected in the field: soil type, percent rock, road surface, road design, traffic level, and specific road topographic values (road grade, road length, road width, fill grade, fill length, buffer grade, and buffer length). In addition, supplemental data was collected on vegetation condition of the buffer, evidence of erosion from the road system, and potential for fish passage failure.

Table 5-27. Road Statistics for Streams in the Lower Clark Fork TPA

Watershed	Watershed Area (sq mi)	Road Density (mi/sq mi)	Number of Crossings	Road Miles	Stream Miles	Unpaved Road Length Within 100' of the stream
Dry Creek	14.1	1.9	17	26.4	31.7	0.8
Bull River	203.8	1.1	111	218.9	408.1	6.9
Marten Creek	71.1	1.9	82	134.0	143.5	4.9
Swamp Creek	54.7	0.6	15	31.2	98.2	1.0
White Pine Creek	36.2	3.3	62	118.0	70.9	4.1
Elk Creek	84.4	1.9	98	162.5	160.0	6.8

5.5.2.2 Sediment from Road Crossings

Often, the majority of sediment loading from roads occurs at road crossings. Road crossings may act as a direct conduit to the stream since these intersections of road and stream are natural drainage locations and often have limited capacity for buffering or diverting sediment laden runoff from the road. The contributing sediment load at road crossings is a function of the road length and condition that leads directly to the crossing, and the other physical and hydrologic characteristics of the immediate area. Addressing road/stream crossings and their contributing sediment load is an important component to managing the sediment load from road networks.

For the purposes of estimating the sediment load from each road crossing in the Lower Clark Fork TPA, the average of all field sites by ownership category assumes that the random subset of crossings assessed as part of this study is representative of the road crossing conditions in each of the six watersheds. Due to accessibility issues, unpaved privately-owned road crossings were not assessed in the Bull River and White Pine Creek watersheds, and one privately-owned crossing was selected in the field in the Marten Creek watershed that was not randomly chosen in the original Sampling and Analysis Plan. The average result from stream crossings on privately owned land in the Swamp Creek and Elk Creek watersheds was used to represent the sediment load on private land.

The road network was classified by major landowner within each watershed, as various entities and administrative controls direct operation and maintenance of the road network. Three major landowner classifications were identified: Federal lands, State of Montana, and private landowners. Mean sediment loads from field assessed sites were used to extrapolate existing loads for each ownership class in each listed watershed. Extrapolation of these results to the remainder of road crossings assumes that the random subset of crossings assessed as part of this study is representative of each of the six watersheds.

5.5.2.3 Sediment from Parallel Segments

Sediment from road/stream crossings addresses the sediment contributed from discrete locations in a watershed where the road and stream intersect. However, road sediment as a result of erosion from those sections of road which may not have a direct entry point to the stream channel is also considered in many source assessment studies and included with the overall sediment load quantification.

Mean sediment loads were calculated for parallel road segments in White Pine Creek watershed, Marten Creek watershed, and Elk Creek watershed. These segments constituted a subset of the overall parallel segments and, as with the road crossing assessment, were classified by land ownership, (however no discernable difference was noted in loading rates between private and Federal segments).

The annual sediment load from each parallel segment was normalized to a per mile sediment load; the normalized results were averaged to represent the six watersheds. Extrapolation of these results to the remainder of parallel segments assumes that the random subset of parallel segments assessed as part of this study is representative of the larger watershed.

In addition to the sediment that is produced from the surface erosion of native or gravel roads, winter maintenance of roads of all surface types may produce an additional sediment load. The quantity of traction sand applied to the roads in the Lower Clark Fork TPA was estimated as 10 cubic yards for 85 lane miles (42.5 road miles, 0.28 tons/mile). The Sanders County Road Department usually plows and re-applies traction sand every day (depending on snowfall) for four to five months in the winter. This would equate to 28 tons/mile/year assuming a five day work week, for five months. The Noxon Section, Montana Department of Transportation (MDT) estimates that, in the past, 10 cubic yards of sand was applied to 15 miles of road along the Bull River (0.83 tons/mile); however MDT has discontinued the use of sand in favor of using salt.

The Blackfoot Headwaters TMDL Unpaved Roads assessment assumed a delivery rate of 10% for roads within 100 feet of surface water, and 5% for those roads within 200 feet. Using this as a guideline, watersheds with paved roads where traction sand is applied were assumed an additional sediment load based on 5-10% of the Sanders County traction sand application rate and miles of paved road within proximity to the stream.

5.5.2.4 Establishing the Total Allowable Load

In order to determine the reductions necessary to achieve a desired condition, or total allowable load from roads, a scenario was developed to simulate the application of Best Management Practices (BMPs) on the unpaved road network. In this case, BMP sediment reduction was evaluated based on a reduction in contributing road length.

The resultant sediment loads from the BMP scenario for estimating sediment load reductions was calculated by assuming a uniform reduction in contributing road length to 200 feet for each unpaved road crossing, and 400 feet for each parallel segment. For those sites assessed with less than 200 feet contributing length for crossings, and 400 feet for parallel segments, the original sediment load derived was retained. Average annual reduced mean sediment loads were then extrapolated to the entire watershed in the same manner in which the existing loads were calculated. Estimated summary load reductions by watershed are shown in **Table 5-28**.

Table 5-28. Sediment Loads from Roads and BMP Reductions

Watershed	Ownership	Existing Road Crossing Load	BMP Road Crossing Load	Existing Parallel Segment Load	BMP Parallel Segment Load	Total Existing Load	Total BMP Load
Bull	Federal	12.2	3.5	3.6	2.0	15.8	5.5
	State	0.1	0.1	0.5	0.3	0.6	0.4
	Private	4.4	1.3	1.0	0.4	5.4	1.7
	Total	16.7	4.9	5.1	2.7	21.8	7.6
Dry	Federal	2.4	0.7	0.7	0.4	3.1	1.1

Table 5-28. Sediment Loads from Roads and BMP Reductions

Watershed	Ownership	Existing Road Crossing Load	BMP Road Crossing Load	Existing Parallel Segment Load	BMP Parallel Segment Load	Total Existing Load	Total BMP Load
Marten	Federal	11.2	3.2	4.0	2.2	15.2	5.4
	Private	0.5	0.1	0.1	0.0	0.6	0.1
	Total	11.7	3.3	4.1	2.2	15.8	5.5
Swamp	Federal	0.8	0.2	0.2	0.1	1.0	0.3
	Private	2.1	0.6	0.6	0.2	2.7	0.8
	Total	2.9	0.8	0.8	0.3	3.7	1.1
White Pine	Federal	8.1	2.3	3.3	1.8	11.4	4.1
	Private	0.9	0.3	0.1	0.0	1.0	0.3
	Total	9.0	2.6	3.4	1.8	12.4	4.4
Elk	Federal	7.3	2.1	3.3	1.8	10.6	3.9
	Private	10.6	3.2	2.4	0.9	13.0	4.1
	Total	17.9	5.3	5.7	2.7	23.6	8.0

Due to the extent of the unpaved road network and the resulting inability to assess it in its entirety, generalized assumptions are necessary for modeling the effects of BMPs. On average, it was found that a 71% reduction in sediment from road crossings could be achieved based on the contributing road length reduction results. For parallel segments, on average a 45% reduction could be achieved from State or Federal roads, and a 64% reduction could be achieved from private road segments. Restoration efforts would need to consider site-specific BMPs that, on average, would be represented by the modeling assumptions. Other management issues that will impact BMP scenarios are the ability to perform restoration work within different land ownership categories.

5.5.2.5 Determining Allocations

Allocations for the reduction of sediment from roads in the Lower Clark Fork are presented as a percent reduction as a function of land ownership, by watershed. It is expected that the maintenance of roads and ultimate achievement of the allowable load is the responsibility of those individuals or entities that control and manage the roads. As stated previously, although the WEPP model does not specifically model BMPs, the reduction in contributing road length allows a simulation in the sediment reduction that would occur if some BMPs were installed. These management practices may be accomplished through a variety of measures that would lead to reduced sediment loading from the road network, such as the installation of structural BMPs (drive through dips, culvert drains, settling basins, silt fence, etc), road surface improvement, reduction in road traffic levels (seasonal or permanent road closures), and timely road maintenance to reduce surface rutting.

It is recognized that in reality, in some cases the majority of the sediment load may come from only a few discrete locations within a watershed, or some roads may currently have some or all of their roads addressed with appropriate BMPs and the allocations may already have been met. It is expected however, that the derived sediment load and expected reductions in this document serve as a starting point for road management investigations, and a guideline for where to begin additional studies to improve and refine these estimates. Complete TMDLs and allocations are presented in **Section 5.6**.

5.5.2.6 Assumptions and Considerations

- The sites assessed are representative of conditions throughout the Lower Clark Fork watershed.

- The contributing road length reduction as simulated in WEPP represents the likely achievable reductions in sediment load that can be gained from Best Management Practice application throughout the watershed.
- GIS identification of parallel segments and road crossings is reasonably accurate.
- Focusing on road/stream crossings and their associated approaching road lengths will effectively reduce the majority of the sediment load from roads.
- BMPs may have already have been implemented on roads but have not been accounted for in the GIS information used in this analysis and therefore the reductions necessary by land owner may be less than described in this document.

*At the time of production of this public review document, information regarding road obliteration projects that may not have been accounted for in the GIS road layers used for this analysis was brought to the attention of DEQ that may reduce the reductions necessary, and alter the summary statistics for some subwatersheds. This information will be reviewed and updated, if necessary, for the final TMDL document.

5.5.3 Upland Sediment

Nonpoint source pollution is pollution that originates over many varied and diffuse sources, where as pollution delivered directly from a specific point or outlet, such as an end of pipe or chimney stack, is known as point source pollution. Typically, non point source pollution is carried to streams and lakes through erosion via surface water (in the form of rainfall or snowmelt), ground water, or wind. It is often difficult to accurately quantify pollutant loads from the landscape when so much variability exists in weather, vegetation, land use practices, soil types, geology, and riparian condition occurs throughout a watershed. However, while many complex processes are intertwined that determine this load, models with varying levels of complexity can be employed to represent the landscape and simulate the processes that occur that allow us to reasonably estimate sediment loads, identify where on the landscape those loads are coming from, and intimate how those loads could be reduced.

In the Lower Clark Fork, three main categories of pollution sources for sediment have been identified: sediment from roads, sediment from bank erosion, and sediment from upland sources. As sediment from bank erosion and sediment from roads have been addressed via alternative methods, a USLE model is used to determine sediment from upland sources, and refers to the sediment from the landscape that is delivered to the stream via overland runoff from rainfall and snowmelt.

5.5.3.1 Quantifying Sediment from Upland Sources Using USLE

Upland sediment loading due to hillslope erosion was modeled using an application of the Universal Soil Loss Equation (USLE) with GIS. In addition, a sediment delivery ratio was incorporated to better simulate the relationship between downslope travel distance and ultimate delivery to the stream. Further, given that riparian zones can be effective sediment filters when wide and well vegetated, that riparian zone health is susceptible to anthropogenic impacts and thus to land management decisions, and that the effectiveness of riparian zones as sediment filters has been quantified in the literature, riparian zone health and its effect on sediment delivery was also incorporated into the sediment delivery ratio. This model provided an assessment of existing sediment loading from upland sources, an assessment of potential sediment loading through the application of BMPs and riparian improvement, and an additional scenario to simulate potential sediment loading before human alterations of the land cover.

USLE uses five main factors by which to estimate soil erosion: R * K* LS * C * P, where:
R = rainfall/intensity
K = erodibility
LS = length/slope
C = vegetation cover
P = field practices

ArcGIS and available data sources were used to develop the appropriate USLE factor values to estimate upland sediment loading. Typically, the ability to modify change to vegetation cover or field practices is the only real way to simulate landscape or land management alterations using USLE. As the P-Factor (field practices) generally relates to specific agricultural plots and at a scale much less than the watershed-scales we are dealing with, the C-Factor is the main variable to represent existing conditions and the potential for improvement. For the Lower Clark Fork TPA, the 2001 National Land Cover Dataset, NRCS C-Factor tables, and the assistance and input of local NRCS and USFS employees served as the basis for establishing the C-Factors for the Lower Clark Fork tributary watersheds.

The riparian corridor quality assessment used to modify sediment delivery to the stream, is taken from the report, "Lower Clark Fork River Drainage Habitat Problem Assessment" (GEI Consultants, Inc., 2005). Riparian corridors are referred to as having low (marginal/limited), moderate (some good, some marginal), or high (majority adequate for aquatic resources) quality and the buffering capacity of the riparian corridor is based on the percent condition for each stream of interest. Existing condition upland sediment loads are presented in **Table 5-29** below. Full details of the upland sediment modeling effort are documented in the report, Lower Clark Fork Tributaries Watershed Sediment Contribution from Hillslope Erosion, (Confluence, Inc., 2009) the text of which is included in **Attachment 2**.

5.5.3.2 Establishing the Total Allowable Load

From the model output, an average annual sediment load delivered to the stream is determined for each subwatershed, (or listed stream watershed). This sediment load represents the best estimation of current conditions resulting in sediment from upland sources.

The initial model outputs represent an estimate of current conditions and practices that result in the upland sediment load. To determine the total allowable load from upland sources, land use/land cover categories where management practices may be improved are modified (through an alteration to the C-Factor, or vegetative condition) to represent those changes on the landscape, and the USLE model is run again to simulate the resultant sediment loads that exist when all reasonable land, soil, and water conservation practices are employed.

For the purposes of this assessment, only a few land use categories were modified. These include grassland/herbaceous, pasture/hay, transitional, and cultivated crops. It is assumed that in the Lower Clark TPA, these land use categories have real potential for improvement and are often not meeting all applicable land, soil, and water conservation practices. The sediment contributions from the other land uses in the Lower Clark Fork TPA are presumed to be either negligible in their contribution, or with little potential for altering the current management to reduce sediment contribution from the existing load. In addition, riparian corridor buffering efficiency was altered to reflect an increase from moderate quality riparian health to high quality, and from areas with low quality riparian health to an improved moderate quality.

