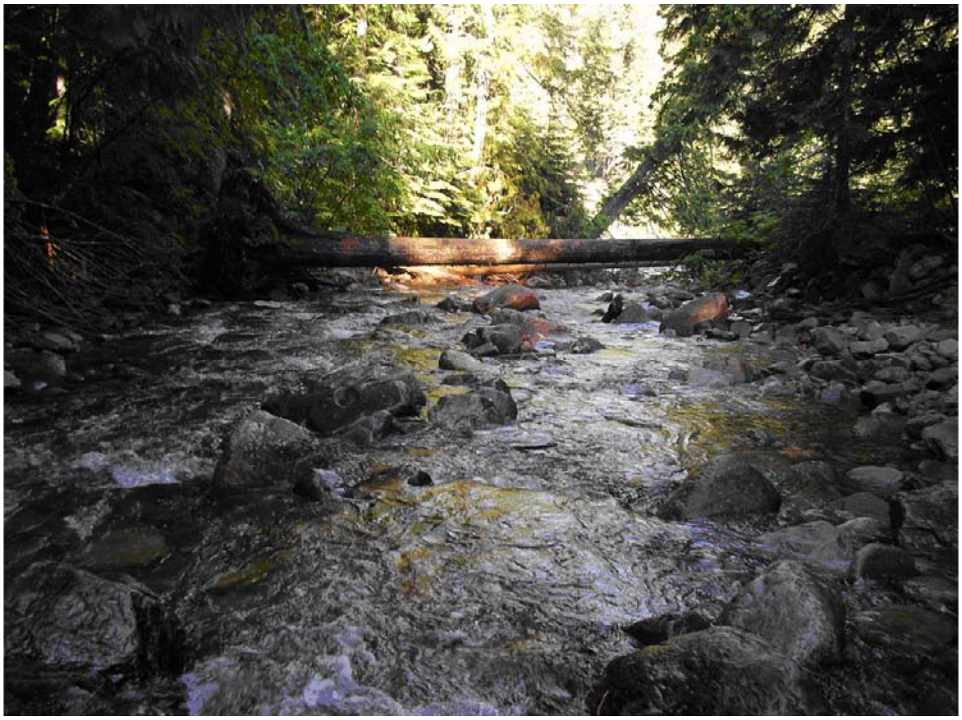
Lower Clark Fork River Subbasin Assessment and Total Maximum Daily Loads



Final

Department of Environmental Quality

2007

Lower Clark Fork River Subbasin Assessment and Total Maximum Daily Loads

Final
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Numerous DEQ staff members were involved in the writing and review of this document. The entire water quality section in the Coeur d'Alene DEQ office provided review and support for this document. Shantel Aparicio (formerly with DEQ) prepared the first draft of Sections 1-4. Glen Pettit provided GIS support. Tyson Clyne provided GIS analysis and TMDL documentation for sediment analysis, and extensive assistance with the temperature TMDL. Bob Steed provided technical oversight and assistance for the entire document. Mark Shumar produced the temperature TMDL Potential Natural Vegetation model and responded to numerous questions and comments throughout the development of the temperature TMDL. Charlotte Scofield provided editorial assistance. Jenna Borovansky facilitated the WAG and served as overall editor for the document.

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Abbreviations, Acronyms, and Symbols

§303(d) Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section of the Act

µ micro, one-one thousandth

§ Section (usually a section of federal or state rules or statutes)

ADB assessment database

AU assessment unit

AWS agricultural water supply

BAG Basin Advisory Group

BLM United States Bureau of Land Management

BMP best management practice

BOD biochemical oxygen demand

Btu British thermal unit

BURP Beneficial Use Reconnaissance Program

C Celsius

CFR Code of Federal Regulations (refers to citations in the federal administrative rules)

cfs cubic feet per second

cm centimeters

CWA Clean Water Act

CWAL cold water aquatic life

CWE cumulative watershed effects

DEQ Department of Environmental Quality

DO dissolved oxygen

DOI U.S. Department of the Interior

DWS domestic water supply

EPA United States Environmental Protection Agency

ESA Endangered Species Act

F Fahrenheit

FPA Idaho Forest Practices Act

FWS U.S. Fish and Wildlife Service

GIS Geographical Information Systems

HUC Hydrologic Unit Code

IDAPA Refers to citations of Idaho administrative rules

IDFG Idaho Department of Fish and Game

IDL Idaho Department of Lands

INFISH the federal Inland Native Fish Strategy

km kilometer

km^2 square kilometer

LA load allocation

LC load capacity

m meter

m^3 cubic meter

mi mile

mi^2 square miles

mg/L milligrams per liter

mm millimeter

MOS margin of safety

MWMT maximum weekly maximum temperature

NB natural background

NFS not fully supporting

NPDES National Pollutant Discharge Elimination System

NRCS Natural Resources Conservation Service

NTU nephelometric turbidity unit

PCR primary contact recreation

SBA subbasin assessment

SCR secondary contact recreation

SFI DEQ's Stream Fish Index

SHI DEQ's Stream Habitat Index

SMI DEQ's Stream Macroinvertebrate Index

SRP soluble reactive phosphorus

SS salmonid spawning

TDG total dissolved gas

TIN total inorganic nitrogen

TKN total Kjeldahl nitrogen

TMDL total maximum daily load

TP total phosphorus

TS total solids

TSS total suspended solids

t/y tons per year

U.S. United States

USDA United States Department of Agriculture

USFS United States Forest Service

USGS United States Geological Survey

WAG Watershed Advisory Group

WBAG *Water Body Assessment Guidance*

WLA wasteload allocation

WQS water quality standard

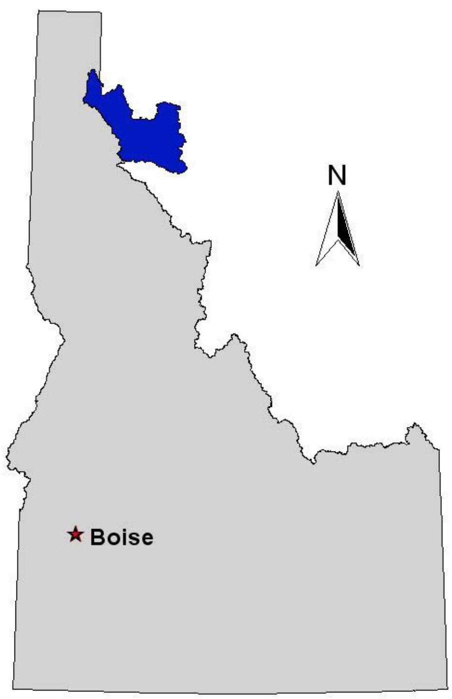
Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. This list must be published every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards and protect beneficial uses.

This document addresses the water bodies in the Lower Clark Fork River Subbasin that have been identified as impaired in Section 5 of Idaho's 2002 Integrated Report, commonly referred to as the "303(d) list". The assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Lower Clark Fork River Subbasin, located in north Idaho. The document was prepared by DEQ in consultation with a local watershed advisory group representing a broad range of stakeholders in the subbasin.

The first part of this document is the Subbasin Assessment (SBA). The starting point for this assessment was Idaho's 2002 Integrated Report. Twenty-five assessment units in eleven water bodies in the Lower Clark Fork River Subbasin are listed as water quality limited in the Integrated Report. The SBA examines the current status of all assessed water bodies in the subbasin and defines the extent of impairment and causes of water quality limitation in those listed as water quality limited. The TMDL analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return impaired waters to a condition of supporting beneficial uses.

Subbasin at a Glance



Lower Clark Fork River Subbasin

Hydrologic Unit Code: 17010213 in Idaho

Water Quality Limited Streams: Clark Fork River, Cascade Creek, Dry Creek, Twin Creek, East Fork Creek, Johnson Creek, Lightning Creek, Mosquito Creek, Rattle Creek, Savage Creek, and Wellington Creek.

Beneficial Uses Affected: Cold water aquatic life, salmonid spawning, primary and secondary contact recreation, domestic water supply, special resource water.

Pollutants of Concern: Sediment, temperature, metals, total dissolved gas.

Uses: Forestry, agriculture, rural residential, recreation.

Figure 1. Location of the Lower Clark Fork River Subbasin.

Primarily located in the state of Montana, the 320 mile long Clark Fork River, hydrologic unit code 17010213, flows from near Butte, Montana to Lake Pend Oreille in Idaho (Figure 1). This document addresses the lower most 247 square miles of the subbasin located in north Idaho. The headwaters of the Clark Fork River originate in northwest Montana in the Silver Bow mountains, and by the time it reaches its terminus in Pend Oreille Lake, the river has drained over 22,000 square miles.

The Lower Clark Fork River provides over 92% of the inflow to Lake Pend Oreille, the recreational and economic hub of the area. The Lightning Creek watershed, its largest tributary in Idaho, harbors a regionally significant bull trout population and supports many other native fish. With approximately 75 % of the subbasin in public ownership, there is a diversity of recreational opportunities, as well as substantial wildlife habitat. Both the mainstem Lower Clark Fork River and Lightning Creek are designated Special Resource Waters by the state of Idaho. Special protections of beneficial uses in these waters are given in recognition of their outstanding or unique characteristics. Primarily, this designation prohibits additional point source pollution permits to protect current beneficial uses.

The mainstem of the Lower Clark Fork River exceeds several of the State of Idaho's water quality standards, as do many of its tributaries. There are twenty-five water quality limited assessment units that will be addressed in this document. These water bodies represent portions of the Lower Clark Fork River Subbasin in Idaho and its tributaries.

Idaho DEQ's annual stream monitoring data, other existing stream surveys, and water quality samples were used to determine whether designated and existing beneficial uses of streams are being supported. Existing beneficial uses include cold water aquatic life, salmonid spawning, primary contact recreation, domestic water supply, and special resource waters.

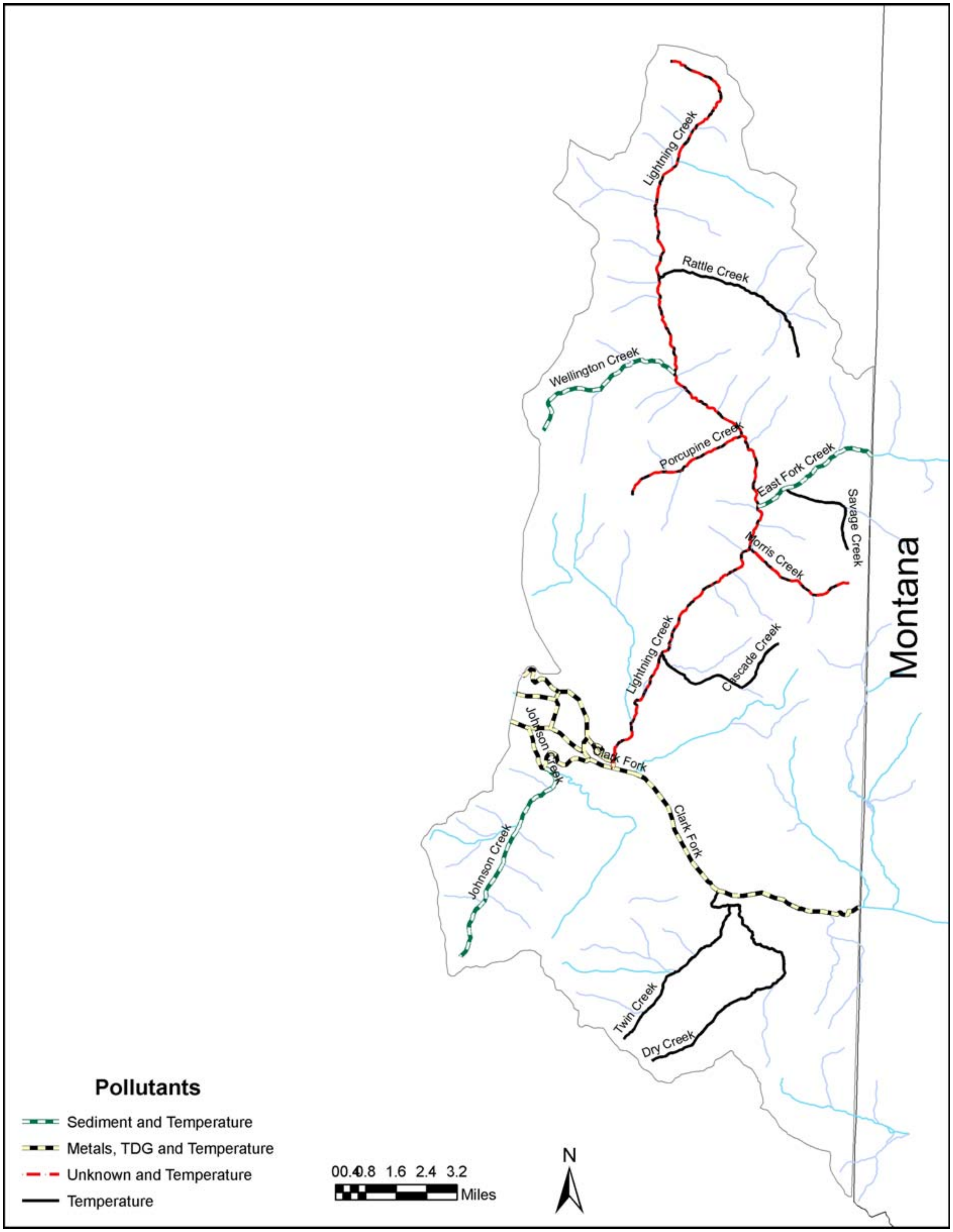


Figure 2. Streams in the Lower Clark Fork River Subbasin identified as impaired in Section 5 of the 2002 Integrated Report.

Total Maximum Daily Loads (TMDLs) were developed for each stream determined to not fully support beneficial uses in accordance with state of Idaho water quality standards. The TMDLs included in this document address in-stream sediment, metal, and temperature reduction goals to maintain or restore cold water aquatic life and salmonid spawning in the tributaries. Cadmium, zinc, copper and Total Dissolved Gas TMDLs were developed for the main stem Clark Fork River. Sediment and temperature TMDLs were developed in the Lightning Creek drainage, Twin and Johnson Creeks. The total maximum daily loads help quantify needed improvements and target management actions to address water quality improvement measures and timelines.

Key Findings

Pollutants of concern identified during the assessment for this process are sediment, temperature, metals, and total dissolved gas (Table 1). Several water bodies were found to be biologically impaired, though the pollutants were unknown at the time of listing. The TMDL process helped identify the pollutants causing impairment in these systems and suggests changes to the Integrated Report to reflect these determinations. Assessment outcomes are summarized in Table 2.

Metals and Total Dissolved Gas pollution are the pollutants of concern in the mainstem Clark Fork River. Intensive mining around the headwaters of the Clark Fork River in Montana left residues of heavy metals behind, which still pose a risk to water quality throughout the basin. The Cabinet Gorge hydropower project is located in Idaho just downstream from the Montana/Idaho border and has been operating on the Lower Clark Fork River since 1952. With additional hydropower facilities upstream, the flows and habitat conditions for native aquatic species in the entire Clark Fork River system have been extensively altered by hydropower development. As a condition of obtaining a federal license to operate the hydropower facility in 2001, a collaborative group of stakeholders and resource agencies partnered with Avista, the operator of the Cabinet Gorge Dam, to direct mitigation measures aimed at restoring water quality and native fish populations in the entire Lower Clark Fork River Subbasin.

Temperature is identified as a pollutant in the Lower Clark Fork River below the Idaho/Montana border. The Lower Clark Fork River on the Montana side of the border has not been found to violate Montana water quality standards for temperature. To better address this issue at a watershed level, Idaho and Montana will investigate available information before the five-year review of this TMDL. Temperature will remain in Section 5 of Idaho's Integrated Report until this time.

Current assessments do not show the Lower Clark Fork River to be impaired by nutrients below Cabinet Gorge dam. Because of the sheer volume of water entering the lake from the Clark Fork, there is a bi-state agreement between Idaho and Montana to limit nutrient contributions to Lake Pend Oreille, where there is a nutrient TMDL established to protect the nearshore area of the lake.

Sediment and temperature are the pollutants of concern in the tributaries to the Lower Clark Fork River. In addition to flow and habitat alterations in the system, thick glacial outwash sediments in steep drainages combined with timber harvest and road construction have created potential sediment problems in several of the tributaries to the Clark Fork River.

Temperatures exceed water quality standards for salmonid spawning throughout the subbasin. Fire and historic timber harvest have created a more open canopy and related stream warming compared to background conditions. A model of potential natural vegetation was created to identify areas of concern where the current solar heating differs greatly from background solar heating conditions.

Figure 2 shows Lower Clark Fork River Subbasin assessment units identified as impaired in the 2002 Integrated Report, and the pollutants for which TMDLs were developed. Table 2 summarizes assessment outcomes by assessment unit and defines boundaries. The 2002 Integrated Report identified Twin Creek, Wellington Creek, Savage Creek and Rattle Creek as impaired by temperature, and the subbasin assessment process identified sediment as an additional pollutant and TMDLs were completed.

Table 1. Streams and pollutants for which TMDLs were developed.

Stream	Pollutant(s)
Clark Fork River	Metals (Cadmium, Copper, Zinc), TDG
Cascade Creek	Temperature
Dry Creek	Temperature
Mosquito Creek	Temperature
Twin Creek	Sediment, Temperature
East Fork Creek	Sediment, Temperature
Johnson Creek	Sediment, Temperature
Lightning Creek	Sediment, Temperature
Rattle Creek	Sediment, Temperature
Savage Creek	Sediment, Temperature
Wellington Creek	Sediment, Temperature

Table 2. Summary of assessment outcomes.

Stream	Assessment Unit	Pollutant	TMDL(s) Completed	Recommended Changes to the 2002 Integrated Report	Justification
Clark Fork River	ID 170213PN005_08 ID 170213PN003_08 ID 170213PN001_08	TDG	Yes	Move to section 4a*	TMDL Completed
		Metals	Yes	Identify metals as cadmium, copper and zinc; Move to section 4a	TMDL Completed
		Unknown	No	Remove pollutant from integrated report	All known pollutants for these assessment units are identified; Flaws in the original analysis of data and information led to the segment being incorrectly listed for this pollutant
		Temperature	No	None	Inadequate information available for a TMDL at this time
Cascade Creek	ID170213PN012_02	Temperature	Yes	Move to section 4a	TMDL Completed
Dry Creek	ID17010213PN004_02a	Temperature	Yes	Move to section 4a	TMDL Completed
Mosquito Creek	ID170213PN009_02	Temperature	Yes	Move to section 4a	TMDL Completed
Lightning Creek	ID17010213PN010_04 ID17010213PN011_02 ID17010213PN011_04 ID17010213PN013_02 ID17010213PN013_04 ID17010213PN016_02	Sediment	Yes	Remove unknown pollutant and move to section 4a	Unknown pollutant identified as sediment and TMDL completed

Stream	Assessment Unit	Pollutant	TMDL(s) Completed	Recommended Changes to the 2002 Integrated Report	Justification
		Temperature	Yes	Move to section 4a	TMDL completed
East Fork Creek	ID17010213PN014_02 ID17010213PN014_03	Sediment	Yes	Move to section 4a	Assessment units included in sediment TMDL and load reduction allocation for Lightning Creek
		Temperature	Yes	Move to section 4a	TMDL completed
Rattle Creek	ID17010213PN018_02	Sediment	Yes	Add pollutant to integrated report	Current load above subbasin target; TMDL completed
		Temperature	Yes	Move to section 4a	TMDL completed
Savage Creek	17010213PN015_02	Sediment	Yes	Add pollutant to integrated report	Current load above subbasin target; TMDL completed
		Temperature	Yes	Move to section 4a	TMDL completed
Wellington Creek	ID17010213PN020_02	Sediment	Yes	Add pollutant to integrated report	Previously identified as sediment impaired in 1998, error in 2002 report did not reflect sediment impairment; Current load above subbasin target; TMDL completed
		Temperature	Yes	Move to section 4a	TMDL completed
Johnson Creek	ID17010213PN002_02 ID17010213PN002_03	Sediment	Yes	Move to section 4a	TMDL completed
		Temperature	Yes	Move to section 4a	TMDL completed
Twin Creek	ID17010213PN004_02 ID17010213PN004_03	Sediment	Yes	Add pollutant to integrated report	Current load above subbasin target; TMDL completed
		Temperature	Yes	Move to section 4a	TMDL completed

* Section 4a of the Integrated Report is “Impaired waters with a completed TMDL”.

1. Subbasin Assessment – Watershed Characterization

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently this list must be published every two years. This document addresses the water bodies in the Lower Clark Fork River Subbasin that have been identified as impaired in Section 5 of Idaho's 2002 Integrated Report (commonly referred to as the "303(d) list").

For waters identified as impaired, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. (In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.)

The overall purpose of the subbasin assessment (SBA) and TMDL is to characterize and document pollutant loads within the Lower Clark Fork River Subbasin in Idaho. The first portion of this document, the SBA, is partitioned into four major sections: watershed characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts (Sections 1 – 4). This information will then be used to develop a TMDL for each pollutant of concern for the Lower Clark Fork River Subbasin (Section 5).

1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Environment Federation 1987, p. 9). The act and the programs it has generated have changed over the years, as experience and perceptions of water quality have changed.

The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the country. The Department of Environmental Quality (DEQ) implements the CWA in Idaho, while the EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt water quality standards and to review those standards every three years (EPA must approve Idaho's water quality standards). Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish a TMDL for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses.

These requirements result in a list of impaired waters, called the "§303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. A SBA and TMDL provide a summary of the water quality status and allowable TMDL for pollutant impaired water bodies. *Lower Clark Fork River Subbasin Assessment and Total Maximum Daily Loads* provides this summary for the currently listed waters in the Lower Clark Fork River Subbasin.

The SBA section of this document (Sections 1 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the Lower Clark Fork River Subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (Water quality planning and management, 40 CFR Part 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also allocates allowable discharges of individual pollutants among the various sources discharging the pollutant.