For the purposes of TMDL development, three scenarios were run in the model. The existing condition scenario (Scenario 1) represents the current sediment loads for the watersheds of interest in the Lower Clark Fork TPA. Scenario 2 represents the reduction in sediment load if only riparian condition were improved. Scenario 3, the improved condition scenario, represents the changes that would occur with improved land management practices, including restoration of the riparian buffers to filter sediment from the landscape. The improved condition scenario provides the desired, or allowable, sediment load from upland erosion which is used in combination with the allowable loads from bank erosion and roads to develop the TMDL. The results and estimated sediment reductions necessary from upland erosion are presented in **Table 5-29**.

Table 5-29. Upland Modeling Results

Watershed	Scenario 1*	Scenario 2**	Percent Change From Existing	Scenario 3***	Percent Change From Existing
Bull River	8118.8	6053.4	25%	5796.3	29%
Dry Creek	482.7	331.5	31%	330.5	32%
Marten Creek	5282.0	3256.2	38%	3214.2	39%
Swamp Creek	2618.9	2095.4	20%	2008.9	23%
White Pine Creek	1977.7	1404.6	29%	1346.4	32%
Elk Creek	4257.4	2626.5	38%	2595.2	39%

*Upland Erosion Sediment Load for Existing Conditions
**Upland Erosion Sediment Load for Existing Upland Conditions and BMP Riparian Health
***Upland Erosion Sediment Load for BMP Conditions and BMP Riparian Health (All BMPs)

Lastly, a historical condition scenario was run. The last scenario was completed not as a target condition, but simply to compare the existing condition to the historical condition to investigate the effects historic timber harvest and fire may have had on past sediment loads. Some observations of the historic scenario results include:

- The 1910 fire affected the most subwatersheds and represented the largest area of disturbance for the 1910-1919 time periods.
- From 1910-1939, the predominant transitional polygon type was fire. After 1960, the predominant transitional polygon type was timber harvest.
- The Marten Creek watershed has experienced a large fire or harvest impact in almost every decade reviewed, except 1940-49, and 1980-89.
- Most events in most subwatersheds have marginal estimated effect on total sediment delivered from upland sources. Severe events such as the 1910 fires are estimated here to have resulted in a 20-30% increase in annual sediment delivery.

The complete results of the historic scenario are presented in **Attachment 2**.

5.5.3.4 Determining Allocations

The upland sediment loads are estimations based on the land uses that exist within a watershed, and combination of climate, geology, geography and other related factors that drive sediment production as described earlier in this section. Further assumptions are made regarding the riparian condition and the ability for improved riparian conditions to effectively reduce sediment loading to the stream. For the purposes of allocating the load amongst the sources, sediment loads from upland erosion are investigated by the land use/land cover classification as identified by the NLCD information. In addition, while only a few land cover classifications were selected to simulate reductions through BMPs, it should be noted that the potential for riparian improvement occurs throughout the watersheds regardless of land cover classification, and that typically riparian improvement constitutes the greatest potential for upland sediment reduction in the Lower Clark Fork, as well as a significant role in stabilizing banks and improving sediment loading from bank erosion as was discussed in **Section 5.5.1**. Complete TMDLs and allocations are presented in **Section 5.6**.

5.5.3.5 Assumptions and Considerations

As with any modeling effort, and especially when modeling at a watershed scale, there are a number of assumptions that must be accepted. For the Lower Clark Fork, the following points serve as some of the more significant considerations:

- The input variables used in the USLE calculations are representative of their respective land use conditions.
- The land management practices (grazing duration, hay cutting, etc) for certain land use categories that define the vegetative cover are relatively consistent and representative of practices throughout the watershed.
- The riparian condition as estimated through the aerial assessment is representative of on-the-ground conditions.
- The improvement scenarios to riparian condition and land management are reasonable and achievable.
- The USLE model provides an appropriate level of detail and is sufficiently accurate for developing upland sediment loads for TMDL purposes.
- The data sources used are reasonable and appropriate to characterize the watershed and parameterize the model.
- The riparian health assessment is of sufficient accuracy, resolution and coverage to serve as the basis for a sediment delivery ratio.
- Megahan and Ketchesons dimensionless equation is appropriate to relate travel distance and delivered volume as the basis for a sediment delivery ratio (Megahan and Ketcheson, 1996).

5.6 TMDL AND ALLOCATIONS (BY STREAM)

The sediment TMDLs for all streams and stream segments presented in **Tables 5-30 – 5-34** below are expressed as a yearly load, and a percent reduction in the total yearly sediment loading achieved by applying the load allocation reductions identified in the associated tables. These reductions address both coarse and fine sediment loading to ensure full protection of beneficial uses. The allocations are based on information provided from the source assessment analyses used within this document, and a determination that these approximate source load reductions for each stream or segment of interest, and its contributing tributaries, will cumulatively account for the total percent reduction needed to meet the TMDL, and is achievable by addressing the major human caused sources described in this section. The sediment load allocations and associated rationale behind the allocations are described in **Section 5.5** and **Appendices D-G**. Due to the uncertainty and assumptions associated with the methods used to determine sediment loads, the specific annual loads should not necessarily be recognized as an exact quantification. However the percent reductions presented offer a valuable and more conceivable goal for watershed restoration planning purposes and an accurate representation of the *degree* of sediment reduction that would result from the implementation of this plan. As required by EPA, TMDLs must also be expressed as actual daily loads. Information on interpreting these values into “daily” sediment loads is presented in **Appendix E**.

Sediment from upland erosion in the following tables is represented as the sum of upland sediment load from each of the land uses within that watershed. This category, by default, incorporates both sediment loads influenced by anthropogenic activities and natural loads. However, within the context of TMDL development and Montana state law, we can interpret the natural load to be the load that results when all reasonable land, soil, and water conservation practices are applied, which in this case, also equates to the sediment load allocation.

A TMDL is determined by the sum of the Waste Load Allocation (WLA), Load Allocation (LA), and Margin of Safety (MOS). Waste Load Allocations are derived for specific point sources, often which require local, state, or federal permits that put limits on the amount of a particular pollutant that a nearby waterbody can receive. There are no WLAs identified in the Lower Clark Fork tributaries of interest.

5.6.1 Bull River

Table 5-30. Bull River Sediment TMDL

Sources		Current Estimated Load (Tons/Year)	Sediment Load Allocation (Tons/Year)	Sediment Load Allocation – Expressed as Percent Reduction
Bank Erosion		4689	1454	69%
Roads	Federal	18.8	6.6	
	State	0.6	0.4	
	Private	5.4	1.7	
Total Road		24.8	8.7	65%
Upland Load	Urban	12.5	7.2	
	Forest	5869	4257.3	
	Wetland	12.1	7.2	
	Shrub/Scrub	1412.2	1082.8	
	Transitional	136.1	46.9	
	Grassland/Herbaceous	668.1	388.1	
	Barren land	5.0	4.8	
	Pasture/Hay	2.5	1.4	
	Cultivated Crops	1.3	0.6	
Total Upland Load		8118.8	5796.3	29%
Total Sediment Load		12,832.6	7259	41%

5.6.2 Dry Creek

Table 5-31. Dry Creek Sediment TMDL

Sources		Current Estimated Load (Tons/Year)	Sediment Load Allocation (Tons/Year)	Sediment Load Allocation – Expressed as Percent Reduction
Bank Erosion		93.2	55.9	40%
Roads	Federal	3.1	1.1	
Total Road		3.1	1.1	66%
Upland Load	Forest	453.8	313.9	
	Wetland	0.1	0.1	
	Shrub/Scrub	23.7	14.7	
	Grassland/Herbaceous	5.2	1.9	
Total Upland		482.7	330.5	32%
Total Sediment Load		579.0	387.5	33%

5.6.3 Marten Creek

Table 5-32. Marten Creek Sediment TMDL

Sources		Current Estimated Load (Tons/Year)	Sediment Load Allocation (Tons/Year)	Sediment Load Allocation – Expressed as Percent Reduction
Bank Erosion		869.5	469.5	46%
Roads	Federal	15.2	5.4	
	Private	0.6	0.1	
Total Road		15.8	5.5	65%
Upland Load	Urban	1.2	0.6	
	Forest	4227.5	2628.1	
	Wetland	6.4	4.0	
	Shrub/Scrub	890.0	534.1	
	Transitional	114.4	35.4	
	Grassland/Herbaceous	42.5	12.1	
Total Upland		5282.0	3214.2	39%
Total Sediment Load		6167.3	3689.2	40%

5.6.4 Swamp Creek

Table 5-33. Swamp Creek Sediment TMDL

Sources		Current Estimated Load (Tons/Year)	Sediment Load Allocation (Tons/Year)	Sediment Load Allocation – Expressed as Percent Reduction
Bank Erosion		533.7	272.2	49%
Roads	Federal	1.0	0.3	
	Private	2.7	0.8	
Total Road		3.7	1.1	70%
Upland Load	Urban	0.7	0.5	
	Forest	1779.0	1428.5	
	Wetland	2.7	2.2	
	Shrub/Scrub	534.4	420.5	
	Transitional	10.8	4.1	
	Grassland/Herbaceous	282.4	148.4	
	Barren Land	0.1	0.1	
	Pasture/Hay	6.8	3.6	
	Cultivated Crops	2.0	0.9	
Total Upland		2618.9	2008.9	23%
Total Sediment Load		3156.3	2282.2	28%

5.6.5 White Pine Creek

Table 5-34. White Pine Creek Sediment TMDL

Sources		Current Estimated Load (Tons/Year)	Sediment Load Allocation (Tons/Year)	Sediment Load Allocation – Expressed as Percent Reduction
Bank Erosion		817.9	253.6	69%
Roads	Federal	11.4	4.1	
	Private	1.0	0.3	
Total Road		12.4	4.4	65%

Table 5-34. White Pine Creek Sediment TMDL

Sources		Current Estimated Load (Tons/Year)	Sediment Load Allocation (Tons/Year)	Sediment Load Allocation – Expressed as Percent Reduction
Upland Load	Forest	1628.8	1617.1	
	Wetland	1.4	0.9	
	Shrub/Scrub	160.4	107.0	
	Transitional	124.5	42.9	
	Grassland/Herbaceous	60.9	27.6	
	Pasture/Hay	0.3	0.2	
	Cultivated Crops	1.5	0.7	
Total Upland		1977.7	1346.4	32%
Total Sediment Load		2808	1604.4	43%

5.7 Seasonality and Margin of Safety

All TMDL documents must consider the seasonal variability, or seasonality, on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and load allocations. TMDL development must also incorporate a margin of safety into the load allocation process to account for uncertainties in pollutant sources and other watershed conditions, and to ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses. This section describes seasonality and margin of safety in the Lower Clark Fork TPA tributary sediment TMDL development process.

5.7.1 Seasonality

The seasonality of sediment impact to aquatic life is taken into consideration in the analysis within this document. Sediment loading varies considerably with season. For example, sediment delivery increases during spring when snowmelt delivers sediment from upland sources and the resulting higher flows scour streambanks. However, these higher flows also scour fines from streambeds and sort sediment sizes, resulting in a temporary decrease in the proportion of deposited fines in critical areas for fish spawning and insect growth. While fish are most susceptible to fine sediment deposition seasonally during spawning, fine sediment may affect aquatic insects throughout the year. Because both fall and spring spawning salmonids reside in the Lower Clark Fork TPA, streambed conditions need to support spawning through all seasons. Additionally, reduction in pool habitat, by either fine or coarse sediment, alters the quantity and quality of adult fish habitat and can, therefore, affect the adult fish population throughout the year. Thus, sediment targets are not set for a particular season, and source characterization is geared toward identifying average annual loads. Annual loads are appropriate because the impacts of delivered sediment are a long-term impact—once sediment enters the stream network, it may take years for sediment loads to move through a watershed. Although an annual expression of the TMDLs was determined as the most appropriate timescale to facilitate TMDL implementation, to meet EPA requirements daily loads are provided in **Appendix E**.

5.7.2 Margin of Safety

Incorporating a margin of safety (MOS) is a required component of TMDL development. The MOS accounts for the uncertainty between pollutant loading and water quality and is intended to ensure that load reductions and allocations are sufficient to sustain conditions that will support beneficial uses. 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 (U.S.Environmental Protection Agency, 1999). This plan incorporates an implicit MOS in a variety of ways:

- By using multiple targets to help verify beneficial use support determinations and assess standards attainment after TMDL implementation. Conservative assumptions were used during target development (see **Section 5.4.1**).
- By using supplemental indicators to help verify beneficial use support determinations and assess standards attainment after TMDL implementation. Conservative assumptions were used during supplemental indicator development (see **Section 5.4.1**).
- By using standards, targets, and TMDLs that address both coarse and fine sediment delivery.
- Conservative assumptions were used for the source assessment process, including erosion rates, sediment delivery ratio, and road and agricultural BMP effectiveness (see **Appendices B**, **D, E, and F**).
- By considering seasonality (discussed above).
- By using an adaptive management approach to evaluate target attainment and allow for refinement of load allocation, targets, modeling assumptions, and restoration strategies to further reduce uncertainties associated with TMDL development (discussed below and in **Section 6.0** and **7.0**).
- By using naturally occurring sediment loads as described in ARM 17.30.602(17) to establish the TMDLs and allocations. This includes an allocation process that addresses all known human sediment causing activities, not just the significant sources.

5.7.3 Uncertainty and Adaptive Management

A degree of uncertainty is inherent in any study of watershed processes related to sediment. The assessment methods and targets used in this study to characterize impairment and measure future restoration are each associated with a degree of uncertainty. This TMDL document includes monitoring and adaptive management strategies to account for uncertainties in the field methods, targets, and supplemental indicators. For the purpose of this document, adaptive management relies on continued monitoring of water quality and stream habitat conditions, continued assessment of impacts from human activities and natural conditions, and continued assessment of how aquatic life and coldwater fish respond to changes in water quality and stream habitat conditions. Adaptive management addresses important considerations, such as feasibility and uncertainty in establishing targets. For example, despite implementation of all restoration activities (**Section 7.0**), the attainment of targets may not be feasible due to natural disturbances, such as forest fires, flood events, or landslides.

The targets established in the document are meant to apply under median conditions of natural background and natural disturbance. The goal is to ensure that management activities achieve loading approximate to the TMDLs within a reasonable timeframe and prevent significant excess loading during recovery from significant natural events. Additionally, the natural potential of some streams could preclude achievement of some targets. For instance, natural geologic and other conditions may contribute sediment at levels that cause a deviation from numeric targets associated with sediment. Conversely, some targets may be underestimates of the potential of a given stream and it may be appropriate to apply more protective targets upon further evaluations. Supplemental indicators are used to help with these determinations. In these circumstances, it is important to recognize that the adaptive management approach provides the flexibility to refine targets and supplemental indicators as necessary to ensure protection of the resource and to adapt to new information concerning target achievability.

Sediment limitations in many streams in the Lower Clark Fork TPA relate to both coarse and fine sediment. In general, roads and upland sources produce mostly fine sediment loads, while streambank erosion can produce all sizes of sediment. Because sediment source modeling may under- or over-estimate natural inputs due to selection of sediment monitoring sections and the extrapolation methods used, model results should not be taken as an absolutely accurate account of sediment production within each watershed. Instead, source assessment model results should be considered used as a tool to estimate sediment loads and make general comparisons of sediment loads from various sources.

Cumulatively, the source assessment methodologies address average sediment source conditions over long timeframes. Sediment production from both natural and human sources is driven by storm events. Pulses of sediment are produced periodically, not uniformly, through time. Separately, each source assessments methodology introduces different levels of uncertainty. For example, the road erosion method focuses on sediment production and sediment delivery locations from yearly precipitation events. The analysis did not include an evaluation of road culvert failures, which tend to add additional sediment loading during large flood events and would, therefore, increase the average yearly sediment loading if calculated over a longer time period. The bank erosion method focuses on both sediment production and sediment delivery and also incorporates large flow events via the method used to identify bank area and retreat rates. Therefore, a significant portion of the bank erosion load is based on large flow events versus typical yearly loading. The hillslope erosion model focuses primarily on sediment production across the landscape during typical rainfall years. Sediment delivery is partially incorporated based on distance to stream. The significant filtering role of near-stream vegetated buffers (riparian areas) was incorporated into the hillslope analysis, resulting in proportionally reduced modeled sediment loads from hillslope erosion relative to the average health of the vegetated riparian buffer throughout the watershed.

Because the sediment standards relate to 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, the percent-reduction allocations are based on the modeled upland and riparian BMP scenarios for each major source type. The allocations reflect reasonable reductions as determined from literature, agency and industry documentation of BMP effectiveness, and field assessments. However, if new information becomes available regarding the feasibility or effectiveness of BMPs, adaptive management allows for the refinement of TMDLs and allocations.

Additionally, as part of this adaptive management approach, shifts in the amount or intensity of land use activities should be tracked and incorporated into the source assessment to determine if allocations need to be revised. Cumulative impacts from multiple projects must also be considered. This approach will help track the recovery of the system and the impacts, or lack of impacts, from ongoing management activities in the watershed. Under these circumstances, additional targets and other types of water quality goals may need to be developed to address new stressors to the system, depending on the nature of the activity.

6.0 Other Problems/Concerns

6.1 Pollution Listings

Water quality issues are not limited simply to those streams where TMDLs are developed. In some cases, streams have not yet been reviewed through the assessment process and do not appear on the 303(d) List. In other cases, streams in the Lower Clark Fork Tributaries TPA may appear on the 303(d) List but may not always require TMDL development for a pollutant, but do have pollution listings such as "alteration in stream-side or littoral vegetation covers" that could be linked to a pollutant. These habitat related pollution causes are often associated with sediment issues, or potential sediment issues, or may be having a deleterious effect on a beneficial use without a clearly defined quantitative measurement or direct linkage to a pollutant to describe that impact. Nevertheless, the issues associated with these streams are still important to consider when attempting to improve water quality conditions in individual streams, and the Clark Fork watershed as a whole. In some cases, pollutant and *pollution* causes are listed for waterbody, and the management strategies as incorporated through the TMDL development for the pollutant, inherently address some or all of the pollution listings. **Table 6-1** presents the *pollution* listings in the Lower Clark Fork Tributarues TPA, and notes those streams listed that do not have any associated pollutant listings.

Table 6-1. Waterbody segments in the Lower Clark Fork Tributaries TPA with pollution listings related to the 2008 303(d) List pollutants of concern addressed in this document

Waterbody ID	Stream Segment	2008 Probable Causes of Impairment
MT76N003_030	**Beaver Creek*,** headwaters to the mouth (Confluence with the Clark Fork River)	*Alteration in stream side or littoral vegetation covers*
MT76N003_040	**Bull River,** the North Fork to the mouth (Cabinet Gorge Reservoir)	*Physical substrate habitat alterations*
MT76N003_080	**Graves Creek*,** headwaters to the mouth (Clark Fork River)	*Alteration in stream side or littoral vegetation covers*
MT76N003_090	**Marten Creek,** headwaters to the mouth (Noxon Reservoir)	*Physical substrate habitat alterations*
MT76N003_100	**Pilgrim Creek*,** headwaters to the mouth (Cabinet Gorge Reservoir)	*Physical substrate habitat alterations*
MT76N003_190	**Rock Creek*,** headwaters to mouth below the Noxon Dam	*Alteration in stream side or littoral vegetation covers*
MT76N003_130	**Vermillion River*,** headwaters to the mouth (Noxon Reservoir)	*Alteration in stream side or littoral vegetation covers*
MT76N003_120	**White Pine Creek,** headwaters to the mouth (Beaver Creek)	*Alteration in stream side or littoral vegetation covers*

* Streams listed for *pollution* only, and have no associated sediment pollutant listings.

6.2 Pollution Causes of Impairment Descriptions

Pollution listings are often used as a probable cause of impairment when available data at the time of assessment does not necessarily provide a direct quantifiable linkage to a specific pollutant, however non-pollutant sources or indicators do indicate impairment. In some cases the pollutant and pollution categories are linked and appear together in the cause listings, however a pollution category may appear independent of a pollutant listing. The following discussion provides some rationale for the application of the identified pollution causes to a waterbody, and thereby provides additional insight into possible factors in need of additional investigation or remediation.

Alteratation in Stream-side or Littoral Vegetation Covers
Alteration in stream-side or littoral vegetation covers refers to circumstances where practices along the stream channel have altered or removed riparian vegetation and subsequently affected channel geomorphology and/or stream temperature. Such instances may be riparian vegetation removal for a road or utility corridor, or overgrazing by livestock along the stream. As a result of altering the stream-side vegetation, destabilized banks from loss of vegetative root mass could lead to over-widened stream channel conditions, elevated sediment loads, and the resultant lack of canopy cover can lead to increased water temperatures.

Physical Substrate Habitat Alterations
Physical substrate habitat alterations generally describe cases where the stream channel has been physically altered or manipulated, such as through the straightening of the channel or from anthropogenically influenced channel downcutting, resulting in a reduction of morphological complexity and loss of habitat (riffles and pools) for fish and aquatic life. For example, this may occur when a stream channel has been straightened to accommodate roads, agricultural fields, or through placer mine operations.

6.3 Monitoring and BMPs for Pollution Affected Streams

Streams listed for *pollution* as opposed to a pollutant should not be overlooked when developing watershed management plans. Attempts should be made to collect sediment and temperature information where data is minimal and the linkage between probable cause, pollution listing, and affects to the beneficial uses are not well defined. The monitoring and restoration strategies that follow in **Sections 7** and **8** are presented to address pollutant and issues for Lower Clark Fork tributaries, are equally applicable to streams listed for the above pollution categories.

7.0 Framework Water Quality Restoration Strategy

7.1 Summary of Restoration Strategy

This section provides a framework strategy for water quality restoration in the Lower Clark Fork watershed, focusing on how to meet conditions that will likely achieve the TMDLs presented in this document. This section identifies which activities will contribute the most reduction in pollutants for each TMDL. Limited information about spatial application of each restoration activity will be provided.

This section should assist stakeholders in developing a more detailed adaptive Watershed Restoration Plan (WRP) in the future. The locally-developed WRP will likely provide more detailed information about restoration goals and spatial considerations within the watershed. The WRP may also encompass broader goals than the focused water quality restoration strategy outlined in this document. The intent of the WRP is to serve as a locally organized "road map" for watershed activities, sequences of projects, prioritizing types of projects, and funding sources towards achieving local watershed goals, including water quality improvements. Within this plan, the local stakeholders would identify and prioritize streams, tasks, resources, and schedules for applying Best Management Practices (BMPs). As restoration experiences and results are assessed through watershed monitoring, this strategy could be adapted and revised by stakeholders based on new information and ongoing improvements.

Although no formal TMDL document or WRP has been developed for the Lower Clark Fork tributaries previously, it should be noted that the Lower Clark Fork Tributaries TPA has seen a considerable amount of restoration activity over the years. Some of the practices outlined in the sections below have been or are currently being implemented throughout the LCFT-TPA, and focused management strategies have been written independently for multiple drainages. The TMDL document provides a broad watershed assessment for specific streams and specific pollutants or water quality/stream habitat issues. The TMDL document should be used in combination with other assessments and resources that provide information at a further detailed scale to assist in the identification of specific areas of concern and potential restoration projects that will ultimately lead to the achievement of the TMDL. These resources, along with the TMDL, should form the basis for the development of the WRP, such that restoration efforts are developed into the most efficient and effective strategies possible. The following documents are examples of assessments that have been completed which should be considered to develop a greater understanding of the issues affecting the Lower Clark Fork Tributaries TPA:

- *Green Mountain Watershed Project Implementation Plan*. GMCD, 1998
- *A Stream Habitat Inventory of Pre and Post Restoration Conditions of the Elk Creek (Heron) Drainage, 1997 and 1998*. Watershed Consulting, 1998
- *West Fork Elk Creek/Deer Creek/Beaver Creek Assessment Report*. (Watershed Consulting LLC, 1999)
- *Draft Phase 1/Phase 2 Total Maximum Daily Load Report for Pilgrim Creek, Northwest Montana*. USFS/River Design Group, 2003
- *Pilgrim Creek Watershed Assessment and Conceptual Design Report*. USFS/River Design Group, 2004
- *Lower Clark Fork River Drainage Habitat Problem Assessment*. (GEI Consultants, Inc., 2005)
- *Vermillion River Watershed Assessment and Preliminary Restoration Plan*. USFS, 2006

7.2 Role of DEQ, Other Agencies, and Stakeholders

The DEQ does not implement TMDL pollutant reduction projects for nonpoint source activities, but can provide technical and financial assistance for stakeholders interested in improving their water quality. The DEQ will work with participants to use the TMDLs as a basis for developing locally-driven WRPs, administer funding specifically to help fund water quality improvement and pollution prevention projects, and can help identify other sources of funding.

Because most nonpoint source reductions rely on voluntary measures, it is important that local landowners, watershed organizations, and resource managers continue to work collaboratively with local and state agencies to achieve water quality restoration which will progress toward meeting water TMDL targets and load reductions. Specific stakeholders and agencies that have been, and will likely continue to be, vital to restoration efforts include the Lower Clark Fork Watershed Group, Green Mountain Conservation District, USFS, USFWS, NRCS, DNRC, FWP, Avista, EPA and DEQ. Other organizations and non-profits that may provide assistance through technical expertise, funding, educational outreach, or other means include Montana Water Trust, Montana Water Center, University of Montana Watershed Health Clinic, and MSU Extension Water Quality Program.

7.3 Watershed Restoration Goals

The following are general water quality goals provided in this TMDL document:

- Provide technical guidance for full recovery of aquatic life beneficial uses to all impaired streams within the Lower Clark Fork TPA by improving sediment related water quality conditions. This technical guidance is provided by the TMDL components in the document which include:
  - water quality targets,
  - pollutant source assessments, and
  - general restoration guidance which should meet the TMDL allocations.
- Assess watershed restoration activities to address significant pollutant sources.

A WRP is a locally-derived plan that can be more dynamic and detailed than the TMDL document. It can be refined as activities progress and address more goals than those included in this TMDL document. The following elements may be included in a stakeholder-derived WRP in the near future:

- Support for implementing restoration projects to protect water conditions so that all streams in the watershed maintain good water quality with an emphasis on waters with TMDLs completed.
- More detailed cost/benefit analysis and spatial considerations for water quality improvement projects.
- Develop an approach for future BMP installment and efficiency results tracking.
- Provide information and education components to assist with stakeholder outreach about restoration approaches, benefits and funding assistance.
- Other various watershed health goals.
- Weed control initiatives
- Other local watershed based issues.

Specific water quality goals (i.e. targets) for sediment are detailed in **Section 5.** These targets serve as the basis for long-term effectiveness monitoring for achieving the above water quality goals. These targets specify satisfactory conditions to ensure protection and/or recovery of beneficial uses of waterbodies in the Lower Clark Fork Tributaries TPA. Section 8 identifies a general monitoring strategy and recommendations designed to track implementation water quality conditions and restoration successes.

7.4 Overview of Management Recommendations

Sediment TMDLs were completed for 5 waterbody segments. Other streams in the watershed may be in need of restoration or pollutant reduction, but insufficient information about them precludes TMDL formation at this time. In general, sediment loading can be greatly reduced by focusing restoration efforts on streamside riparian restoration and long term riparian zone and floodplain recovery management. Stream channel restoration may be necessary in areas that have lost channel integrity due to long term riparian vegetation impacts. Other sediment restoration actions include unpaved road erosion control near streams, application of Best Management Practices in agriculture and timber harvest operations, and sound and conscientious future planning for growth and development.

7.4.1 Sediment Restoration Approach

Streamside riparian vegetation restoration and long term riparian area management are vital restoration practices that must be implemented across the watershed to achieve the sediment TMDLs. Vigorous native streamside riparian vegetation provides root mass which hold streambanks together. Suitable root mass density ultimately slows bank erosion. Riparian vegetation filters sediment from upland runoff. Therefore, improving riparian vegetation will decrease bank erosion by improving streambank stability and will also reduce sediment delivery from upland sources. Sediment is also deposited more heavily in healthy riparian zones during flooding because water velocities slow in these areas enough for excess sediment to settle out.