Some conditions that impair water quality do not receive TMDLs. The EPA considers certain human-caused conditions, such as flow alteration (e.g., hydropower operations), human-caused lack of flow, or habitat alteration, that are not the result of a specific pollutant discharge, as "pollution." TMDLs are not required for water bodies impaired by pollution that is not caused by a specific "pollutant". A TMDL is only required when a pollutant, like sediment or temperature, can be identified and in some way quantified.

Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through anti-degradation provisions.

The state may assign or designate beneficial uses for particular Idaho water bodies to support. These beneficial uses are identified in the Idaho water quality standards and include the following:

- Aquatic life support–cold water, seasonal cold water, warm water, salmonid spawning
- Contact recreation–primary (swimming), secondary (boating)
- Water supply–domestic, agricultural, industrial
- Wildlife habitats

- Aesthetics

The Idaho legislature designates uses for water bodies. Industrial water supply, wildlife habitats, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body is unclassified, then cold water aquatic life and primary contact recreation are used as the default designated uses when water bodies are assessed.

A SBA entails analyzing and integrating multiple types of water body data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the water body (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the water body, particularly the identity and location of pollutant sources.
- Determine the causes and extent of the impairment when water bodies are not attaining water quality standards.

Public Participation

In compliance with Idaho Code §39-3611(8), the development of the Lower Clark Fork River Subbasin Assessment and TMDL included extensive public participation by the Watershed Advisory Group (WAG) and other interested parties in the subbasin. All meetings were open to the public and advertised at least one-week prior to the meeting, in addition to being noted on the DEQ public meeting calendar on the internet and posted at the DEQ regional office in Coeur d'Alene.

2003-2004: DEQ worked with Designated Management Agencies to gather relevant information for the TMDLs. Public notice was given, and two public meetings were held in Spring 2004 to introduce the public to the TMDL process and to form a WAG. Due to staff changes and budget limitations, between May 2004 and May 2005 there were limited resources to devote to this TMDL.

In June 2005, DEQ work on the TMDL began again.

In August 2005, DEQ sent a letter and survey to all participants in the original meetings, designated management agencies and interested parties in the region. Follow-up phone calls were made to individuals who had expressed interest in joining the WAG in 2004.

In September 2005, the first meeting to re-initiate the WAG and invite new participation was held. Efforts were made to identify stakeholders as outlined in Idaho Code. Participants were given a draft copy of the Subbasin Assessment, background on DEQ's responsibility under HB145 and a draft schedule for completion. Public notice was given for each meeting in local newspapers and radio public calendars. An e-mail list of interested parties was created for notification of future meetings.

In October 2005, follow-up invitations were sent to parties who had expressed interest in 2004, but did not attend the meeting or respond to the September mailing. Public notice on community calendars and at the DEQ office was given for the meeting. Participants reviewed beneficial use designations in the watershed and water quality information to date, and comment was taken on the draft Subbasin Assessment.

In November 2005, a mailing went to approximately 80 individuals identified by the WAG and DEQ as being potential interested parties. The mailing included a meeting announcement for the December 2005 meeting and information on a web page dedicated to sharing information from the meetings. Public notice on community calendars was given, and a small newspaper article announcing the December meeting was published in the Bonner County Bee and the Coeur d'Alene Press.

In December 2005, a WAG meeting was held to discuss existing water quality information in the mainstem Clark Fork River and the Lightning Creek drainage and input on TMDL development was provided by the WAG and other interested parties attending the meeting.

In January 2006, a WAG meeting was held to discuss draft temperature and metals TMDLs. Preliminary load calculations for each pollutant were presented, and hard copies of these draft TMDLs were provided to the WAG for review.

In February 2006, a WAG meeting was held to discuss the strategy for addressing sediment TMDLs, with a focus on the Lightning Creek drainages. WAG feedback on specific parameters of the proposed sediment model was taken. In addition, water quality information on Cascade Creek and Twin Creek was discussed with local landowners familiar with those areas.

In April 2006, a WAG meeting was held to discuss TMDL calculations for sediment impaired streams in the subbasin. Proposed sediment reduction targets were presented, based on reference streams recommended by the WAG at the February meeting. An updated draft of the SBA was provided to the WAG and comments and changes to the draft temperature TMDLs were discussed with the WAG.

In May 2006, draft sediment TMDLs and the Total Dissolved Gas TMDL were provided to the WAG. Additional questions about the development and presentation of the sediment tributary TMDL target was discussed, and a follow-up conference call on temperature issues was scheduled with a subgroup of the WAG.

In June 2006, DEQ presented an updated version of the SBA and all TMDLs to the WAG. A subgroup of the WAG met via conference call and recommended changes to temperature TMDL targets that were accepted by the full WAG. Operating procedures were memorialized in an interim procedures document that is posted on the DEQ web-site. The WAG recommended that with changes discussed at this meeting, the document is ready for public comment.

In September 2006, DEQ presented a summary of the public comment version of the SBA and TMDL before the Panhandle Basin Advisory Group, with a recommendation from the WAG that the TMDL is ready for public comment. A 45-day public comment period was opened on January 19, 2007 and closed on March 5, 2007. The document was made available on the DEQ web-site and at local libraries. A public meetings was held January 30, 2007 at the Sandpoint federal building.

In May 2007, DEQ's final draft and response to comment were presented to the Lower Clark Fork Watershed Advisory group. The WAG recommended that the Panhandle Basin Advisory Group recommend submittal of the TMDL to EPA for final approval.

DEQ has complied with the WAG consultation requirements set forth in Idaho Code § 39-3611. DEQ has provided the WAG with all available information concerning applicable water quality standards, water quality data, monitoring, assessments, reports, procedures and schedules. DEQ worked closely with the WAG in collecting the information for the proposed Waste Load Allocations and in developing the Subbasin Assessment. All presentations and drafts provided at WAG meetings were made available on the DEQ web-site throughout the process.

DEQ utilized the knowledge, expertise, experience and information of the WAG in developing this TMDL. DEQ also provided the WAG with an adequate opportunity to participate in drafting the TMDL and to suggest changes to the document. Subsequent to the development of the original draft SBA proposed in 2005, the WAG and members of the public attending WAG meetings have continued to provide DEQ with input, information and suggestions during monthly meetings in late 2005 and early 2006.

1.2 Physical and Biological Characteristics

The Clark Fork River originates near Butte, Montana and drains approximately 22,000 square miles in western Montana and northern Idaho, 247 square miles of which comprise the Lower Clark Fork subbasin in northern Idaho. The river drains into the 95,000-acre surface area Lake Pend Oreille and as the lake’s largest tributary, the Clark Fork River contributes approximately 92% of the annual inflow to the lake and most of the annual suspended sediment load.

The following section outlines climate data for the entire Subbasin, as well as the hydrography and geology of the area. General trends in fish populations and influences to their survival are presented. Finally, specific stream type information for individual streams is presented. This information serves as background for understanding current and potential water quality impairment.

Climate

Monthly climate data has been collected near the Cabinet Gorge Dam, Idaho by the Western Regional Climate Center since 1956. (Weather station locations are shown in Figure 3.) The average monthly temperature over the 49-year period of record (1956-2005) ranges from a high of 82.6° F in July to a low of 21.2° F in January. The extreme maximum of all daily maximum temperatures over the period of record was 105° F in early August 1961. The extreme minimum of all daily minimum temperatures over the period of record was minus 28° F in late December 1968.

At the Cabinet Gorge station (2260 feet elevation), the average annual precipitation over the period of record was 32.33 inches with November being the wettest month and July the driest. Most precipitation is in the form of snow, with the highest snowfall levels generally occurring in January. Due to the mountainous terrain, precipitation varies noticeably among some of the watersheds in the subbasin.

Particularly at higher elevations, average snow pack in the Clark Fork Basin can be significant. For example, the Bear Mountain snow telemetry station at an elevation of 5400 feet, near the headwaters of Rattle Creek, reported a maximum of 82 inches of precipitation in form of snow for the 2002 water year. Rain-on-snow events and spring runoff have the potential of moving tremendous amounts of bedload, especially in the Lightning Creek drainage.

Subbasin Characteristics

The Lower Clark Fork subbasin includes 180 miles of perennial streams. The river itself flows from east to west, with its main tributary, Lightning Creek, entering from the north. Steam channels in the basin tend to be Rosgen A or B types, with gradients ranging from .05% to 7%.

Hydrography

River flow information is collected at two stations in the subbasin. USGS gaging stations are located just below the Cabinet Gorge dam and at the mouth of Lightning Creek near the City of Clark Fork. There is a NRCS weather station at Bear Mountain in the Lightning Creek drainage, and a National Weather Service station at the Cabinet Gorge dam. Gaging station locations are shown in Figure 3.

The Clark Fork River flows into four reservoirs and passes over four power-generating dams before entering the northeast portion of Lake Pend Oreille. Three of the reservoirs and dams are located entirely in Montana, while the final dam (Avista's Cabinet Gorge facility) is located just downstream from the Montana/Idaho border 10 miles before the river enters Lake Pend Oreille. Primarily in Montana, the Cabinet Gorge reservoir has a storage capacity of 105,000 acre feet at full pool, with a pool that backs up to the Noxon Rapids dam. It is licensed to produce 263 megawatts of power. The minimum flow over the dam is 5,000 cubic feet per second[1], however, flows are generally much higher, ranging from minimum flow to over 50,000 cfs during peak run-off.

The entire subbasin is highly influenced by rain-on-snow events, with a portion of most subwatersheds in the primary rain-on-snow zone between 3000-4500 feet (915-1372 m). During warm years, the rain-on-snow zone can extend to elevations as high as 7000 feet (2,134 m) (cited in PWA 2004).

Peak flows can be extreme, and will move tremendous amounts of bedload through the system. For example, Table 8 summarizes peak flow activity in the Lightning Creek drainage. Compared to peak flows of 2,000 to 6,000 cfs, the average mean daily flow recorded at the Lightning Creek station is about 400 cfs. The system has a long history of flood and associated mass wasting events that are frequently associated with rain-on-snow events. For a more detailed summary of historic flooding and climate data for the Lightning Creek watershed, see PWA (2004) and Cacek (1989).

[1] The minimum flow for the Cabinet Gorge dam is a license condition, designated in 1999 Settlement Agreement for operation of the Noxon Rapids and Cabinet Gorge dams.