Riparian disturbance has occurred throughout the Lower Clark Fork TPA as a result of many influencing factors. Historic forest fires, riparian timber harvest, and the conversion of forest and valley bottoms for agriculture, livestock production, and residential development have all had varying degrees of impact, depending on the drainage. Restoration recommendations involve the promotion of riparian recovery through the application of timber harvest best management practices, improved grazing management (including the timing and duration of grazing, the development of multi-pasture systems that include riparian pastures, and the development of off-site watering areas), and floodplain and streambank stabilization and revegetation efforts where necessary. In general, natural recovery of disturbed systems is preferred, however it is acknowledged that the climate and geology of the Lower Clark Fork area may not readily allow for unassisted recovery in some areas where disturbance has occurred. Active vegetation planting along with bank sloping may increase costs, but still remains within a reasonable and relatively cost effective restoration approach. When stream channel restoration work is needed because of altered stream channels, costs increase and projects should be assessed on a case by case basis. Any BMPs implemented should aim to prevent availability, transport, and delivery of sediment by a combination of minimizing sediment delivery, reducing the rate of runoff, and intercepting sediment transport, through the most natural or natural-like means possible. Appropriate BMPs will differ by location and are recommended to be included and prioritized as part of a comprehensive watershed scale plan (e.g. WRP).

Although roads may be a small source of sediment at the watershed scale, sediment derived from roads may cause significant localized impact in some stream reaches. Restoration approaches for unpaved roads near streams should be to divert water off of roads and ditches before it enters the stream. The diverted water should be routed through natural healthy vegetation, which will act as filter zones for the sediment laden runoff before it enters streams. Sediment loads from culvert failure and culvert caused scour were not assessed by the TMDL source assessment, but should be considered in road sediment restoration approaches.

Assistance from resource professionals from various local, state, and federal agencies or non-profit groups is widely available in the Lower Clark Fork TPA. In particular, the Green Mountain Conservation District in Thompson Falls, and the Lower Clark Fork Watershed Group are two resources that are valuable aids for assisting with investigating, developing, and implementing measures to improve conditions in the Lower Clark Fork watershed.

7.4.2 Pollution Restoration Approach

Although TMDL development is not required for pollution listings, they are frequently linked to pollutants, and addressing pollution sources is an important component of TMDL implementation. Pollution listings within the Lower Clark Fork TPA are described in **Section 6**. Typically, habitat impairments are addressed during implementation of associated pollutant TMDLs. Therefore, if restoration goals within the Lower Clark Fork TPA are not also addressing pollution impairments, additional pollution-related BMP implementation should be considered.

7.5 Restoration Approaches by Source

Generalized management recommendations are outlined below for the major sources of human caused pollutant loads in the Lower Clark Fork TPA: grazing, upland sources, riparian vegetation removal, irrigation, unpaved roads. Applying ongoing BMPs are the core of the sediment reduction strategy, but are only part of the restoration strategy. Restoration activities may also address other current pollution-causing uses and management practices. In some cases, efforts beyond implementing new BMPs may be required to address key sediment sources. In these cases, BMPs are usually identified as a first effort and an adaptive management approach will be used to determine if further restoration approaches are necessary to achieve water quality standards. Monitoring is also an important part of the restoration process. Monitoring recommendations are outlined in **Section 8.0**.

7.5.1 Upland Sediment (Agriculture)

The primary strategy of the recommended upland BMPs is to reduce sediment and nutrient inputs. The major factors involved in decreasing sediment loads are reducing the amount of erodible soil, reducing the rate of runoff, and intercepting eroding soil before it enters waterbodies. The main BMP recommendations for the Lower Clark Fork watersheds are riparian buffers and vegetated filter strips (VFS), where appropriate. Both of these methods reduce the rate of runoff, promote infiltration of the soil (instead of delivering runoff directly to the stream), and intercept sediment. Effectiveness is typically about 70 percent for filter strips and 50 percent for buffers (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2007). Filter strips and buffers are most effective when used in conjunction with agricultural BMPs that reduce the availability of erodible soil such as conservation tillage, crop rotation, stripcropping, and precision farming. Additional BMPs and details on the suggested BMPs can be obtained from NRCS and in Appendix A of Montana's NPS Management Plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2007).

Reducing sediment loading will decrease loading of sediment-bound nutrients, but nutrient management is also needed to reduce nutrient loading. Nutrient management is managing the amount, source, placement, form, and timing of plant nutrients and soil amendments. Nutrient management components of the conservation plan should include the following information:

- Field maps and soil maps,
- Planned crop rotation or sequence,
- Results of soil, water, plant, and organic materials sample analysis,
- Realistic expected yields,
- Sources of all nutrients to be applied,
- Nutrient budget, including credits of nutrients available,
- Nutrient rates, form, timing, and application method to meet crop demands and soil quality concerns,
- Location of designated sensitive areas, and
- Guidelines for operation and maintenance.

More information about nutrient management techniques can be found at your local NRCS office or in the NRCS publication MT 590-1. Further discussion of management practices related to specific elements of agricultural production continue below.

7.5.1.1 Grazing

Although grazing and livestock production is not as prevalent in the Lower Clark Fork watershed as in other TMDL planning areas, development of riparian grazing management plans should be a goal for any landowner in the watershed who operates livestock and does not currently have such plans. Private land owners may be assisted by state, county federal, and local conservation groups to establish and implement appropriate grazing management plans (note that riparian grazing management does not necessarily eliminate all grazing in riparian corridors). Nevertheless, in some areas, a more restrictive management strategy may be necessary for a period in order to accelerate re-establishment of a riparian community with the most desirable species composition and structure.

Grazing management includes the timing and duration of grazing, the development of multi-pasture systems, including riparian pastures, and the development of off-site watering areas. The key strategy of the recommended grazing BMPs is to develop and maintain healthy riparian vegetation and minimize disturbance of the stream bank and channel. The primary recommended BMPs for the Lower Clark Fork watershed are providing off-site watering sources, limiting livestock access to streams and hardening the stream at access points, planting woody vegetation along stream banks, and establishing riparian buffers. Although bank revegetation is a preferred BMP, in some instances bank stabilization may be necessary prior to planting vegetation. Other general grazing management recommendations and BMPs to address grazing sources of pollutants and pollution are listed below (**Table 7-1**). Further information on grazing BMPs can be obtained in **Appendix A** of Montana's NPS Management Plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2007).

Table 7-1. General grazing/wildlife BMPs and management techniques.

BMP and Management Techniques	**Pollutants Addressed**
Design a grazing management plan and determine the intensity, frequency, duration, and season of grazing to promote desirable plant communities and productivity of key forage species. In this case, native riparian vegetation.	Sediment, temperature, nutrients
Encourage the growth of woody species (willow, alder, etc.) along the streambank, which will limit animal access to the stream and provide root support to the bank.	Sediment, nutrients, temperature

Table 7-1. General grazing/wildlife BMPs and management techniques.

BMP and Management Techniques	Pollutants Addressed
Establish riparian buffer strips of sufficient width and plant composition to filter and take up nutrients and sediment from concentrated animal feeding operations.	Sediment, nutrients,
Create riparian buffer area protection grazing exclosures through fencing.	Sediment, temperature, nutrients
Maintain adequate vegetative cover to prevent accelerated soil erosion, protect streambanks, and filter sediments. Set target grazing use levels to maintain both herbaceous and woody plants.	Sediment
Ensure adequate residual vegetative cover and regrowth and rest periods. Periodically rest or defer riparian pastures during the critical growth period of plant species.	Sediment, nutrients
Distribute livestock to promote dispersion and decomposition of manure and to prevent the delivery of manure to water sources.	Nutrients
Alternate a location's season of use from year to year. Early spring use can cause trampling and compaction damage when soils and streambanks are wet. If possible, develop riparian pastures to be managed as a separate unit through fencing.	Nutrients, sediment
Provide off-site, high quality water sources.	Nutrients, sediment
Periodically rotate feed and mineral sites and generally keep them in uplands.	Nutrients, sediment
Place salt and minerals in uplands, away from water sources (ideally ¼ mile from water to encourage upland grazing).	Sediment, nutrients, temperature
Monitor livestock forage use and adjust strategy accordingly.	Sediment, nutrients, temperature
Create hardened stream crossings.	Sediment

7.5.1.2 Animal Feeding Operations

Animal feeding operations (AFOs) can pose a number of risks to water quality and public health due to the amount of animal manure and wastewater they generate. To minimize water quality and public health impacts from AFOs and land applications of animal waste, the USDA and EPA released the Unified National Strategy for AFOs in 1999 (US Department of Agriculture, 2005). This strategy encourages owners of AFOs of any size or number of animals to voluntarily develop and implement site-specific Comprehensive Nutrient Management Plans (CNMPs) by 2009. This plan is a written document detailing manure storage and handling systems, surface runoff control measures, mortality management, chemical handling, manure application rates, schedules to meet crop nutrient needs, land management practices, and other options for manure disposal. An AFO that meets certain specified criteria is referred to as a Concentrated Animal Feeding Operation (CAFO), and in addition may be required to obtain a Montana Pollution Discharge Elimination System (MPDES) permit as a point source. Montana's AFO compliance strategy is based on federal law and has voluntary, as well as, regulatory components. If voluntary efforts can eliminate discharges to state waters, in some cases no direct regulation is necessary through a permit. Operators of AFOs may take advantage of effective, low cost practices to reduce potential runoff to state waters, which additionally increase property values and operation productivity. Properly installed vegetative filter strips, in conjunction with other practices to reduce waste loads and runoff volume, are very effective at trapping and detaining sediment and reducing transport of nutrients and pathogens to surface waters, with removal rates approaching 90 percent (US Department of Agriculture, 2005). Other options may include clean water diversions, roof gutters, berms, sediment traps, fencing, structures for temporary manure storage, shaping, and grading. Animal health and productivity also benefit when clean, alternative water sources are installed to prevent contamination of surface water. Studies have shown benefits in red meat and milk production of 10 to

20 percent by livestock and dairy animals when good quality drinking water is substituted for contaminated surface water.

Opportunities for financial and technical assistance (including CNMP development) in achieving voluntary AFO and CAFO compliance are available from conservation districts and NRCS field offices. Voluntary participation may aide in preventing a more rigid regulatory program from being implemented for Montana livestock operators in the future.

Further information may be obtained from the DEQ website at: http://www.deq.mt.gov/wqinfo/mpdes/cafo.asp. Montana's NPS pollution control strategies for addressing AFOs are summarized in the bullets below:

- Work with producers to prevent NPS pollution from AFOs.
- Promote use of State Revolving Fund for implementing AFO BMPs.
- Collaborate with MSU Extension Service, NRCS, and agriculture organizations in providing resources and training in whole farm planning to farmers, ranchers, conservation districts, watershed groups and other resource agencies.
- Encourage inspectors to refer farmers and ranchers with potential nonpoint source discharges to DEQ watershed protection staff for assistance with locating funding sources and grant opportunities for BMPs that meet their needs. (This is in addition to funds available through NRCS and the Farm Bill).

Develop early intervention of education & outreach programs for small farms and ranches that have potential to discharge nonpoint source pollutants from animal management activities. This includes assistance from the DEQ internal (Permitting Division), as well as external entities (DNRC, local watershed groups, conservation districts, MSU Extension, etc.).

7.5.2 Irrigation

Flow alteration and dewatering are commonly considered water quantity rather than water quality issues. However, changes to stream flow can have a profound effect on the ability of a stream to attenuate pollutants, especially nutrients, metals and heat. Flow reduction may increase water temperature, allow sediment to accumulate in stream channels, reduce available habitat for fish and other aquatic life, and may cause the channel to respond by changing in size, morphology, meander pattern, rate of migration, bed elevation, bed material composition, floodplain morphology, and streamside vegetation if flood flows are reduced ((Andrews and Nankervis, 1995), (Schmidt and Potyondy, 2004)). Restoration targets and implementation strategies recognize the need for specific flow regimes, and may recommend flow-related recommendations and enhancements as a means to achieve full support of beneficial uses. However, local coordination and planning are especially important for flow management because State law indicates that legally obtained water rights cannot be divested, impaired, or diminished by Montana's water quality law (MCA 75-5-705).

Irrigation management is a critical component of attaining both cold water fishery conservation and TMDL goals. Irrigation efficiency management practices in the lower Clark Fork should involve investigating how to reduce the amount of stream water diverted during July and August, while still growing crops on traditional cropland. It may be desirable to investigate irrigation practices earlier in the year that promote ground water return during July and August. Understanding irrigation water, ground water and surface water interactions is an important part of understanding how irrigation practices will affect stream flow during specific seasons.

7.5.2.1 Irrigation Flow Restoration Recommendations

Improving Irrigation Efficiency During Low Streamflow Timeframes

Many of the irrigation practices in western Montana are based in flood irrigation methods. In some cases, head gates and ditches leak, which can decrease the amount of water in-channel flows. The following recommended activities would result in notable water savings.

- Install upgraded head gates for more exact control of water diversions and to minimize leakage when not in operation.
- Develop more efficient means to supply water to livestock.
- Determine necessary amounts of water to divert that would reduce over watering and improve forage quality and production.
- Redesign irrigation systems.
- Upgrade ditches (including possible lining) to increase ditch conveyance efficiency.

Future studies could investigate irrigation water return flow timeframes from specific areas along the Lower Clark Fork River tributaries. A portion of spring and early summer flood irrigation water likely returns as cool ground water to the streams during the heat of the summer. These critical areas could be identified so that they can be preserved as flood irrigation areas. Other irrigated areas which do not contribute to summer ground water returns to the river should be identified as areas were year round irrigation efficiencies could be more beneficial to preserving flow in the stream during hot summer timeframes. Winter baseflow should also be considered during these investigations.

7.5.3 Upland Sediment (Forestry and Timber Harvest)

Currently, active timber harvest is not significantly affecting sediment production in the Lower Clark Fork TPA, but harvesting will likely continue in the future within the Kootenai National Forest, Lolo National Forest, and on private land. Future harvest activities should be conducted by all landowners according to Forestry BMPs for Montana (Montana State University, Extension Service, 2001) and the Montana SMZ Law (MCA 77-5-301 through 307). The Montana Forestry BMPs cover timber harvesting and site preparation, harvest design, other harvesting activities, slash treatment and site preparation, winter logging, and hazardous substances. While the SMZ Law is intended to guide commercial timber harvesting activities in streamside areas (i.e. within 50 feet of a waterbody), the riparian protection principles behind the law can be applied to numerous land management activities (i.e. timber harvest for personal use, agriculture, development). Prior to harvesting on private land, landowners or operators are required to notify the Montana DNRC. DNRC is responsible for assisting landowners with BMPs and monitoring their effectiveness. The Montana Logging Association and DNRC offer regular Forestry BMP training sessions for private landowners.

Timber harvest should not increase the peak water yield by more than 10 percent of historic conditions. If a natural disturbance, such as a forest fire, increases peak water yield, the increase should be accounted for as part of timber harvest management.

7.5.4 Riparian Corridors

Reduction of riparian vegetative cover by various land management activities and/or natural occurences, is a principal cause of water quality and habitat degradation in the Lower Clark Fork TPA. Although implementation of passive BMPs that allow riparian vegetation to recover at natural rates is typically the most cost-effective approach, active restoration (i.e. plantings) may be necessary in some instances. The primary advantage of riparian plantings is that installation can be accomplished with minimum impact to the stream channel, existing vegetation, and private property. In addition to providing shade (and possible reduced water temperature) and cover for aquatic species, riparian plantings can develop root masses that penetrate deep into the soils, increasing bank resilience to erosion. All areas that are actively restored with vegetation must have a reasonable approach to protecting the invested effort from further degradation from livestock or hay production.

Factors influencing the appropriate riparian restoration would include severity of degradation, site-potential for various species, and availability of local sources for transplant materials. In general, riparian plantings would promote establishment of functioning stands of native species (grasses and willows). The following recommended restoration measures would allow for stabilization of the soil, decreasing sediment delivery to the stream, and increasing absorption of nutrients from overland runoff.

- Harvest and transplant locally available sod mats with an existing dense root mass which provide immediate promotion of bank stability and filtering nutrients and sediments.
- Transplanting mature shrubs, particularly willows (*Salix* sp.), provides rapid restoration of instream habitat and water quality through overhead cover and stream shading as well as uptake of nutrients.
- Seeding with native graminoids (grasses and sedges) and forbs is a low cost activity where lower bank shear stresses would be unlikely to cause erosion.
- Willow sprigging would expedite vegetative recovery, involving harvest of dormant willow stakes from local sources.

7.5.5 Unpaved Roads

The road sediment reductions in this document represent a gross estimation of the sediment load that would remain once road BMPs were applied, assuming no current BMPs are in place. In general, a road with associated BMPs assumes contributing road treads, cut slopes, and fill slopes were reduced to 100 feet (from each side of a crossing). This distance is selected as an example to illustrate the potential for sediment reduction through BMP application and is not a formal goal at every crossing. For example, many roads may easily have a smaller contributing length, while others may not be able to meet a 100ft milestone. Achieving this reduction in sediment loading from roads may occur through a variety of methods at the discretion of local land managers and restoration specialists. Road BMPs can be found on the Montana DEQ or DNRC websites and within Montana's NPS Management Plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2007). Examples include:

- Providing adequate ditch relief up-grade of stream crossings.
- Constructing waterbars, where appropriate, and up-grade of stream crossings.
- Instead of cross pipes, using rolling dips on downhill grades with an embankment on one side to direct flow to the ditch. When installing rolling dips, ensure proper fillslope stability and sediment filtration between the road and nearby streams.
- Insloping roads along steep banks with the use of cross slopes and cross culverts.
- Outsloping low traffic roads on gently sloping terrain with the use of a cross slope.
- Using ditch turnouts and vegetative filter strips to decrease water velocity and sediment carrying capacity in ditches.
- For maintenance, grading materials to the center of the road and avoiding removing the toe of the cutslope.
- Preventing disturbance to vulnerable slopes.
- Using topography to filter sediments; flat, vegetated areas are more effective sediment filters.
- Where possible, limit road access during wet periods when drainage features could be damaged.

7.5.5.1 Culverts

Although culverts were not part of the source assessment, they can be large sources of sediment, and should be included in the restoration strategy. A field survey should be conducted and combined with local knowledge to prioritize culverts for restoration. As culverts fail, they should be replaced by culverts that pass a 100 year flood on fish bearing streams and at least 25 year events on non fish bearing streams. Culverts should be at grade with the streambed, and inlets and outlets should be vegetated and armored. Some road crossings may not pose a feasible situation for upgrades to these sizes because of road bed configuration; in those circumstances, the largest size culvert feasible should be used.

Another consideration for culvert upgrades will be providing fish passage. During the assessment and prioritization of culverts, additional crossings should be assessed for streams where fish passage is a concern. Each fish barrier should be assessed individually to determine if it functions as an invasive species and/or native species barrier. These two functions should be weighed against each other to determine if each culvert acting as a fish passage barrier should be mitigated. Montana FWP can aid in determining if a fish passage barrier should be mitigated, and, if so, it should be involved in culvert design. If funding is available, culverts should be prioritized and replaced prior to failure.

A subset of culverts in the Lower Clark Fork were analyzed for fish passage using the criteria from A Summary of Technical Considerations to Minimize the Blockage of Fish at Culverts on National Forests in Alaska (U.S.Department of Agriculture, 2002). Using this methodology, 33 of 35 culverts were classified as partial or total fish barriers, and 2 of 35 were classified as needing additional evaluation. None of the field assessed culverts were classified as capable of passing fish at all flows and life stages. More information regarding the roads and culvert assessment can be found in **Attachment 1, Road Sediment Assessment and Modeling.**

7.5.6 Bank Hardening/Riprap/Revetment/Floodplain Development

The use of riprap or other “hard” approaches is not recommended and is not consistent with water quality protection or implementation of this plan. Although it is necessary in some instances, it generally redirects channel energy and exacerbates erosion in other places. Bank armoring should be limited to areas with a demonstrated infrastructure threat. Where deemed necessary, apply bioengineered bank treatments to induce vegetative reinforcement of the upper bank, reduce stream scouring energy, and provide shading and cover habitat. Limit infrastructure threats by reducing floodplain development through land use planning initiatives.

Bank stabilization using natural channel design techniques can provide both bank stability and habitat potential. The primary recommended structures are large woody debris jams. These natural arrays can be constructed to emulate historical debris assemblages that were introduced to the channel by the adjacent cottonwood dominated riparian community types. When used in together, woody debris jams and straight log vanes can benefit the stream and fishery by improving bank stability, reducing bank erosion rates, adding protection to fill slopes and/or embankments, reducing near-bank shear stress, and enhancing aquatic habitat and lateral channel margin complexity.

7.7 Restoration Activities in the Lower Clark Fork Watershed

For much of the last decade, various stakeholders and interested parties within the Lower Clark Fork Tributaries TPA have been actively pursuing and implementing projects to improve the overall health and condition of the watershed. Many of these projects have been consistent with the goals of this TMDL, and the restoration principles described above. As work continues in the Lower Clark Fork, it will be important to maintain and improve upon the effectiveness and efficiency of these endeavors, and ensure that the achievement of Montana state water quality standards are ultimately met. **Table 7-2** presents a compilation of restoration project completed to date.

Table 7-2. Restoration Projects in the Lower Clark Fork Tributaries TPA

Stream	Year	Project Name	Project Type	Project Goal
Elk Creek	1997	Elk Creek (Heron)	Channel Restoration	Channel and Bank Stabilization
Clear Creek	1997	Clear Creek Restoration	Channel Restoration	Restoration/Reveg (failed)
Elk Creek	1998	Springer EWP	Emergency Watershed Protection	Bank Stabilization
East Fork Elk Creek	1999	Platt Riparian Fencing	Riparian Fencing	Bank Stabilization
Beaver Creek	Late 90s	Beaver 301 (ERFO)	Channel Restoration	Bank Stabilization
Elk Creek	Early 00s	John Hollinshed WRP	Bank Stabilization	Bank Stabilization
Thorne Creek	2000	Thorne Creek Culvert Removal	Culvert Replacement	Fish Passage
Whitepine Creek	2001	Whitepine Creek Restoration 2001	Channel Restoration	Bank Stabilization
Bull River	2001	McDowell Bank Stabilization	Bank Stabilization	Bank Stabilization
East Fork Bull River	2001	East Fork Bull River - Stein	Channel Restoration	Bank Stabilization
East Fork Bull River	2001	EFBR vegetation restoration	Riparian Revegetation	Bank Stabilization
Elk Creek	2001	Platt Restoration #1		Bank Stabilization
Prospect Creek	2001	Lower Prospect Creek Restoration - Phases I & II	Channel Restoration	Bank Stabilization
Trout Creek	2001	Trout Creek Restoration (Morkert)	Stream Restoration	Bank Stabilization
Whitepine Creek	2002	Whitepine Creek Restoration 2002	Channel Restoration	Bank Stabilization
East Fork Bull River	2002	EFBR Stein Revegetation	Riparian Revegetation	Riparian Revegetation
Bull River	2002	McDowell Revegetation	Riparian Revegetation	Bank Stabilization
Jungle Creek	2002	Jungle Cr. Culvert Replacement	Culvert Replacement	Fish Passage
Whitepine Creek	2003	Michaels Repair	Restoration Repair	Bank Stabilization
South Fork Bull River	2003	SFBR Slide Restoration	Channel Restoration	Channel Reconstruction
Pilgrim Creek	2003	King Channel Shaping	Channel Restoration	Bank Stabilization
Prospect Creek	2003	YPL Relocation/Removal Reclamation	Bank Stabilization	Remove YPL
Whitepine Creek	2004	Chambers Repair	Restoration Repair	Bank Stabilization
Whitepine Creek	2004	Chambers and Self Repair	Restoration Repair	Bank Stabilization
Whitepine Creek	2004	Michaels Repair	Restoration Repair	Bank Stabilization
Snake Creek	2004	SN-6 Snake Creek Restoration	Channel Restoration	Sediment Reduction
East Fork Bull River	2004	EF-9 Lost Girl Slide Stabilization	Riparian Revegetation	Bank Stabilization

Table 7-2. Restoration Projects in the Lower Clark Fork Tributaries TPA

Stream	Year	Project Name	Project Type	Project Goal
Whitepine Creek	2005	Cole Creek Road Decomissioon	Culvert Installation	Road decomission
Pilgrim Creek	2005	King Road Dip and Riparian Reveg	Riparian Revegetation	Bank Stabilization
Daisy Creek	2005	Daisy Creek Restoration	Channel Restoration	Bank Stabilization
Bull River	2006	Dabronski Bridge Removal	Abutment Removal	Bank Stabilization
Bull River	2006	Ross Revegetation (North)	Riparian Revegetation	Bank Stabilization
Bull River	2006	Ross Revegetation (South)	Riparian Revegetation	Bank Stabilization
South Fork Bull River	2006	SF-17 SFBR bridge replacement	Culvert and Bridge Replacement	Fish Passage
Elk Creek	2006	Platt Restoration #2	Channel Restoration	Bank Stabilization
Pilgrim Creek	2006	Pilgrim Creek Railroad Bridge	Channel Restoration	Bank Stabilization
Pilgrim Creek	2006	Reishus/McDowell Restoration	Channel Restoration	Bank Stabilization
Pilgrim Creek	2006	West Fork Pilgrim Creek Bridge	Bridge Replacement	Bridge Replacement
Thompson River (upper)	2006	Thompson River Riparian Restoration	Revegetation	Revegetation
Fishtrap Creek	2006	Fishtrap Creek LWD Pilot (Plum Creek)	LWD Addition	Habitat Improvement
Vermilion River	2006	Vermilion Bank Stabilization	Channel Restoration	Bank Stabilization
Whitepine Creek	2007	Whitepine Fish Habitat Improvement	Channel Restoration	Fish Habitat Improvement
Bull River	2007	McDowell Revegetation	Riparian Revegetation	Bank Stabilization
East Fork Bull River	2007	EFBR - Stein repair	Minor Restoration Repair	Bank Stabilization
East Fork Elk Creek	2007	Lans Restoration	Channel Restoration	Bank Stabilization
Graves Creek	2007	Graves Creek Trap Site Improvement	Other	Stabilize Trapping Site
Pilgrim Creek	2007	King Revegetation	Riparian Revegetation	Bank Stabilization
West Fork Pilgrim Creek	2007	WFk Pilgrim Creek restoration	Channel Restoration	Channel Stabilization
Pilgrim Creek	2007	Reishus/McDowell Repair	Restoration Repair	Channel Stabilization
Cooper Gulch	2007	Cooper Gulch Culvert Replacement	Culvert Removal	Fish Passage
Chipmunk Creek	2007	Chipmunk Creek Culvert Replacement	Culvert Removal	Fish passage
Crow Creek	2007	Crow Creek Restoration	Channel Restoration	Fish Habitat Improvement
Bull River	2008	Ross Revegetation (again)	Riparian Revegetation	Bank Stabilization
East Fork Bull River	2008	EFBR slide restoration	Channel Restoration	Sediment Reducation
Pilgrim Creek	2008	Reishus/McDowell Repair	Restoration Repair	Channel Stabilization
Prospect Creek	2008	Wilkes Creek Bridge Abutment Removal	Bridge Abutment Removal	Bank Stabilization
Swamp Creek	2008	Swamp Creek Ford	Replace Concrete Ford	Other
Graves Creek	2009	Graves Creek Restoration (Cox/Newby)	Channel Restoration	Improve Channel Function

Table 7-2. Restoration Projects in the Lower Clark Fork Tributaries TPA

Stream	Year	Project Name	Project Type	Project Goal
Marten Creek	2009	Marten Creek - Smith	Channel Restoration	Bank Stabilization
Cooper Gulch	2009	Cooper Gulch LWD	LWD Addition	Habitat Improvement
Prospect Creek	2009	YPL Riparian Revegetation	Revegetation	Revegetation
Prospect Creek	2009	Prospect Creek Riparian Re-Forestation	Revegetation	Riparian Revegetation
Fishtrap Creek	2009	Fishtrap Creek LWD (USFS)	LWD Addition	Habitat Improvement
Whitepine Creek	Pending	Whitepine Bank Stabilization	Channel Restoration	Bank Stabilization
East Fork Blue Creek	Pending	Blue Creek mine tailings	Clean Up Mine Tailings Pile	Remove Contaminants
Bull River	Pending	Bull River - Scalf	Road Decommission and Revegetation	Wetland & Riparian Restoration
Marten Creek	Pending	Marten Creek Revegetation	Revegetation	Revegetation

8.0 MONITORING STRATEGY AND ADAPTIVE MANAGEMENT

8.1 INTRODUCTION

The monitoring strategies discussed in this section are an important component of watershed restoration, a requirement of TMDL development under Montana's TMDL law, and the foundation of the adaptive management approach. Montana state law contains provisions that address evaluation of TMDL effectiveness through long-term water quality monitoring. As defined in (MCA 75-5-703 (7) (9):

> *"(7) Once the control measures identified in subsection (6) have been implemented, the department shall…develop a monitoring program to assess the waters that are subject to the TMDL to determine whether compliance with water quality standards has been attained for a particular water body or whether the water body is no longer threatened. The monitoring program must be designed based on the specific impairments or pollution sources. The department's monitoring program must include long-term monitoring efforts for the analysis of the effectiveness of the control measures developed.*
>
> *(9) If the monitoring program … demonstrates that the TMDL is not achieving compliance with applicable water quality standards within 5 years after approval of a TMDL, the department shall conduct a formal evaluation of progress in restoring water quality and the status of reasonable land, soil, and water conservation practice implementation to determine if:*
>
> *(a) the implementation of a new or improved phase of voluntary reasonable land, soil, and water conservation practice is necessary;*
>
> *(b) water quality is improving but a specified time is needed for compliance with water quality standards; or revisions to the TMDL are necessary to achieve applicable water quality standards."*

Water quality targets and allocations presented in this document are based on available data at the time of analysis, however the scale of the watershed coupled with constraints on time and resources often result in compromises that must be made that include estimations, extrapolation, and a level of uncertainty. The margin of safety (MOS) is put in place to reflect some of this uncertainty, but other issues only become apparent when restoration strategies are underway. Having a monitoring strategy in place allows for feedback on the effectiveness of restoration activities (whether TMDL targets are being met), if all significant sources have been identified, and whether attainment of TMDL targets is feasible. Data from long-term monitoring programs also provide technical justifications to modify restoration strategies, targets, or allocations where appropriate.