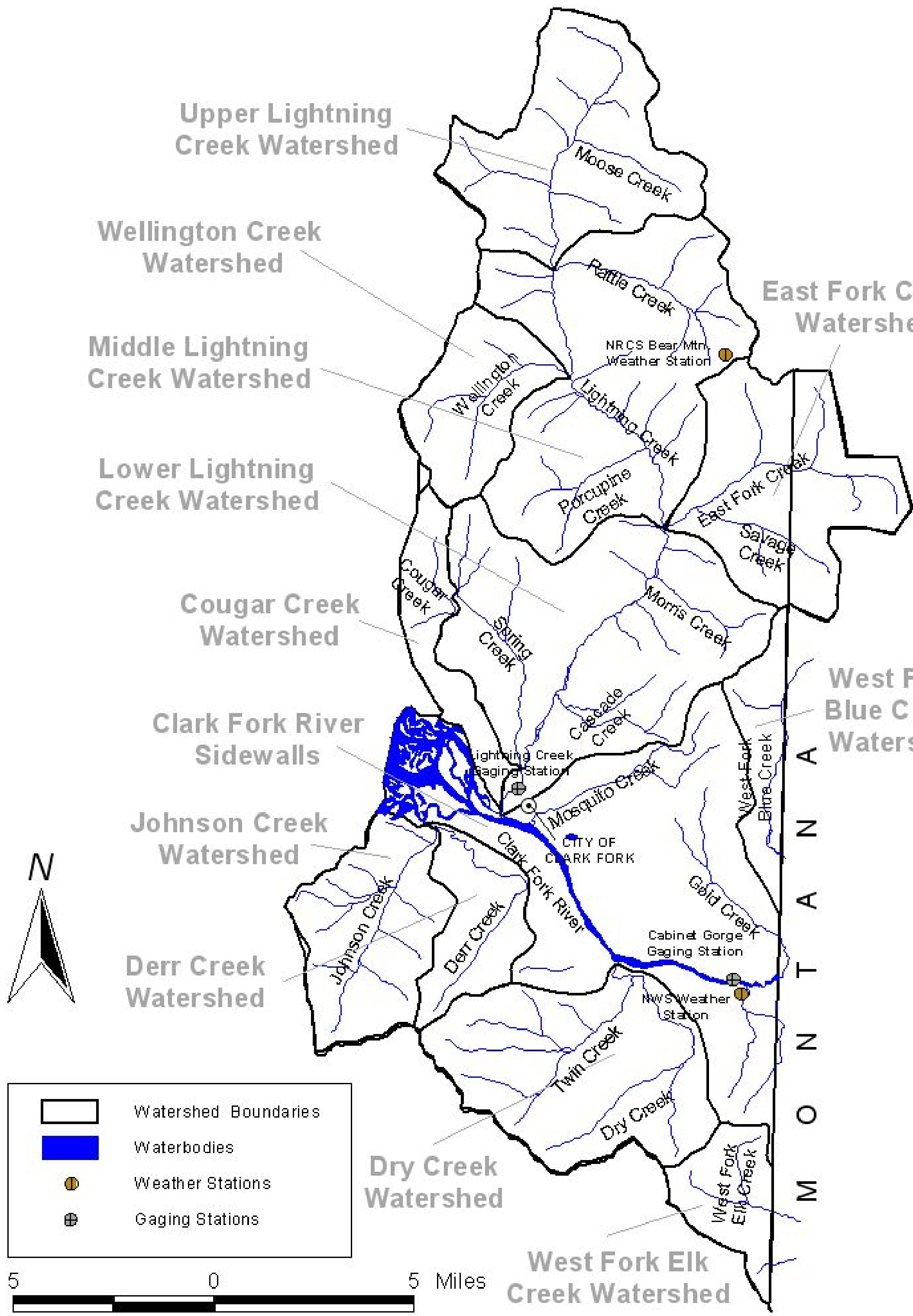


Figure 3. Lower Clark Fork River Watersheds, Hydrography, Weather, and Gaging Station.

Geology[2]

The geologic parent materials found in the Pend Oreille watershed are the product of millions of years of sedimentation, metamorphosis, uplift, and intrusion. Figure 4 shows the underlying geology of the subbasin. Belt series and Kaniksu batholith are the major underlying bedrock types. The Clark Fork River is primarily located within Belt Series bedrock (Savage 1965). The Belt Series are metamorphic sedimentary deposits comprised partially by the Bitterroot and Cabinet Mountains. These rocks were formed during the Precambrian period when shallow seas inundated northern Idaho. Clay, sand, and silt sediments settled out of brackish waters as the seas retreated. The sediments subsequently metamorphosed, folded, and faulted. The metamorphosed rocks in the basin include argillite, siltite, quartzite, and dolomite (Hoelscher et al. 1993).

The Kaniksu batholith formed about 70 to 80 million years ago when large masses of granite magma rose to the upper part of the Earth's crust. As this mass of granite magma rose, it caused part of the crust to shear off and move easterly, forming a part of the Cabinet Mountains.

The basin was substantially altered by major glacial events in the late Pleistocene period. The present Clark Fork River valley was alternately plugged and scoured by dams of ice and deposited debris that likely served as the primary feature controlling the level and size of glacial Lake Missoula. Lake Missoula once covered much of present day Western Montana. Existing soils in the watershed are derived from the erosion of Precambrian metasediments and granitic batholith, volcanic deposition, glacial outwash, and alluvium. Most land types have ten inches (25.4 cm) or more of surface soils composed of Mt. Mazama volcanic ash, which has very high infiltration rates. The Mt. Mazama ash layer was deposited about 7,000 years ago and is resistant to erosion-causing overland flows.

Watersheds in the Cabinet Mountains, including the Clark Fork subbasin, are prone to rapid runoff events due to the effects of glacial scour. Glacial advances resulted in highly dissected watersheds, shallow soils, and subsoil compaction of glacial tills. Glaciers acted as ice dams and deposited large amount of till in the subbasin. Fine, sandy sediments deposited in the dammed water are known as glacial fluvial deposits. Today these sandy areas appear on mountainside slopes and are very erosive.

Mass erosion is significant in the watershed. Since glacial outwash makes up most of the valley bottoms in the Cabinet Mountains in-channel erosion rates are relatively high. Activities, such as road construction, that intercept groundwater between compacted till layers and the ash layer, can increase surface flow and the potential for mass wasting. On disturbed landscapes, landslides are frequent contributors of sediment due to steep hillslopes and layering of erodible soils over impermeable silts and clays, particularly in the Lightning Creek drainages.

However, when forest conditions are undisturbed within the Pend Oreille basin, surface erosion is generally low to nonexistent on most upland land types.

The geology of an area influences the productivity potential for biological communities in the watershed. Generally, streams on the northern side of Lake Pend Oreille tend to be

[2] Much of the geological information in this section was originally reported in the Lake Pend Oreille Key Watershed Bull Trout Problem Assessment (PBTTAT 1998).

biologically productive with little fine sediment. These Belt Series streams are more likely to have bedload as a limiting factor than the fine sediments. Fish growth is typically slower in the nutrient-poor granitic watersheds flowing from the Cabinet Mountains. Natural waterfalls are found throughout the basin and preclude the use of several tributaries (or portions thereof) by migratory fish.

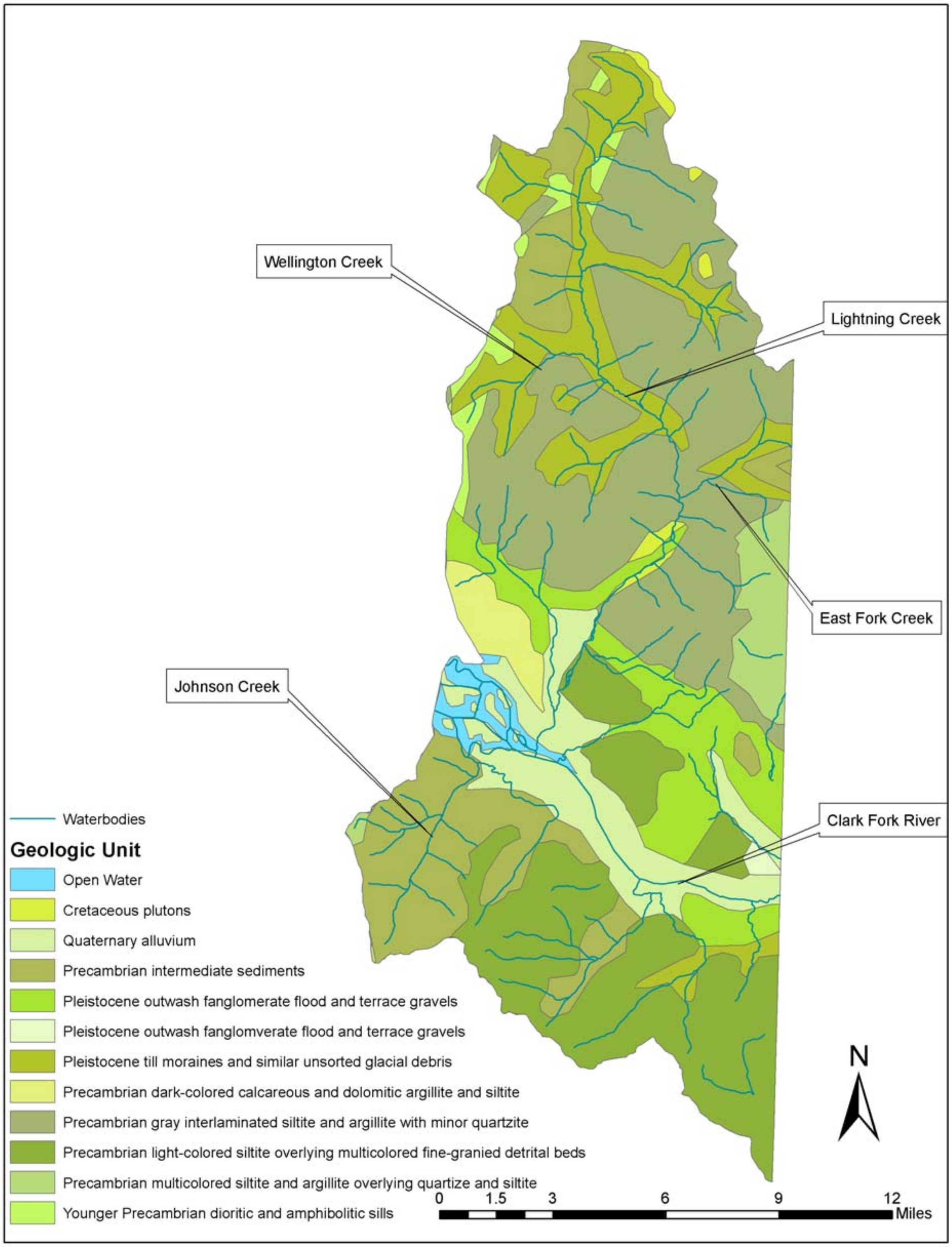


Figure 4. Geology of the Lower Clark Fork Subbasin.

Topography

The Lower Clark Fork subbasin varies greatly in elevation from lows of 2,060 feet near the Clark Fork River Delta, to a height of 7,009 feet at Scotchman Peak near the center of the subbasin. The subbasin is long and narrow, bounded to the east by the Cabinet Mountains. The river itself runs the width of the subbasin, from east to west, while the river's main tributary, Lightning Creek, enters from the north side of the river. Lightning Creek is north-south oriented and accounts for the upper three quarters of the watershed. Johnson Creek, the river's main southern tributary, originates in the Bitterroot Mountains. The river valley is generally concave in shape, having been formed by glacial activity and the draining of glacial Lake Missoula more than 10,000 years ago. Steep slopes characterize much of the subbasin, with slopes near Scotchman Peak and in the southern portion of the subbasin ranging from 47º to 63º. Slopes in the central and northern part of the subbasin are generally no greater than 16º.

Vegetation

Historic vegetation patterns in the Lower Clark Fork subbasin were largely influenced by wildfire. Early accounts and photographs of the basin indicate that old growth stands of western red cedar (*Thuja plicata*) were common in riparian zones and floodplains. Large cedar stumps can still be found in many riparian areas along streams in the basin. Watershed uplands were more typically dominated by several species in various stages of succession, with age and composition largely dependent on fire cycles and slope aspect.

Early settling of the Clark Fork subbasin was accompanied by forest clearing, agricultural development, logging, introduction of nonnative species, mining, railroad construction, hydroelectric development, and general urbanization. Present day vegetative conditions are a product of these activities and natural and human-caused forest fires.

Forest fires had a profound impact on vegetation within the lower Clark Fork River watershed during the last century. The Montana Department of Fish, Wildlife, and Parks (1984) reports that fires in 1910 burned over 60% of the Cabinet National Forest, part of the present-day Kootenai and Lolo National Forests. That fire burned an estimated 3,000,000 acres (121 km^2) in western Montana and northern Idaho. The most severely burned areas were reportedly on the north and south slopes of the Bitterroot Mountains (Guth and Cohen 1991, Pratt and Houston 1993) which form the west-southwest flank of the Clark Fork River valley. However, fire ecologists speculate that riparian areas along the river may have escaped the fire (MDFWP 1984).

Low elevation riparian zones near tributary mouths include areas with and without tree canopy cover. Along stream corridors where overstory does not exist or is thin, vegetation includes shrubs and small trees such as thin-leaf alder (*Alnus sinuata*), willows (*Salix spp.*), snowberry (*Symphoricarpos albus*), Rocky Mountain maple (*Acer glabrum*), red-osier dogwood (*Cornus stolonifera*), blue elderberry (*Sambucus cerulea*), and black hawthorn (*Crataegus douglasii*). Where tree canopy is present, tree species include black cottonwood (*Populus trichocarpa*), water birch (*Betula occidentalis*), quaking aspen (*Populus tremuloides*), and a mix of conifer species including western red cedar, western hemlock (*Tsuga heterophylla*), Douglas fir (*Psuedotsuga menziesii*), grand fir (*Abies grandis*), Ponderosa pine (*Pinus ponderosa*), and western white pine (*Pinus monticola*). White pine stands have been significantly impacted by white pine blister rust, an introduced pathogen.

Affected areas have been replanted with rust-resistant varieties by the US Forest Service since the mid-1970s, but the replanted area represents only a small part of the area previously occupied by white pine.

Conifer forests in the watershed consist of mixed stands, typified by stands of western red cedar/western hemlock, stands of co-dominant Douglas fir and Ponderosa pine, and stands of Douglas fir, western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*), and western white pine. Dense stands of Douglas fir, larch, and lodgepole pine are characteristic of slopes with north and east aspects. Relatively open stands of Douglas fir and Ponderosa pine are typically on the warmer, dryer slopes with south and west aspects.

Representative species of upland shrubs include western serviceberry (*Amenlanchier alnifolia*), Rocky Mountain maple, snowberry, mountain balm (*Ceanothus velutinus*), mallow ninebark (*Physocarpus malvaceus*), and huckleberry (*Vaccinium spp.*).

Vegetation can strongly influence stream conditions. Canopy cover adjacent to streams provides shade and helps to maintain cooler water temperatures during summer months. Conifers may also provide insulation during winter months, reducing freezing and formation of anchor ice. Large trees that fall into streams and floodplains help to shape channels, create pools, provide cover, introduce and store nutrients, dissipate stream energy, and contribute to overall stream stability. Riparian vegetation also plays an important role in providing stream bank stability through binding of soils by roots. The amount, type, and stage of vegetation in a watershed can also influence stream flows. Vegetation removal by fire or timber harvest can result in increased peak flows during storm events and increased summer flows. Increased peak flows during winter months, when bull trout eggs are hatching, may decrease survival rates.

Fisheries and Aquatic Fauna

There are four salmonids native to the Lower Clark Fork subbasin: westslope cutthroat trout; bull trout; pygmy whitefish; and mountain whitefish (IDFG 2001). Other species in the subbasin are listed in Table 3. Most of the non-native fishes are found in the warmer, lower portions of the subbasin near the mouth of the Clark Fork River. Species such as black crappie, brown bullhead, largemouth bass, pumpkinseed sunfish, and yellow perch are generally associated with warmer water habitat like that found in the Clark Fork River Delta. Early settlers wanting to establish a fishery stocked with familiar fish introduced these warm water species into the system. Cold water non-native fish were introduced as game fish, or, like the kokanee salmon, migrated downstream from the Flathead River in Montana in the early 1930s (IDFG 2001).

Table 3. Fishes in the Lower Clark Fork River Subbasin[1].

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Brown Bullhead	*Ameiurus nebulosus*
Brown Trout	*Salmo trutta*
Bull Trout	*Salvelinus confluentus*
Cutthroat Trout	*Oncorhynchus clarki*
Kokanee Salmon	*Oncorhynchus nerka*
Lake Trout	*Salvelinus namaycush*
Lake Whitefish	*Coregonus clupeaformis*
Largemouth Bass	*Micropterus samoides*
Largescale Sucker	*Catostomus macrocheilus*
Longnose Sucker	*Catostomus catostomus*
Mountain Whitefish	*Prosopium williamsoni*
Northern Pikeminnow	*Ptychocheilus oregonensis*
Peamouth Chub	*Mylocheilus caurinus*
Pumpkinseed Sunfish	*Lepomis gibbosus*
Rainbow Trout	*Oncorhynchus mykiss*
Redside Shiner	*Richardsonius balteatus*
Slimy Sculpin	*Cottus cognatus*
Tench	*Tinca tinca*
Yellow Perch	*Perca flavescens*

[1]Presence of fishes as reported in 1994 Evaluation of Fish Communities on the Lower Clark Fork River, Idaho (WWP 1995).

Because of declining populations throughout their range, bull trout are a species of special concern in this watershed. Bull trout were listed as threatened by the U.S. Fish and Wildlife Service under the Federal Endangered Species Act in 1998. Despite adverse impacts of land use practices leading to the degradation of critical habitat, bull trout can be found in most Lower Clark Fork River drainages where they occurred historically. However, declines in distribution and abundance have been observed (USFWS 2003).

Prior to the federal listing of bull trout, a Bull Trout Conservation Plan was introduced by the office of Idaho Governor Philip Batt. This plan identifies the entire Lake Pend Oreille Basin, including all subbasins draining to the lake, as a key bull trout watershed recommended for habitat protection and restoration (Batt 1996). A Bull Trout Problem Assessment and Conservation Plan have been completed for the Lake Pend Oreille key watershed and identified priorities that should be incorporated into the implementation phase of this TMDL.

According to surveys completed prior to the 1998 Problem Assessment (PBTTAT 1998), Johnson, Twin, Lightning, East Fork Lightning, Savage, Char, Porcupine, Wellington, and Rattle Creeks as well as the mainstem Clark Fork River are utilized for spawning and recruitment. In the mainstem, bull trout make use of a spawning channel that was installed as part of the mitigation package accompanying the construction of the Cabinet Gorge Dam in the 1950s.

Bull trout are thought to be highly sensitive to temperature with spawning areas often associated with spring fed areas where water temperatures are less than 10° C (Pratt 1996). Several streams in the watershed are subject to special temperature criteria established by the

EPA to reflect the current or historical presence of bull trout. These EPA listed bull trout streams include: Cascade Creek, East Fork Creek, Johnson Creek, Lightning Creek, Mosquito Creek, Porcupine Creek, Rattle Creek, Spring Creek, Twin Creek, and Wellington Creek.

Historically, bull trout were associated with the lower ends of transport reaches in gradients of 2-8%. The majority of the channels of this type are in East Fork, Char, Savage, Rattle, Porcupine, Middle Lightning and Morris Creeks (PWA 2004). Current distribution is impacted by altered stream stability and other factors in some of these reaches. With the exception of West Fork Blue Creek, the Bull Trout Problem Assessment team (PBTTAT 1998) rated current conditions for bull trout throughout the Lower Clark Fork subbasin as poor to fair. However, the majority of the streams are considered high priority for restoration and/or protection given the high potential to increase bull trout numbers.

Additionally, the State of Idaho considers the westslope cutthroat trout (*Oncorhynchus clarki lewisi*) to be a species of special concern, and Region 1 of the U.S. Forest Service has determined the fish to be a sensitive species. Distribution of cutthroat spawning areas is poorly defined in the area (Pratt 1996). However, it is suspected that pure strains of westslope cutthroat continue to exist throughout the basin, most likely in headwater areas located above natural migration barriers such as Char Falls, Wellington Creek Falls, Rattle Creek Falls, and Johnson Creek Falls. Mature cutthroat trout are also known to use the mainstem of the river, preferring areas with gravel substrates (Pratt 1996).

The Idaho Department of Fish and Game (IDFG) enforce several fishing regulations for the purpose of protecting bull trout and westslope cutthroat trout. In 1996, the Clark Fork basin was closed to the harvest of bull trout (IDFG 2001). If bull trout are hooked while anglers are fishing for other species, the bull trout must be released unharmed. In addition, the Clark Fork River and Lightning Creek have a cutthroat limit of two fish per day, if over 16 inches during the regulated season.

Throughout the subbasin, the decline in bull trout and cutthroat populations has been attributed to a legacy of road construction, and timber harvest that impact stream stability and habitat. In the case of bull trout, some subwatersheds experience poaching pressure. Both species prefer instream habitat conditions of cold, clear water, riffles, runs, and pool tail-outs with gravel beds low in percent fines for spawning; and deep pools with complex cover for feeding, resting, and over-wintering. Many of the subwatersheds exhibit excess bedload, loss of large woody debris and altered water delivery and flow patterns that result in unstable channels. These factors are believed to be major limiting factors to bull trout populations in much of the Lightning Creek watershed and its tributaries (PBTTAT 1998).

Bull trout have specific habitat requirements and are often associated with spring fed areas in the watershed where there are cool water sources. Bull trout generally spawn from late August through November (Needham and Vaughn 1952, Pratt 1985 cited in PBTTAT 1998) and spawning activity generally peaks in mid-October. Water temperature is a critical factor is determining habitat for bull trout (PBTTAT 1998, p. 10):

> Water temperature is likely an important and inflexible habitat requirement for bull trout, but its influence on bull trout distribution has not been completely defined. Temperatures above 59˚ F (15 ˚ C) are thought to limit distribution (Allan 1980, Brown 1992, Fraley and Shepard 1989, Goetz 1991, Oliver 1979, Pratt 1984, Saffel

and Scarnecchia 1995, Shepard et al. 1984), while optimum temperatures for rearing are reported to be 44˚ to 47˚ F (7˚ to 8˚C) (Goetz 1989). Saffel and Scarnecchia (1995) observed that juvenile bull trout densities in Pend Oreille tributaries increased with temperature up to 50 ˚ F (10˚C). Rieman and McIntyre (1995) observed that distribution of bull trout rearing habitat during summer months was linked to elevation, with higher elevations correlating to cooler stream temperatures. Bull trout spawn at temperatures near 46˚F (8˚C).

In addition to temperature influences on spawning and rearing, unstable stream structure and widening or lack of canopy cover can both increase probability of winter freezing that may impact wintering bull trout.