The monitoring strategy presented in this section provides a starting point for the development of more detailed and specific planning efforts regarding monitoring needs; it does not assign monitoring responsibility. Monitoring recommendations provided are intended to assist local land managers, stakeholder groups, and federal and state agencies in developing appropriate monitoring plans to meet aforementioned goals. Funding for future monitoring is uncertain and can vary with economic and political changes. Prioritizing monitoring activities depends on stakeholder priorities for restoration and funding opportunities.

8.2 Adaptive Management Approach

An adaptive management approach is recommended to control costs and meet the water quality standards to support all beneficial uses. This approach works in cooperation with the monitoring strategy, and as new information is collected, it allows for adjustments to restoration goals or pollutant targets, TMDLs, and/or allocations, as necessary.

8.3 Future Monitoring Guidance

The objectives for future monitoring in the Lower Clark Fork watershed include: 1) strengthen the spatial understanding of sources for future restoration work, which will also strengthen source assessment analysis for future TMDL review, 2) gather additional data to supplement target analysis, better characterize existing conditions, and improve or refine assumptions made in TMDL development, 3) gather consistent information among agencies and watershed groups that is comparable to targets and allows for common threads in discussion and analysis, 4) expand the understanding of streams throughout the Lower Clark Fork beyond those where TMDL have been developed and address issues if necessary, and 5) track restoration projects as they are implemented and assess their effectiveness.

8.3.1 Strengthening Source Assessment

In the Lower Clark Fork TPA, the identification of sources was conducted largely through watershed field tours, aerial assessment, the incorporation of GIS information, available data and literature review, with limited field verification and on-the-ground analysis. In many cases, assumptions were made based on overall TPA conditions and extrapolated throughout the watershed. As a result, the level of detail often does not provide specific areas by which to focus restoration efforts, only broad source categories to reduce sediment loads from in each of the discussed subwatersheds. Strategies for strengthening source assessments for each of the pollutants may include:

Sediment
Field surveys of road and road crossing to identify specific contributing road crossings, their associated loads, and prioritize those road segments/crossings of most concern.

Review of land use practices specific to subwatersheds of concern to determine where the greatest potential for improvement and likelihood of sediment reduction can occur for the identified major land use categories.

More thorough examinations of bank erosion conditions and investigation of related contributing factors for each subwatershed of concern through site visits and subwatershed scale BEHI assessments. Additionally, the development of bank erosion retreat rates specific to the Lower Clark Fork TPA would provide a more accurate quantification of sediment loading from bank erosion. Bank retreat rates can be determined by installing bank pins at different positions on the streambank at several transects across a range of landscapes and stability ratings. Bank erosion is documented after high flows and throughout the year for several years to capture retreat rates under a range of flow conditions.

8.3.2 Increase Available Data

While the Lower Clark Fork watershed has been the recipient of significant remediation and restoration activities, data is still often limited depending on the stream and pollutant of interest. Infrequent sampling events at a small number of sampling sites may provide some indication of overall water quality and habitat condition, however regularly scheduled sampling at consistent locations, under a variety of seasonal conditions is the best way to assess overall stream health and monitor change.

Sediment

For sediment investigation in the Lower Clark Fork, each of the streams of interest were stratified into unique reaches based on physical characteristics and anthropogenic influence. A total of 25 sites were sampled throughout the watershed, however this equates to only a small percentage of the total number of stratified reaches, and even less on a stream by stream basis. Sampling additional monitoring locations to represent some of the various reach categories that occur would provide additional data to assess existing conditions, and provide more specific information on a per stream basis as well as the TPA as a whole, by which to assess reach by reach comparisons and the potential influencing factors and resultant outcomes that exist throughout the watershed.

In addition to the sediment and habitat parameters targeted during the 2008 DEQ field assessment, there are further parameters that would support the analysis of sediment impact on beneficial uses, such as McNeil core sampling of subsurface substrate composition, and suspended sediment concentrations within the water column. Aquatic biological community information would also aid in assessing the response to changes in sediment loads; fish assemblages, redd numbers, macroinvertebrate population diversity, and periphyton analyses are all factors that could be incorporated toward assessing achievement of beneficial uses.

8.3.3 Consistent Data Collection and Methodologies

Data has been collected throughout the Lower Clark Fork TPA for many years and by many different agencies and entities, however the type and quality of information is often variable. Where ever possible, it is recommended that the type of data and methodologies used to collect and analyze the information be consistent so as to allow for comparison to TMDL targets and track progress toward meeting TMDL goals.

The Montana Department of Environmental Quality (DEQ) is the lead agency for developing and conducting impairment status monitoring. However, other agencies or entities may work closely with DEQ to provide compatible data if interest arises. Impairment determinations are conducted by the state but can use data collected from other sources. The information in this section provides general guidance for future impairment status monitoring and effectiveness tracking.

It is important to note that monitoring recommendations are based on TMDL related efforts to protect beneficial uses in a manner consistent with Montana's water quality standards. Other regulatory programs with water quality protection responsibilities may impose additional requirements to ensure full compliance with all appropriate local, State and Federal laws. For example, reclamation of a mining related source of metals under CERCLA and CECRA typically requires source-specific sampling requirements, which cannot be defined at this time, to determine the extent of and the risk posed by contamination, and to evaluate the success of specific remedial actions.

Sediment

Sediment and habitat assessment protocols consistent with DEQ field methodologies and that serve as the basis for sediment targets and assessment within this TMDL should be conducted whenever possible. Current protocols are identified within Field Methodology for the Assessment of TMDL

Sediment and Habitat Impairments (DEQ, 2010). It is acknowledged that various agencies and entities have differing objectives, as well as time and resources available to achieve those objectives. However, when possible, when collecting sediment and habitat data in the Lower Clark Fork it is recommended that at a minimum the following parameters be collected to allow for comparison to TMDL targets:

- Riffle Cross Section; using Rosgen methodology
- Riffle Pebble Count; using Wolman Pebble Count methodology
- Pool Assessment; Count and Residual Pool Depth Measurements
- Greenline Assessment; NRCS methodology

As mentioned in **8.3.2**, additional information will undoubtedly be useful and assist DEQ with TMDL effectiveness monitoring in the future. Macroinvertebrate studies, McNeil core sediment samples, and fish population surveys and redd counts are examples of additional useful information used in impairment status monitoring and TMDL effectiveness monitoring which were not developed as targets but reviewed where available during the development of this TMDL. Wherever possible, the methods used to collect and analyze these data should also strive to be consistent throughout the watershed.

8.3.4 Effectiveness Monitoring for Restoration Activities

As restoration activities are implemented, watershed-scale monitoring may be valuable in determining if restoration activities are improving water quality, instream flow, and aquatic habitat and communities. It is important to remember that degradation of aquatic resources happens over many decades and that restoration is also a long-term process. An efficiently executed long-term monitoring effort is an essential component to any restoration effort.

Due to the natural high variability in water quality conditions, trends in water quality are difficult to define and even more difficult to relate directly to restoration or other changes in management. Improvements in water quality or aquatic habitat from restoration activities will most likely be evident in fine sediment deposition and channel substrate embeddedness, changes in channel cumulative width/depths, improvements in bank stability and riparian habitat, increases in instream flow, and changes in communities and distribution of fish and other bio-indicators. Specific monitoring methods, priorities, and locations will depend heavily on the type of restoration projects implemented, landscape or other natural setting, the land use influences specific to potential monitoring sites, and budget and time constraints.

As restoration activities begin throughout the watershed, pre and post monitoring so as to understand the change that follows will be necessary to track the effectiveness of specific given practices or implementation projects. The following recommendations are categorized by the type of restoration practice to which they apply.

8.3.4.1 Road BMPs

Monitoring road sediment delivery is necessary to determine if BMPs are effective, to determine which are most effective, and to determine which practices or sites require modification to achieve water quality goals. Effectiveness monitoring should be initiated before implementing BMPs at treatment sites.

Monitoring actual sediment routing is difficult or prohibitively expensive. It is likely that budget constraints will influence the number of monitored sites. Once specific restoration projects are identified, a detailed monitoring study design should be developed. To overcome environmental variances, monitoring at specific locations should continue for a period of two to three years after BMPs are initiated.

Specific types of monitoring for separate issues and improvements are listed in **Table 8-1**.

Table 8-1. Monitoring Recommendations for Road BMPs

Road Issue from Section 7.0 (Restoration)	Restoration Recommendation	Monitoring Recommendation	Recommended Methodology
Ditch Relief Combined with Stream Crossings	Re-engineer & rebuild roads to completely disconnect stream sloped ditches from stream crossings. Techniques may include: • Ditch relief culverts • Rolling dips • Water Bars • Outsloped roads • Catch basins • Raised road grade near stream crossing	• Place silt trap directly upslope of tributary crossing to determine mass of sediment routed to that point. • Rapid inventory to document improvements and condition.	• Sediment yield monitoring based on existing literature/USFS methods. • Revised Washington Forest Practices Board methodology.
Ditch Relief Culverts	• Consider eliminating stream sloped ditches and outsloping the road or provide rolling dips. • When maintaining/ cleaning ditch, do not disturb toe of cutslope. • Install culverts with proper slope and angle following Montana road BMPs. • Armor culvert outlets. • Construct stable catch basins. • Vegetate cutslopes above ditch. • Increase vegetation or install slash filters. • Provide infiltration galleries where culvert outlets are near a stream.	• Rapid inventory to document improvements and condition. • Silt traps below any ditch relief culvert outlets close to stream.	• Revised Washington Forest Practices Board methodology. • Sediment yield monitoring based on existing literature/USFS methods.
Stream Crossings	• Place culverts at streambed grade and at base of road fill. • Armor and/or vegetate inlets and outlets. • Use proper length and diameter of culvert to allow for flood flows and to extend beyond road fill.	• Repeat road crossing inventory after implementation. • Fish passage and culvert condition inventory.	• Revised Washington Forest Practices Board methodology. • Montana State (DNRC) culvert inventory methods.
Road Maintenance	• Avoid casting graded materials down the fill slope & grade soil to center of road, compact to re-crown. • Avoid removing toe of cut slope. • In some cases graded soil may have to be removed or road may have to be moved.	• Repeat road inventory after implementation. • Monitor streambed fine sediment (grid or McNeil core) and sediment routing to stream (silt traps) below specific problem areas.	• Revised Washington Forest Practices Board methodology. • Standard sediment monitoring methods in literature.

Table 8-1. Monitoring Recommendations for Road BMPs

Road Issue from Section 7.0 (Restoration)	Restoration Recommendation	Monitoring Recommendation	Recommended Methodology
Oversteepened Slopes/ General Water Management	• Where possible outslope road and eliminate inboard ditch. • Place rolling dips and other water diverting techniques to improve drainage following Montana road BMPs. • Avoid other disturbance to road, such as poor maintenance practices and grazing.	• Rapid inventory to document improvements and condition.	• Revised Washington Forest Practices Board methodology.

8.3.4.2 Agricultural BMPs

Grazing BMPs reduce grazing pressure along streambanks and riparian areas. Implementing BMPs may improve water quality, create narrower channels and cleaner substrates, and result in recovery of streambank and riparian vegetation. Effectiveness monitoring for grazing BMPs should be conducted over several years, making sure to start monitoring before BMPs are implemented. If possible, monitoring reaches should be established in pastures keeping the same management as well as in those that have changed. Where grazing management includes moving livestock according to riparian use level guidelines, it is important to monitor changes within the growing season as well as over several years. Monitoring recommendations to determine seasonal and long-term changes resulting from implementing grazing BMPs are outlined below in **Table 8-2**.