Subwatershed Characteristics

In this assessment, the Lower Clark Fork River subbasin is divided into 12 subwatersheds. Most of the watersheds are named for the single waterbody that drains it. For the purposes of this assessment, the Clark Fork River Sidewalls includes the mainstem river, Mosquito Creek, and Gold Creek. South-north watersheds draining into the mainstem are: Johnson Creek; Twin Creek, including Dry Creek; Derr Creek; West Fork Blue Creek; and West Fork Elk Creek. The Lightning Creek watershed has been divided into three sections: Upper Lightning Creek, headwaters to Rattle Creek; Middle Lighting Creek, including the mainstem from Rattle Creek to East Fork Creek, and Porcupine Creek; and Lower Lightning Creek, East Fork Creek to the mouth, including Morris Creek. Lightning Creek tributaries treated separately are: Wellington Creek; Cascade Creek; and Rattle Creeks.

Several attributes of each subwatershed are shown in Table 4.

Table 4. Watershed Characteristics of the Lower Clark Fork River Subbasin.

Watershed	Area (mi^2)	Land Form	Dominant Aspect	Relief Ratio	Mean Elevation (feet)	Dominant Slope
Clark Fork River Sidewalls	43.0	Glacial Valley	West	.09	3,731	14%
Cougar Creek Sidewalls	6.5	Mountainous	Southwest	.09	3,418	28%
Derr Creek	7.6	Mountainous	North	.14	4,172	50%
Dry Creek	23.0	Mountainous	Northeast	.13	4,179	50%
East Fork- Savage Creeks	20.0	Mountainous	Southwest	.11	5,653	30%
Johnson Creek	14.0	Mountainous	Northeast	.12	4,152	50%
Lightning Creek						
Upper Lightning	21.0	Mountainous	South	.10	5,749	29%
Middle Lightning	16.2	Mountainous	Southeast	.11	5,350	30%
Lower Lightning	28.1	Mountainous	Southwest	.12	4,800	28%
Wellington Creek	9.8	Mountainous	Northeast	.13	5,440	30%
West Fork Blue Creek (in Idaho)	5.6	Mountainous	North	.16	4,896	28%
West Fork Elk Creek (in Idaho)	6.2	Mountainous	East	.15	4,263	50%

Stream Characteristics

A total of approximately 115,000 acres are reviewed in this assessment. All of the perennial streams in the Lower Clark Fork River subbasin share similar geologic and vegetative characteristics. The mountainous streams pass through Precambrian Belt Supergroup metasediments, interspersed with glacial till. In the lower elevations, the mouths of creeks feeding into the Clark Fork River flow through glacial debris and unconsolidated alluvium. Cedar-hemlock forests can be found in the lower elevations, while mixed conifer forests consisting of Douglas fir, grand fir, western red cedar, larch, hemlock, ponderosa pine, lodgepole pine, and western white pine are located higher up in the watershed. Alder and willow grow in very wet areas. Subalpine fir, spruce, alder, alpine meadows, and brush fields can be found at the highest elevations (Saunders and Raiha 2003a).

Additional physical watershed characteristics are described below. Specific water quality information and beneficial use support status is discussed in Section 2. Streams are characterized using the Rosgen stream typing criteria based upon the morphological features of the river, including valley types, materials, gradients, shapes and meander patterns. This universal classification system helps to predict changes in streams over time, based on comparisons with other rivers of the same classification. (This stream typing can be a useful reference when establishing water quality targets and expected outcomes of restoration activities.) Rosgen (1996) describes stream types and restoration potential in depth. For example, a Rosgen Type A stream is a steep (4-10% gradient), high energy, bedrock stream, while a Type E stream is a low gradient, meandering stream. Stream gradients are given as an indicator of steepness, which helps to predicate the amount of sediment and bedload that may be transported or deposited in the system, and in some cases, fish habitat is linked with particular gradients. Width to depth ratios are an indicator of the stability of a stream system and along with other characteristics, indicate a stream’s ability to dissipate the energy inherent to moving water.

A more extensive review of specific watershed information on streams located within the Lightning Creek drainage is available in the Lightning Creek Watershed Assessment (PWA 2004).

Clark Fork River

For the purposes of this assessment, the river consists of the main stem of the Clark Fork from the Montana border to the river’s mouth, including all river delta channels, and Mosquito Creek for a total of drainage area of 115,204 acres. The river is an eighth order stream at its mouth, and has a gradient of .05%. The river’s average width to depth ratio is 145.1.

The Clark Fork River is approximately 11 miles (18 km) long from the Idaho-Montana border to Pend Oreille Lake. It consists of a main channel, a side channel at Foster Rapids, and a large delta at its mouth. The main channel has two riffles (Whitehorse and Foster Rapids) and several large, deep pools with a maximum depth of 76 feet (23 m). River-like conditions persist in the channel downstream to the second vehicle bridge (now closed) at the City of Clark Fork. Beyond this point, varying lake levels begin to influence velocity, depth, and general hydraulic conditions in the lower river channel and the delta.

Mosquito Creek is a second order stream with a gradient of 2%, flowing into the river from the north. It has a Rosgen B, u-shaped channel with an average width to depth ratio of 42.6.

Cougar and Spring Creek

Cougar Creek is a small first order stream located on the western edge of the Lower Clark Fork River subbasin. Cougar Creek appears to drain into Denton Slough, and therefore, was reassigned to a separate assessment unit from Spring Creek, which drains into Lower Lightning Creek.

Spring Creek is a second order, 6465 acre watershed draining into Lower Lightning Creek.

Derr Creek

Derr Creek is a 4,973 acre watershed located on the southern side of the Clark Fork River. Stream and floodplain alterations interrupt flow before the creek reaches the Clark Fork River (PBTTAT 1998).

Twin and Dry Creeks

The Twin Creek subwatershed contains Dry Creek and Delyle Creek, totaling 14,882 acres. Twin and Dry Creeks are located on the southern side of the Clark Fork River, just east of Derr Creek. Twin Creek is a third order stream with a Rosgen A type channel. The stream flows down a v-shaped valley and has a gradient of 4%. Twin Creek's average width to depth ratio is 16.1. BURP data were collected on Twin Creek in 1995 and 2001.

Dry Creek is a second order stream. Stream and floodplain alterations interrupt flow before the creek reaches the Clark Fork River (PBTTAT 1998). Dry Creek is reportedly dry except for during spring run-off. A BURP crew visiting Dry Creek also found it dry in August.

East Fork and Savage Creeks

East Fork and Savage Creeks are located in the middle third of the Lower Clark Fork subbasin, on the far eastern side. In Idaho, they total 12,630 acres with the headwaters of each stream originating in Montana and flowing down a u-shaped valley. East Fork Creek is a third order stream, while Savage Creek is a second order tributary to East Fork Creek. East Fork Creek is a Rosgen A type channel, with a 4% gradient near the mouth and a 6% gradient farther upstream. It has an average width to depth ratio of 52.9. Savage Creek also has a gradient of 6%. Its channel type is Rosgen A, and its average width to depth ratio is 17.3. East Fork Creek is also known as the East Fork of Lightning Creek, but will be referred to as East Fork Creek throughout this document.

Johnson Creek

The Johnson Creek watershed encompasses Johnson Creek and the West Fork of Johnson Creek. They total 9,960 acres of Rosgen B type channels located on the southern side of the Clark Fork River near the river's mouth. Johnson Creek runs through a v-shaped valley at a 3% gradient in the upper portion of the watershed and a 1.5% gradient near the mouth. The stream's width to depth ratio is 93.2. The lower most assessment unit in Johnson Creek (17010213PN001_03) is primarily delta area of the Lower Clark Fork River.

Lightning Creek

Lightning Creek is the Clark Fork River's largest tributary in Idaho, entering the river from the north, just above the river delta. For the purposes of this assessment, Lightning Creek includes the main stem of Lightning Creek and Cascade, Morris, Porcupine, Rattle, and Spring Creeks, which are all second order streams. The main stem of Lightning Creek and its tributaries have been divided into three sections: Upper; Middle; and Lower Lightning Creek.

Upper Lightning Creek is a 13,478 acre watershed (Saunders and Raiha 2003b), extending from the headwaters to Rattle Creek. It is a third order Rosgen A type channel with a flat bottom. The gradient of the upper portion of the creek is 6% and the average width to depth ratio is 90.

Middle Lightning Creek drains approximately 10,368 acres, beginning at Rattle Creek and ending at East Fork Creek. The Creek changes from a transport reach (2-4% gradient) to a response reach (<2% gradient) near Wellington Creek (PWA 2004). The channel type is Rosgen B and the average width to depth ratio is 54.6.

Lower Lightning Creek is a fourth order stream that begins at East Fork Creek and extends to the mouth of Lightning Creek. This section is an approximately 17,600 acre watershed (Saunders and Raiha 2003a) and has a 1% gradient. The channel type is Rosgen C with a flat bottom. The average width to depth ratio in this portion of the stream is 92.2.

Lightning Creek's smallest tributary, Morris Creek, is located on the eastern side of the creek, just south of Savage Creek. The gradient of Morris Creek is 4% and the channel type is Rosgen B. Morris Creek's average width to depth ratio is 11.8.

The next largest tributary of Lightning Creek is Cascade Creek, located on the eastern side of the creek near its mouth. Cascade Creek has a flat-bottomed, Rosgen C type channel and an average width to depth ratio of 26.8.

Just opposite of Cascade Creek is Spring Creek, a Rosgen B type stream with a trough-like channel and a 3% gradient.

Porcupine Creek is located directly north of Cascade Creek, on the western side of Lightning Creek. It has a u-shaped, Rosgen A type channel, with a 4% gradient. The stream's average width to depth ratio is 32.8.

Rattle Creek

Rattle Creek, a 6,824 acre watershed, is Lightning Creek's northernmost and largest tributary. Rattle Creek is the watershed's steepest, with a 7% gradient. It is a u-shaped, Rosgen A type channel. The average width to depth ratio of Rattle Creek is 35.8.

Wellington Creek

Wellington Creek is a third order tributary of Lightning Creek and a 6,790 acre watershed. It is centrally located in the western side of the Lightning Creek watershed. Wellington Creek has a gradient of 4%. It has a v-shaped, Rosgen A channel. The lowest reach is a bedrock canyon, with a fish barrier falls less than one-third mile upstream of the confluence with Lightning Creek. The stream's average width to depth ratio is 45.1.

West Fork of Blue Creek

The West Fork of Blue Creek is located on the far western side of the subbasin. It originates in Idaho and flows into Montana. The headwaters portion in Idaho consists of 3,858 acres.

West Fork of Elk Creek

The West Fork of Elk Creek and is located on the far western side of the Subbasin, flowing into Montana. It is intermittent and will not be addressed further in this assessment.

Cascade Creek

Cascade Creek is a 3,849 acres watershed and a second order tributary to Lightning Creek. Cascade Creek is located low in the Lightning Creek watershed on the eastern side of Lightning Creek and orientated with an east-west aspect. Cascade Creek exhibits a 1.5% gradient in the lower Rosgen C type channel. The average width to depth ratio of Cascade Creek is 20.

1.3 Cultural Characteristics

The Lower Clark Fork River subbasin is a rural residential community. The watershed's most dense populations can be found in the river valley, where homes and businesses are clustered within the City of Clark Fork. The remaining population is scattered between large farming operations on the river's floodplain and mountain retreats higher up in the watershed.

Land Use

Land use in the Lower Clark Fork River subbasin is shown in Figure 5. Land use is divided between the mountainous uplands and the sloping floodplains of the river bottom. The mountainous areas of the watershed are forested, while the floodplains are mostly grasslands used for hay production. Until recently, the area was characterized by little land use change. However, over the past two years (2004-2005), dramatic, increasing development pressures in the Sandpoint area and surrounding Lake Pend Oreille are likely to draw people to nearby areas like Clark Fork. Because of the large public ownership in the forested areas of the subbasin, development is likely to follow current patterns, focusing on the valley areas along the mainstem and the south side of the river. This could create future water quality challenges. For example, the City of Clark Fork is currently completely serviced by aging septic systems. An increase in population and building in the area will likely increase the number of septic systems and could impact the water quality in the Clark Fork River with additional nutrient inputs, in addition to sediment and nutrients typical to all housing and development activities.

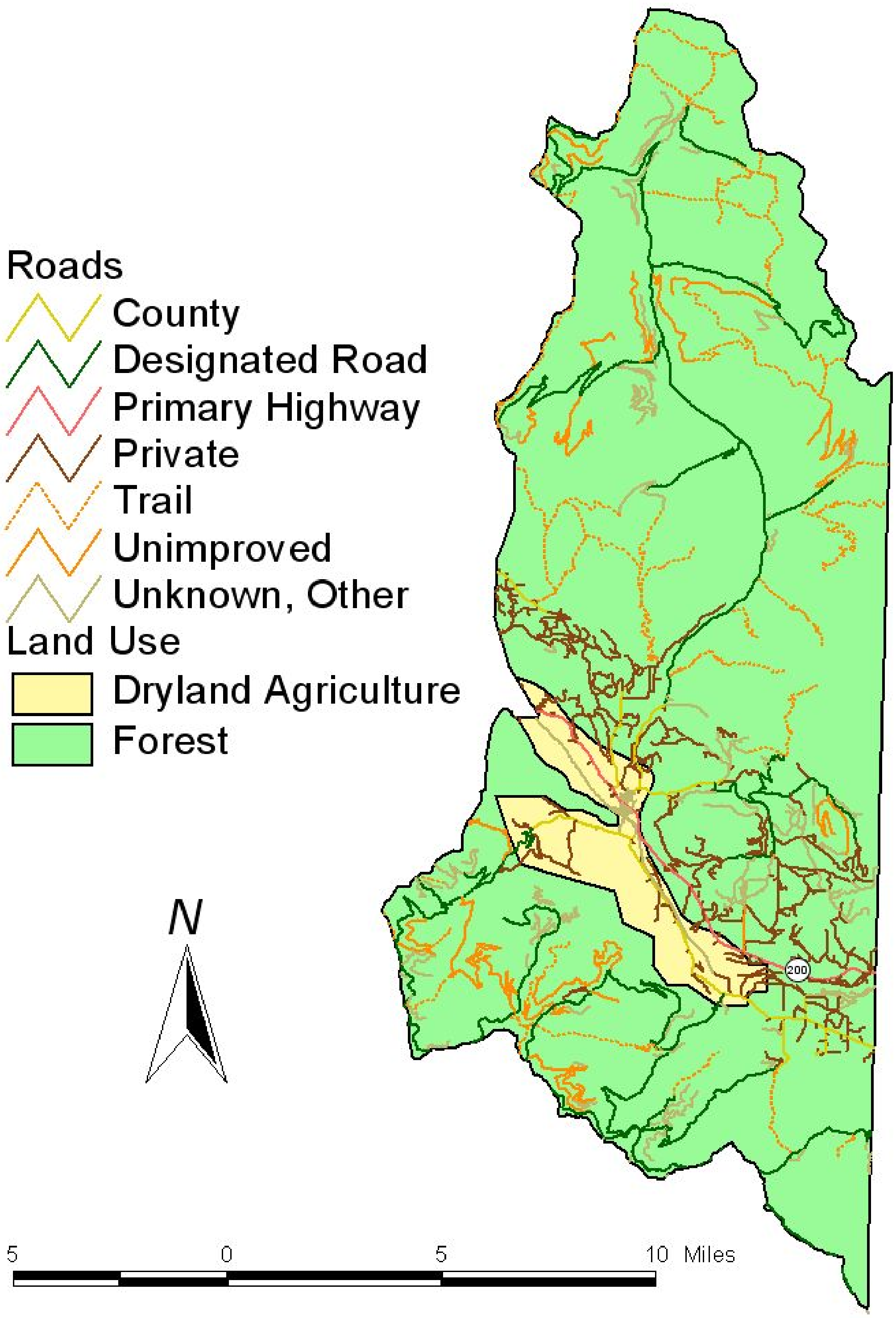


Figure 5. Lower Clark Fork Subbasin Land Use and Roads.

Land Ownership, Cultural Features, and Population

The Lower Clark Fork River subbasin is located entirely in Bonner County. The population of the county is 36,835 (US Census Bureau 2003). The only town located in the subbasin is the City of Clark Fork, incorporated in 1912. The city has a population of approximately 530 residents and encompasses nearly one square mile of land on the north side of the river. Its elevation is 2,084 feet above sea level.

Land ownership in the watershed is divided between private, state, and federal lands (Figure 6). There are 31,653 acres of privately owned property in the subbasin. Private property is generally located at lower elevations in the watershed. It comprises 23% of the watershed. The Bureau of Land Management (BLM) manages 1,404 acres or .01% the subbasin, primarily located in the river valley. The state of Idaho owns .02% of the subbasin, which is just over 2,711 acres. Like privately owned and BLM lands, state lands are located in the river valley. The largest land manager in the subbasin is the US Forest Service, which manages 74% of the watershed (101,505 acres). The remainder of the subbasin is water.

Several recreation areas are located within the subbasin and the forested areas are popular winter and summer recreation sites. There is an USFS campground at Porcupine Lake, and a non-USFS campground at the mouth of Johnson Creek. A sportsman's access and two boat launches are located along the river. Additionally, the IDFG manages the Clark Fork Game Management area located at the mouth of the Clark Fork River.

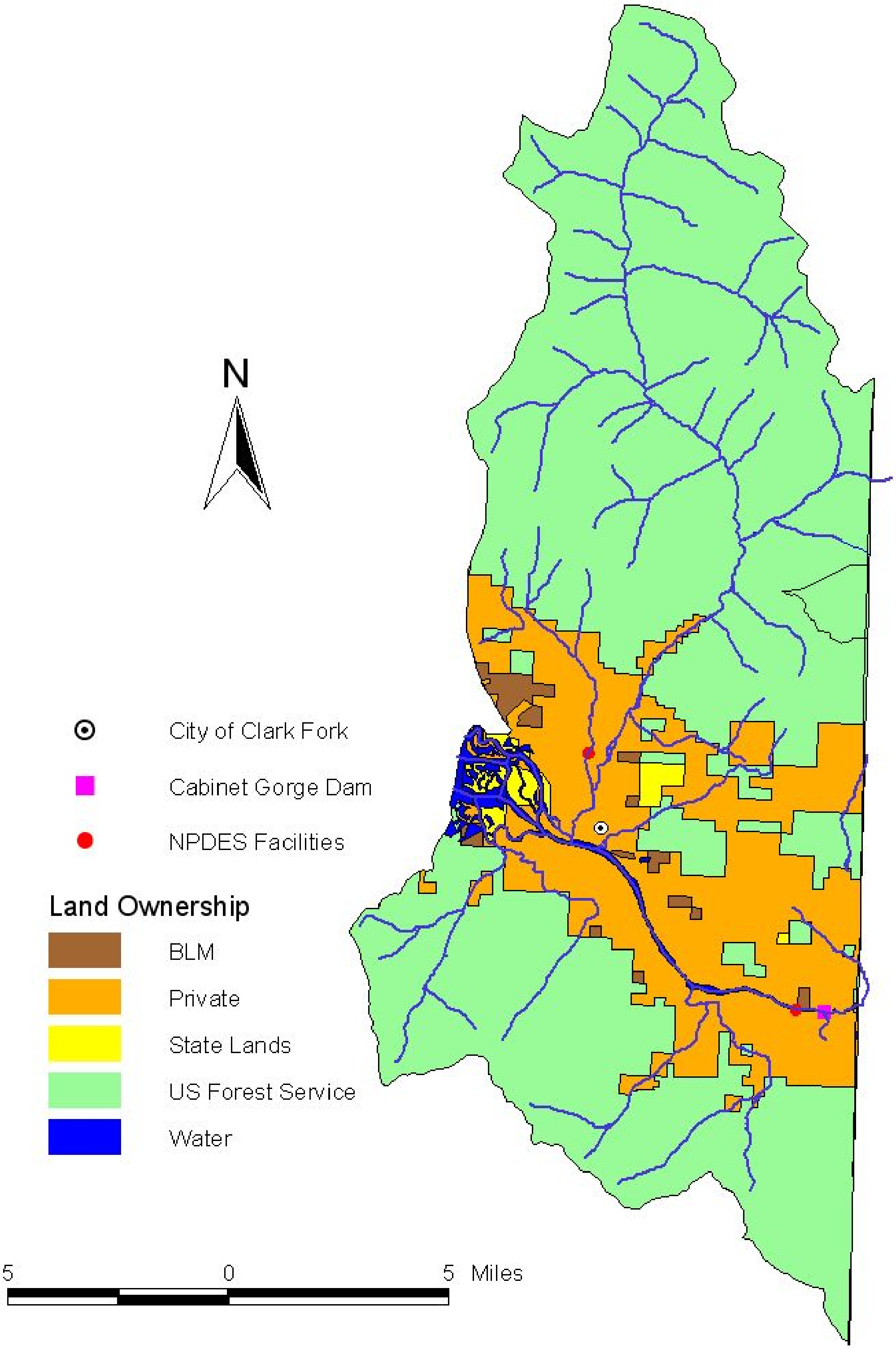


Figure 6. Land Ownership in the Lower Clark Fork River Basin.

History and Economics

Historically, the principal economic activities in the Lower Clark Fork Subbasin were mining, logging, sawmills, and farming. Sawmill activity flourished up until World War II, while mining activities were central to the subbasin's economy until the 1950's. The subbasin's mines produced galena ore, the source of lead, silver, and zinc. Small prospecting claims are located throughout the watershed, but the commercially operated mines were located near the present-day Spring Creek Fish Hatchery, on Antelope Mountain, and near the previous location of the University of Idaho Field Campus (Key 2003).

The early 1950's brought construction of the Cabinet Gorge Dam. The dam is a hydropower project operated by Avista Corporation. Construction was completed in 1952. The arch-type dam spans the width of the 600 foot wide channel. It is 208 feet high with a licensed generating capacity of 231 megawatts. The minimum flow allowed over the dam is 5,000 cubic feet per second. Inside the dam are one Kaplan, one mixed flow, and two propeller turbines. The reservoir behind the dam is capable of storing 42,780 acre feet of water.