Table 8-2. Effectiveness Monitoring Recommendations for Grazing BMPs by Restoration Concern

Recovery Concern	Monitoring Recommendations	Methodology or Source
Seasonal impacts on riparian area and streambanks	• Seasonal monitoring during grazing season using riparian grazing use indicators. • Streambank alteration. • Riparian browse. • Riparian stubble height at bank and “key area.”	BDNF/BLM riparian standards (Bengeyfield and Svoboda, 1998)
Long-term riparian area recovery	• Photo points. • PFC/NRCS Riparian Assessment (every 5-10 yrs). • Vegetation Survey (transects perpendicular to stream and spanning immediate floodplain) every 5-10 years. • Strip transects- Daubenmire 20cm x 50cm grid or point line transects • Greenline.	(Harrelson et al., 1994); (Bauer and Burton, 1993); (US Department of Agriculture, 2001)
Streambank stability	• Greenline including bare ground, bank stability, woody species regeneration (every 3-5 years)	Modified from (Winward, 2000)
Channel stability	• Cross-sectional area, with % fines/ embeddedness. • Channel cross-section survey. • Wolman pebble count. • Grid or McNeil core sample. • Bank Erosion Hazard Index.	(Rosgen, 1996); (Harrelson et al., 1994)

Table 8-2. Effectiveness Monitoring Recommendations for Grazing BMPs by Restoration Concern

Recovery Concern	Monitoring Recommendations	Methodology or Source
Aquatic habitat condition	• Aquatic macroinvertebrate sampling. • Pool quality. • R1/R4 aquatic habitat survey. • Longitudinal Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments.	(Montana Department of Environmental Quality, 2004); (Hankin and Reeves, 1988); (Overton et al., 1997) DEQ Longitudinal Assessment Protocols (DEQ, 2010)
General stream corridor condition	• EMAP/Riparian Assessment (every 5-10 yrs).	(US Department of Agriculture, 2001); (Peck et al., 2003).

8.3.5 Watershed Wide Analyses

Recommendations for monitoring in the Lower Clark Fork should not be confined to only those streams addressed within this document. The water quality targets presented herein are applicable to all streams in the watershed, and the absence of a stream from the State's 303(d) List does not necessarily imply a stream Fully Supporting all beneficial uses. Furthermore, as conditions change over time and land management evolves, the consistent application of data collection methods and information collected throughout the watershed will best allow resource professionals to identify problems as they occur, and to track improvements over time.

9.0 PUBLIC PARTICIPATION AND RESPONSE TO COMMENTS

Public and stakeholder involvement is a component of TMDL planning efforts. Stakeholders, including Green Mountain Conservation District, Lower Clark Fork Watershed Group (LCFWG) (which serves as an umbrella organization for watershed groups within the lower Clark Fork watershed including: Bull River Watershed Council, Elk Creek Watershed Council, Little Beaver Creek Watershed Council, Pilgrim Creek Watershed Council, Prospect Creek Watershed Council, Rock Creek Watershed Council, Trout Creek Watershed Council, and Whitepine Creek Watershed Council), Avista Corporation, Montana Department of Environmental Quality (DEQ), Montana Fish, Wildlife and Parks (MFWP), US Department of Agriculture - Natural Resources Conservation Service (DNRC), US Department of Agriculture - US Forest Service (Kootenai and Lolo National Forests), US Department of Interior – US Fish & Wildlife Service, as well as local land owners and watershed residents were kept abreast of the TMDL process through periodic meetings of the Lower Clark Fork Watershed Group and Green Mountain Conservation District. In addition, Technical Advisory Group meetings, and other outreach and education efforts conducted by the LCFWG provided opportunities to review and comment on technical documents. Stakeholder review drafts were provided throughout the process to several agency representatives, landowners, conservation district and government representatives, and representatives from conservation and watershed groups. Stakeholder comments, both verbal and written, were accepted and are addressed within the document.

An additional opportunity for public involvement is the public comment period. This public review period was initiated on September 23rd, 2010 and extended to October 8th, 2010. At a public meeting on October 4th in Noxon, MT, DEQ provided an overview of the Lower Clark Fork River Tributaries Total Maximum Daily Loads, made copies of the document available to the public, and solicited public input and comment on the plan. The announcement for that meeting was distributed among the Technical Advisory Group, and advertised in the following newpapers: Sanders County Ledger, The Missoulian, and the Clark Fork Valley Press. This section includes DEQ's response to all official public comments received during the public comment period. This final document was updated, based on public input and comment.

9.1 RESPONSE TO PUBLIC COMMENTS

The formal public comment period for the Lower Clark Fork River Tributaries Sediment TMDLs and Framework for Water Quality Restoration (TMDL) extended from September 23rd to October 8th, 2010. One letter compiling formal comments was submitted to DEQ during the public comment period. Excerpts from the comment letter are provided below. Responses prepared by DEQ follow each of the individual comments and where applicable, the text of the Final document has been modified to address these comments. Original comment letters are held on file at the DEQ and may be viewed upon request.

Dave McCarthy, Copper Environmental Consulting, LLC, on behalf of Roy Thun, Atlantic Richfield Company

Comment #1
The basis of the original impairment determination is not presented. This information should be transparently presented, and linked to the narrative standards presented, and to the characterization of impairment presented in the 2008 impaired waters list. Impairment appears to be assumed, as is the linkage between excess sediment and impairment. Only generic text references are provided to

establish the relationship between sediments and impairment, but no specific ecological, biological, or water quality data or other information providing evidence of impairment in the tributaries in question are provided.

Response to #1
Impairment has not been assumed, rather it has been determined through an assessment process developed by the State and approved by the EPA. The process for how waterbodies are identified as impaired is summarized in **Section 3.0**, which also contains reference to Montana's Water Quality Integrated Report where a full description of the methodology for determining the impairment status of a waterbody is included in **Appendix A** of that document. The linkages between excess sediment and impairment are described in detail in **Sections 5.1**, **5.4.1, and 5.4.2**.

This document specifically addresses those impairment listings and develops TMDLs as a result of the state's impairment determinations. To further clarify this connection, summary information from the original assessment files has been added to **Section 5.4.3 –** Comparison of Listed Waters to Targets (by stream segment). The data used for target development and presented in **Section 5.4.3** is made available to further describe and characterize the impairment determinations. In some cases, this information may lead DEQ to revisit an impairment determination; however in the cases of the Lower Clark Fork tributaries, it served as further evidence of impairment. For a full review of all data that was originally reviewed as part of the assessment and impairment determination process, the assessment files for each of the waterbodies addressed in this document are available at the main DEQ office in Helena, and electronically via the internet at http://cwaic.mt.gov/.

The exception to the above paragraph is Swamp Creek, which did not have sufficient information to determine impairment at the time of original assessment. However, data collected and reviewed during the development of this TMDL document concluded that impact from sediment exists and warrants the TMDL. Although Swamp Creek has not yet gone through the full assessment and impairment determination protocol, the data and conclusions presented in this document were reviewed by DEQ's Monitoring and Assessment staff, and were found acceptable. It should be noted that a stream need not be listed for a pollutant for a TMDL to be developed.

Comment #2
Based on an assumption of impairment and an assumption of a linkage between impairment and excess sediment, target development is then pursued based on considering physical attributes of stream condition (which are assumed to be linked to excess sediment). The resulting targets (reflected as specific stream attribute goals which are then translated to sediment loading reductions) are assumed to achieve a reference condition which will achieve designated beneficial uses. There is no discussion provided, however, of the potential for the LCFR tributaries to achieve the same biological usage/productivity as the reference streams, and/or how this relates to the original basis for assuming that coldwater fisheries and/or aquatic life are impacted *vis-à-vis* the narrative criteria (i.e., by sediment loads above and beyond background conditions).

Response to #2
As described in the Response to #1, the impairment is not assumed. Data was reviewed and considered sufficient and credible to make the initial impairment determination, and further supported by the review of additional information contained within this document.

The linkage between sediment impairment and the physical attributes of stream condition is well documented and the target parameters chosen were specifically selected based on their ability to display effects from sedimentation, and the impacts these effects then have on aquatic life and cold water fish – in the case of the Lower Clark Fork tributaries, specifically bull trout and cutthroat trout. These linkages are discussed in **Section 5.4** and **Appendix D** and include references to scientific literature and academic research that support these linkages. These discussions within the text have been reviewed and, where deemed appropriate, additional text has been included to clarify these linkages.

The water quality targets provided in **Section 5.4** and **Appendix D** are developed to serve as a tool to indicate if impact to the beneficial uses persists, the degree of that impact, and which direction conditions in a particular stream are trending. It is the source assessment information, presented in **Section 5.5**, which serves as the basis for the analysis of sediment load, and the potential for sediment reductions that can be achieved. In determining those sediment load reductions, the existing conditions are considered along with the potential for recovery and sediment reduction in comparison to reference conditions. Reference conditions are reflective of desired conditions and reasonable expectations for sediment reduction within the basin as a result of watershed wide analyses specific to the Lower Clark Fork and based on known and accepted practices as they relate to the Lower Clark Fork tributary watersheds. It is therefore a reasonable expectation that as sediment loads are reduced from the various sources, and stream conditions comply with target values, that subsequently biological usage/productivity will improve, and stream conditions will reflect 'full support' of the previously impaired beneficial uses.

It is acknowledged that the targets and load reductions developed in this document are at a watershed scale and that in some cases, discrete locations may not be able to achieve all targets or source load reductions. In any case, the overall watershed improvement and resultant effects is discussed both explicitly and implicitly throughout **Section 5.0** and the appendices and attachments included in this document.

Comment #3
It is also stated in the draft TMDL that the proposed stream attribute targets cannot necessarily be looked at individually, or in any specific combination to define impairment. It then logically follows that they could not be looked at individually, or in any specific combination, to establish attainment of designated uses.

Response to #3
In its full context, the discussion on stream attribute targets describes the application of target values as a 'weight-of-evidence' approach, where not one specific target value holds prominence over others, but a combination of factors lead to a determination of impairment. Never the less, the discussion of the use of stream attribute targets as presented in the draft document has been reworded to provide better clarity about how these targets should be applied and what divergence from the targets indicates.

Comment #4
It is unclear how the adaptive implementation process will be applied given these uncertainties. A comprehensive monitoring program is indicated, yet there appear to be no specific success criteria. The net result is that the proposed TMDL provides little basis for determining if or when use attainment can, will be, or has been achieved.

Response to #4
Given Comment #3, it is understandable that there is confusion regarding the expected outcome as it relates to the water quality targets. That language has been edited to provide clarity as described in Response to #3. With that in mind, the goal of any TMDL document is to reduce pollutants to levels where beneficial uses are supported. The water quality targets are developed to indicate when and where use attainment has occurred, and the source assessment and allocations are developed to direct measures via pollutant reductions necessary to achieve use attainment. Progress towards TMDL achievement will be gauged by permit adherence for WLAs, BMP implementation for nonpoint sources, and improvement in or attainment of water quality targets. Any effort to calculate loads and percent reductions for purposes of comparison to TMDLs and allocations in this document should be accomplished via the same methodology and/or models used to develop the loads and percent reductions presented within this document.

The ultimate responsibility for meeting a TMDL is with the residents and resource managers of that affected watershed. However, as the assessments and analysis of data is often at a broader, watershed scale, the adaptive management strategy is incorporated to acknowledge a level of uncertainty and allow for further refinement of targets, and evaluation of the potential for reduction within a watershed. The TMDL document provides information and suggestions for stakeholders to implement pollutant reductions and assess progress. This information is provided in **Section 5.7.3, Section 7.0**, and **Section 8.0**. **Section 8.0** has also been expanded to describe the relationship between Montana state law, monitoring needs, and TMDLs.

Comment #5
Table 3-3 summarizes applicable narrative standards [e.g., no increases are allowed above naturally occurring concentrations of sediment or suspended sediment (except as permitted in 75-5-318, MCA), settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife], where naturally occurring is defined as "conditions or materials 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." **Section 3.3.2** of the TMDL document states that "reasonable land, soil, and water conservation practices" are defined as "methods, measures, or practices that protect present and reasonably anticipated beneficial uses." Hence, the narrative standards described circular logic where uses are deemed protected if reasonable practices are installed, and reasonable practices are defined as those that protect uses.

Response to #5
Montana's narrative sediment standard was built to protect the Montana's aquatic resources. The narrative standard is expressed in its' current form of "no person may violate the following specific water quality standards…" (17.30.623(a)) and is followed by "No increases are allowed above naturally occurring concentrations of sediment… that are likely to render the waters harmful…" (17.30.623(a)(f)) in order to protect Montana's diverse landscape. The narrative expression is designed to allow for anthropogenic activity while maintaining the varying conditions promulgated by the diverse landscape settings; differing geologies, climate, soils, hydrology and other natural physiochemical differences. In other words, the intent is to capture a unique waterbody's potential and to protect conditions that do not limit this potential.

The naturally occurring definition is designed for management of anthropogenic activity that will not lead to impairment of beneficial uses. The intent is not to preclude all human activity. Due to the inherent natural variability in Montana's waterways, reasonable land, soil, and water conservation practices that protect the beneficial use in a resilient landscape may not be protective of a more sensitive landscape. Therefore, describing what is reasonable in standards language would lead to regulations that may protect some waterbodies while impairing others. Determining the sufficiently protective practices for specific waterbodies can be difficult. Due to these complexities, defining these "reasonable" conditions is done on a case-by-case basis with the end goal being the support of the beneficial use.

Taken at face value, the logic appears to be circular. When considering the intent of the logic, and implementation, the expression of the standards allows for varying levels of anthropogenic activity while protecting beneficial uses.

Comment #6
The interpretation of the narrative standards does not address the following critical questions:

1. What is the nature and scale of the stated impairment?
2. Are excess sediments the only, or the most significant, stressor impacting uses?
3. What reductions in pollution loading are needed to result in attainment of designated uses?

The TMDL should specifically address these critical questions, and relate the answers specifically to the definition of the problem (the description of impairment), and the solution (the proposed TMDLs for sediments).

Response to #6

1. The nature and scale of the stated impairment is described within the waterbody assessment files that were used to list the streams on the 303(d) List. Information presented in **Section 5.4.3** further describes the condition of the streams and their relative impairment. Summaries from the assessment files have been included to each of the applicable streams within this document.
2. Given the data available to DEQ at the time of assessment, it was found that sediment is a significant stressor impacting uses. This document addresses only sediment as a pollutant, and pollution in the form of habitat alterations, etc that have common linkages to sediment. However, White Pine Creek is also listed for impairment from temperature. That pollutant will be addressed in a future document.
3. Necessary reductions in pollutant loading to attain the TMDL, and thereby the attainment of designated uses (affected by sediment), are clearly described in **Section 5.6**.

Comment #7
It does not appear that any attempt has been made to document where impairment may exist (from a biological use perspective) and to relate this to actual measures of sediment loading (e.g. total settleable solids or particulate loads during storm flow and/or baseflow). Another approach for connecting total allowable load to achievement of goals would be to more specifically identify load reduction potential based on "reasonable land, soil, and water conservation practice" and evaluate the potential for use attainment given the predicted loading reductions.

Response to Comment #7
Information within the assessment files used in the 303(d) listing process may contain some site specific information, or reach bracketed information, including biological data, as part of the data used to make the impairment determination. Once that determination has been made however, it is the ultimate goal of the TMDL document to reduce those pollutants that cause the impairment. The approach taken by DEQ, and accepted by EPA, is to address sediment impairment at the watershed scale. In so doing,

numerous sites throughout a watershed under a variety of conditions, and from a variety of sources were investigated on the ground to determine their loading characteristics and potential for improvement. This real data serves as the basis for the extrapolation of loads and improvement measures across the watershed, which provides a reasonable approximation and characterization of what is occurring in the streams of interest. The targets developed to measure the level of impact are directly related to the success of coldwater fish and aquatic life, and the reductions in sediment are determined based on the potential for improvement as identified in the field assessments, discussions with stakeholders and local resource managers, and documented literature. The total allowable load takes into account "reasonable land, soil, and water conservation practices."

Comment #8

The use of stream attribute targets to estimate allowable load is unsupported. For example, the median percent eroding banks (i.e., 9%) of the total sample population was used as a basis for determining stream specific allowable loads. For each stream, the existing load (expressed as average percent eroding banks) was reduced by the percent reduction necessary for that stream to achieve an equivalent of 9% eroding banks. The difference is proposed to represent the desired sediment load reduction from eroding banks, and translated directly to the allowable load. There are a number of problems with this approach. The use of the median percent from the sample population is not substantiated, as half of the sample population would then be identified as requiring a load reduction to attain designated uses. Also, no direct connection has been established between this metric and impairment and/or use attainment. If the 9% goal cannot be achieved in all stream segments or on average by applying reasonable land, soil, and water conservation practices, then this metric should be removed as a basis for identifying allowable loads.

Response to Comment #8

Due to the scale of the watersheds concerned, and the resources available in developing a TMDL, it is necessary to combine real field data, conclusions from scientific literature, and land use/water quality models in order to determine existing and total allowable loads for sediment from the various sources that occur in the watershed. This approach, and a variety of other approaches, is supported within the EPA document *Protocols for Developing Sediment TMDLs*.

The median is used precisely because the sample population contains a combination of sites displaying a variety of stream conditions and levels of impact. It stands to reason then that not all of a sample population will display "desired conditions." **Appendix D** provides further discussion on the use of statistics in developing targets and analyzing data, and has been further expanded for the final document. Part of this discussion is included below:

"The use of a non-parametric statistical distribution for interpreting narrative WQS or developing numeric criteria is consistent with EPA guidance for determining nutrient criteria (EPA 2000). Furthermore, the selection of the applicable 25th or 75th percentile values from a reference data set is consistent with ongoing DEQ guidance development for interpreting narrative WQS where it is determined that there is "good" confidence in the quality of the reference sites and resulting information (DEQ 2004). If it is determined that there is only a "fair" confidence in the quality of the reference sites, then the 50th percentile or median value should be used, and if it is determined that there is "very high" confidence, then the 90th percentile of the reference data set should be used. Most reference data sets available for water quality restoration planning and related TMDL development, particularly those dealing with sediment and habitat alterations, would tend to be "fair" to "good" quality. This is primarily due to a the limited number of available reference sites/data points available after applying all potentially applicable stratifications on the data, inherent variations in monitoring results among field crews, the potential for variations in field methodologies, and natural yearly variations in stream systems often not accounted for in the data set."

The 9% eroding banks is applied at the watershed scale within each stream of concern and represents a reasonable expectation of a desired condition based on the data and statistical analysis. Adaptive management however allows for additional data and assessment to be used to adjust a target value or allocation if it can be shown that this metric is unachievable or inappropriate for a specific waterbody.

Comment #9
Despite the emphasis on the derivation of "target values", it appears that these values are not directly linked to TMDL allocations. TMDL allocations for sediment were apparently based on the widespread application of BMPs. Consequently, the TMDL is not water quality-based, but technology (i.e., BMP)-based, which is appropriate when nonpoint sources are the primary source of impairment. Given that this TMDL appears to address nonpoint sources, and the numeric targets and proposed quantitative and proposed quantitative load reductions are not directly tied to use attainment, the purpose and implications of providing specific numeric instream targets or goals is unclear. A better approach might be to specifically define "reasonable land, soil, and water conservation practices", estimate potential loading reductions associated with implementation of these actions, and conduct a more specific assessment of biological or ecological indicators to monitor progress toward use attainment.

Response to Comment #9
The development of a TMDL combines the use of various metrics to determine impact from a particular pollutant of concern. These metrics may include water quality values, habitat and morphology characteristics, or biological and ecological community indices. These targets reflect a condition that is supportive of the beneficial uses and are developed to determine the degree of impairment in a given watershed. Once impairment is determined, a review and assessment of the various sources is completed, which incorporates an estimate of potential loading reduction associated with the application of reasonable land, soil, and water conservation practices. These practices are described within **Section 5.5** and **Section 7.0**. Therefore it is a combination of both water quality based measures and technology based measures by which a TMDL is assessed and achieved. If over time, additional data collection and analysis finds that either the targets are unachievable or the allocations of load reductions are unachievable, despite all best efforts, the TMDL process allows for adaptive management to address these issues, just as you have suggested.

Comment #10
The draft TMDL describes the MOS as accounting for "the uncertainty between pollutant loading and water quality and is intended to ensure that load reductions and allocations are sufficient to sustain conditions that will support beneficial uses", and states that it can be applied implicitly by using conservative assumptions, or by setting aside a specific portion of the allowable load" (p32). It is difficult, however, to understand if the MOS inherent in this TMDL results in an overly conservative characterization of actions needed to achieve use attainment, as the linkages between current sediment loads and impairment, and sediment loading reductions and attainment, have not been defined.

Response to Comment #10
The MOS in this document is incorporated implicitly as a result of the conservative characterization of sediment loads developed from the methods employed in this study, and is described in **Section 5.7.2**. The specific assumptions and considerations within each method are described in their respective

sections within the document. Linkages between sediment loads, impairment, and reductions and attainment have been defined within the document but as before, strengthened and clarified where ever possible.

Comment #11
A site-specific evaluation of mechanisms of effect is needed. The draft TMDL provides only a generic discussion of potential effects associated with increased sediment, and provides no discussion of magnitudes of "sediment increases" and association with types or magnitudes of impacts. A general statement is provided indicating that "an accumulation of benthic fine sediment reduces the flow of water through gravels harboring salmonid eggs, hindering emergence of newly hatched fish, depleting oxygen supply to embryos, and causing metabolic wastes to accumulate around embryos, resulting in higher mortality rates (Armour et. Al, 1991)", yet no attempt is made to relate these potential impacts to the tributaries addressed by the TMDL.

Response to Comment #11
Full assessment of biological communities and site-specific evaluation of mechanisms of effect would certainly further clarify the linkages between sediment impact and the beneficial uses for the streams of interest. This further evaluation however increases the time and cost of the assessment and development of the TMDL, the resources to which, are not unlimited. The data collected throughout the course of the analysis of this watershed, both site specific and modeled, is sufficient for addressing the sediment impairment determination and understanding of the impacts to the beneficial uses, as well as the development of allocations to eventually attain full support. This is sufficient largely because a considerable wealth of information is known regarding the impacts of sediment to fish and aquatic life, and the morphological characteristics we can view that display the effects of sediment and infer health of the aquatic biologic community. Examples of this information are cited throughout the document.

Comment #12
For a parameter such as sediment, attainment of aquatic life uses should be at least partially based on biological monitoring. It is acknowledged that sediment is a difficult parameter to link directly to use attainment. Even if target values were directly based on designated use attainment, as recommended above, there is expected to be a certain amount of uncertainty in the "correct" target values. For this reason, the adaptive management approach should include mechanisms for directly evaluating the biological health of stream segments, and assessing attainment of aquatic life uses accordingly. For example, if in-stream aquatic life is healthy and has adjusted to modified stream morphology, the aquatic life use should be considered attained even if certain stream metrics do not conform to target values.

Response to Comment #12
It is agreed that the inclusion of biological data as a metric by which to determine impairment and eventual use attainment should be included within the adaptive management strategy. Language in **Section 8.0** has been strengthened to address this point.

However, the classification of in-stream aquatic life as healthy should also include those features and functions that support the in-stream aquatic life. The presence of a particular species within a modified environment does not necessarily equate to healthy aquatic life. The potential to support and propagate that species within that environment (e.g. a modified stream morphology), provided all reasonable land, soil, and water conservation practices, is equally important to sustaining and protecting that species, and thereby attaining that beneficial use. To provide another example, a bull trout may reside in an environment with limited resources, yet enough resources to keep that individual trout healthy. But if pollutant reductions and land and water quality management changes provided conditions that would allow greater population abundance and/or diversity in that environment more akin to what would be expected for that stream, then that would be the measure of attaining a healthy system to support that beneficial use.

Comment #13
One of the water quality targets for sediments is stream morphology (i.e., width/depth ratio, entrenchment ratio, residual pool depth, substrate composition). Again, no data is presented illustrating how departing from these targets actually results in impacts to the aquatic life and other beneficial uses.

Response to Comment #13
A significant amount of scientific research has been done that correlates the target parameters chosen for the Lower Clark Fork tributaries to aquatic life and cold water fisheries. The development of these types of targets is also consistent with EPA sediment TMDL guidance. These relationships are well described and literature is cited throughout the discussion in **Section 5.4** and **Appendix D**.

Comment #14
There is some difference between the target values and those values measured at the reference locations. For example, the target entrenchment ratio for high gradient streams, as presented in Appendix D, is between 1.4 and 2.2; however, the median of the field measured values was 3.0.

Response to Comment #14
The data used by which to develop many of the targets were taken from sites throughout the watershed, and under a variety of stream conditions and therefore reflect that variability. The target values chosen to represent the expected and acceptable conditions were based on the median value of this mixed (desired and impaired conditions) data set. In the case of the targets for entrenchment ratio and width/depth ratio, these values were taken directly from the criteria presented in David Rosgen's Classification of Natural Rivers. The data set used to develop Rosgen's critera is much more extensive and has undergone rigorous scientific evaluation and confirmation. Because of this, the Rosgen values for those parameters were deemed to be appropriate, despite the slight variance between the median value for the LCF sites and the Rosgen criteria value.

Comment #15
The sediments found within a stream are highly variable over time: that is, if measurements are taken following a flood or a long drought, very different substrate compositions may result. This variability is important, and should be explicitly addressed from an uncertainty perspective in the TMDL.

Response to Comment #15
This variability and the application of the TMDL targets as a result of seasonal and annual variability are explicitly addressed in **Section 5.7.3 – Uncertainty and Adaptive Management**.

Comment #16
The draft TMDL states that "…adaptive management relies on continued monitoring of water quality and stream habitat conditions, continued assessment of impacts from human activities and natural conditions, and continued assessment of how aquatic life and coldwater fish respond to changes in water quality and stream habitat conditions" (p.72). While we applaud the use of an adaptive management strategy, given the uncertainties associated with actual loading reductions needed to

attain designated uses, the approach for adaptive implementation needs to be more focused. The monitoring approach described would be difficult to design and costly to implement, and there are no specific defined criteria for any of the proposed endpoints on which to judge success. As previously stated, the proposed stream attribute targets cannot necessarily be looked at individually, or in any specific combination to define impairment or attainment.

Response to Comment #16
The initial comment regarding the application of stream attribute targets (Comment #3) was taken out of context, however to stem any future misconceptions, the description of the application and interpretation of targets has been edited and clarified within the document. These targets, and the allocations of sediment reduction, are the endpoints on which to judge success. However, adaptive management allows for refinement of these targets and endpoints as more information becomes available. As the above comments have pointed out, additional information can be collected and analyzed to provide more specific answers to what is being impacted, how it is being impacted, where these impacts are greatest, etc. The monitoring methods described are not a prescription per say, but examples of the options available to local land managers and stakeholders by which to evaluate the achievement of the TMDL, and gather further knowledge about the mechanisms effecting impairment throughout the watershed. It is ultimately up to the people who live and work in the watershed to implement and achieve the TMDL, therefore the monitoring strategies that are employed should follow criteria by which to measure success of the projects they undertake, and the TMDLs as a whole. Generally, the reproduction of methods and assessment as had been done for the development of this TMDL would be the first step in analysis of comparing data to monitor change over time, and this point is explicitly stated in **Section 8.0**.

Comment #17
The TMDL has not defined the current baseline for aquatic or coldwater fish use, or the metrics to determine impairment or attainment of these designated uses. Prior to implementation of an extensive monitoring program to support adaptive implementation, specific goals and associated metrics for biological and ecological condition, and the associated natural range or variability should be defined.

Response to Comment #17
As previously stated in the Response to Comment #1, further information to describe the process for determining impairment and listing a waterbody to the State's Impaired Waters list can be found in Montana's Water Quality Integrated Report. A summary of this process is included in **Section 3.0**.

The information provided within this document offers a solid foundation by which to assess and implement change in the Lower Clark Fork tributaries. The targets developed herein serve to measure the impact from sediment, and directly relate to healthy environments that support coldwater fish and aquatic life.

Watershed scale recovery from pollutant impacts is a time consuming and sometimes expensive endeavor to undertake, yet a necessary one for the well being of the health of these ecosystems, and the people who live, work, and play there. The desire to have a more thorough picture of the complex mechanisms of sediment input, and the interactions between sediment loads, land management, and stream ecology is shared by the DEQ, but does not preclude actions from being taken now to ultimately achieve full support of the beneficial uses in the Lower Clark Fork tributaries. The Lower Clark Fork Watershed Group has worked collaboratively for well over the past decade with land owners, businesses, and local, state, and federal agencies to form partnerships by which to investigate these issues. The strategies they, among others, have implemented, and the projects they have put on the ground have made a difference and are bringing the Lower Clark Fork tributaries closer to meeting the goals set forth in this document. This document is yet another tool in the toolbox for these individuals to use and more efficiently and effectively refine and focus their efforts for the continued reduction of pollutants and protection and improvement of these important watersheds.

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