Current activities include a handful of large farms, commercial timber harvest on private and federally owned lands, and two state operated fish hatcheries. The Clark Fork fish hatchery is located on Spring Creek, 1.5 miles northwest of the city of Clark Fork. It was completed in 1938 to house westslope cutthroat trout, brook trout, brown trout, golden trout, rainbow trout, Arctic grayling, and kokanee and has been closed to operation since 2001. The Bonneville Power Administration and the IDFG built the second hatchery in 1985. The hatchery, operated by IDFG, is located approximately one mile downstream of the Cabinet Gorge dam and produces mostly kokanee.

The historically diverse land uses and economic activities in the Clark Fork River drainage area have led to an associated range of water quality problems. Many agencies, citizen groups, local businesses and governments have come together to address water quality issues throughout the Lower Clark Fork River Subbasin in Idaho and Montana. Two significant efforts include an agreement between Avista and interested stakeholders to mitigate for impacts of its major hydropower developments on Clark Fork River, and the Tri-State Water Quality Council, a collaboration that includes Washington, Idaho and Montana stakeholders, with the goal to manage and improve water quality in the entire Clark Fork-Pend Oreille system.

2. Subbasin Assessment – Water Quality Concerns and Status

This section contains an assessment of water quality concerns and status for all ten of the water quality impaired subwatersheds in the Lower Clark Fork River subbasin. Twenty-five water quality limited segments within these subwatersheds are identified in this section, along with a discussion of the applicable water quality standards for these water bodies, existing water quality data, and data gaps. Monitoring performed by DEQ, Avista Utilities, the Tri-State Water Quality Council and the USFS has identified water quality concerns in these subwatersheds.

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

The Clean Water Act mandates that the chemical, physical, and biological integrity of the nation's waters be restored and maintained (33 USC §§ 1251 – 1387). In accordance with this mandate, the State of Idaho has adopted water quality standards per section 318 of the CWA, to protect fish, shellfish, and wildlife while providing recreation in and on water whenever attainable. As required by section 303(d) of the CWA the state must identify and prioritize water bodies that are water quality limited (i.e., exhibit impaired beneficial uses). The list of water quality limited waters is published every two years. For waters identified as impaired, TMDLs are set at a level to achieve the state's water quality standards by supporting beneficial uses.

The river and its tributaries on the 303(d) list for impairment due to metals, sediment, total dissolved gas and temperature are shown in Table 5. A discussion of the pollutants, available data, beneficial uses, and exceedances of standards is presented in the following sections.

Section 303(d) of the CWA states that waters that are unable to support their beneficial uses and that do not meet water quality criterion must be listed as water quality limited waters. Subsequently, these waters are required to have TMDLs developed to set load targets consistent with water quality standards. In 2002, the DEQ further refined its system of managing data for water quality limited streams by establishing assessment units throughout the state. This process is described below.

About Assessment Units

Assessment units (AUs) are groups of similar streams that have similar land use practices, ownership, or land management. Stream order is the main basis for determining AUs. If ownership and land use change significantly, the AU can be further delineated. Over 5,200 AUs define all the waters of the state of Idaho. These units and the methodology used to describe them can be found in the Water Body Assessment Guidance II (Grafe et al. 2002).

Using assessment units to describe water bodies offers many benefits, the primary benefit being that all the waters of the state are now defined consistently. In addition, using AUs fulfills the fundamental requirement of EPA's section 305(b) report, a component of the Clean Water Act wherein states report on the condition of all the waters of the state. Because AUs are a subset of water body identification numbers identified in state code, there is now a direct tie to the water quality standards for each AU. Beneficial uses defined in the water quality standards are clearly tied to streams on the landscape.

The new framework of using AUs for reporting and the reconciliation of the legacy of 303 (d) listed streams occurred when Idaho submitted the 2002 Integrated Report and is reflected in this report. Due to the nature of court-ordered 1994 303(d) listings, and the subsequent 1998 303(d) list, all segments were added with boundaries from "headwaters to mouth" in 1998.

Impaired Waters

Table 5 shows the AU boundaries and the pollutants identified as impairing beneficial uses in the 2002 Integrated Report. The subbasin assessment is an opportunity for DEQ and Watershed Advisory Groups to take a deeper look at the status of assessment units. Not all of the water bodies identified as impaired will require a TMDL, as will be discussed later. In addition, the subbasin assessment process identified additional pollutants that are impairing beneficial uses and these are proposed for addition to Section 5 of the next Integrated Report. A thorough investigation of available data was performed before any status changes were recommended. This investigation, along with a presentation of the evidence of non-compliance with standards is contained in the following sections.

Table 5. Impaired water bodies in the Lower Clark Fork River Subbasin identified in the 2002 Integrated Report Section 5.

Water Body Name	Assessment Unit	Boundaries	Pollutants	Beneficial Uses [a]
Clark Fork River	17010213PN005_08	Mainstem Clark Fork River forebay portion from the Idaho/Montana Border to Cabinet Gorge Dam	TDG, Metals, Unknown[b], Temperature	CWAL, SS, PCR, DWS, SRW (Designated)
	17010213PN003_08	Mainstem Clark Fork River from Cabinet Gorge Dam to Mosquito Creek		
	17010213PN001_08	Mainstem Clark Fork River delta portion, Mosquito Creek to Lake Pend Oreille		
Cascade Creek	17010213PN012_02	First and second order portions of Cascade Creek, including the mainstem to Lightning Creek	Temperature	CWAL, SS, SCR (Existing)
Dry Creek	17010213PN004_02a	Dry Creek – source to Twin Creek	Temperature	CWAL, SS, SCR (Existing)
Twin Creek	17010213PN004_03	Third order portion of mainstem Twin Creek from Delyle Creek to the Lower Clark Fork River	Temperature	CWAL, SS, SCR (Existing)
	17010213PN004_02	First and second order portions of Twin Creek to Delyle Creek, including Delyle Creek		
Mosquito Creek	17010213PN009_02	Mosquito Creek source to Lower Clark Fork River	Temperature	CWAL, SS, SCR (Existing)

Water Body Name	Assessment Unit	Boundaries	Pollutants	Beneficial Uses [a]
East Fork Creek	17010213PN014_02	First and second order portions of East Fork Creek, including mainstem East Fork Creek from Idaho/Montana border to Savage Creek	Temperature, Sediment	CWAL,SS, SCR (Existing)
	17010213PN014_03	Third order portion of mainstem East Fork Creek from Savage Creek to Lightning Creek		
Johnson Creek	17010213PN002_02	First and second order portions of Johnson Creek, including West Johnson Creek	Temperature, Sediment	CWAL, SS, PCR (Existing)
	17010213PN002_03	Third order portion of Johnson Creek to the Clark Fork Delta		
Upper Lightning Creek	17010213PN0019_02	First and second order portions of Lightning Creek from source to Rattle Creek	Temperature, Unknown[c]	CWAL, SS, PCR, DWS, SRW (Designated)
	17010213PN0019_03	Third order portion of mainstem Lightning Creek from Fall Creek to Rattle Creek		
Middle Lightning Creek	17010213PN0017_02	First and second order portions of Lightning Creek from Rattle Creek to Wellington Creek, including Sheep and Bear Creeks	Temperature, Unknown[c]	CWAL, SS, PCR, DWS, SRW (Designated)
	17010213PN0017_03	Third order portion of mainstem Lightning Creek from Rattle Creek to Wellington Creek		
	17010213PN0016_02	First and second order portions of Lightning Creek from Wellington Creek to East Fork Creek, including Porcupine Creek		
	17010213PN0016_03	Third order portion of Lightning Creek mainstem from Wellington Creek to East Fork Creek		

Water Body Name	Assessment Unit	Boundaries	Pollutants	Beneficial Uses [a]
Lower Lightning Creek	17010213PN0013_02	First and second order portions of Lightning Creek from East Fork Creek to Cascade Creek, including Morris Creek	Temperature, Unknown[c]	CWAL, SS, PCR, DWS, SRW (Designated)
	17010213PN0013_04	Fourth order portion of mainstem Lightning Creek from East Fork Creek to Cascade Creek		
	17010213PN0011_02	First and second order portions of Lightning Creek from Cascade Creek to Spring Creek		
	17010213PN0011_04	Fourth order portion of mainstem Lightning Creek from Cascade Creek to Spring Creek		
	17010213PN0010_04	Fourth order portion of mainstem Lightning Creek from Spring Creek to the Clark Fork River		
Rattle Creek	17010213PN018_02	First and second order portions of Rattle Creek from headwaters to Lightning Creek	Temperature	CWAL,SS, SCR (Existing)
Savage Creek	17010213PN015_02	First and second order portions of Savage Creek from the Idaho/Montana border to East Fork Creek	Temperature	CWAL,SS, SCR (Existing)
Wellington Creek	17010213PN020_02	First and second order portions of Wellington Creek from the headwaters to Lightning Creek	Temperature, Sediment	CWAL,SS, SCR (Existing)

[a] CWAL – cold water aquatic life, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, AWS – agricultural water supply, DWS – domestic water supply, SRW – special resource water
[b] The Subbasin Assessment process determined that all known impairments in the Clark Fork River are identified as temperature, metals and total dissolved gas. This unknown listing is recommended for removal.
[c] Unknown biological impairments were identified as sediment during the development of the SBA and TMDLs for sediment were developed.

In addition to those pollutants listed in Table 5, all AUs in the mainstem Clark Fork River and Johnson Creek were included on the 2002 Integrated Report, Section 4C, “Rivers Impaired by Flow or Habitat Alteration,” (IDEQ 2005). DEQ recognizes that these impairments impact beneficial uses of a water body. Because habitat and flow alterations are characterized as pollution, but are not measurable pollutants, TMDLs will not be developed for these impairments.

2.2 Applicable Water Quality Standards

Existing beneficial uses and water quality standards for water bodies in the Lower Clark Fork subbasin are discussed below. Designated beneficial uses for the Lower Clark Fork include cold water aquatic life, salmonid spawning, primary contact recreation, domestic water supply, and special resource water (IDAPA 58.01.02.04). The designated beneficial uses of water bodies in the subbasin are presented in Table 5 and Table 6. Section 303(d) listed tributaries that have not had beneficial uses designated have been assigned existing beneficial uses. These include cold water aquatic life, salmonid spawning, and primary or secondary contact recreation (IDAPA 58.01.02.101.01). Narrative and numeric water quality standards relevant to designated beneficial uses are also discussed in this section.

Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as briefly described in the following paragraphs. The *Water Body Assessment Guidance*, second edition (Grafe et al. 2002) gives a more detailed description of beneficial use identification for use assessment purposes.

Existing Uses

Existing uses under the CWA are “those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards.” The existing in-stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.050.02, 58.01.02.051.01, and 58.01.02.053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a waterbody that could support salmonid spawning, but salmonid spawning is not occurring due to other factors, such as dams blocking migration.

Designated Uses

Designated uses under the Clean Water Act are “those uses specified in water quality standards for each water body or segment, whether or not they are being attained.” Designated uses are simply uses officially recognized by the state. In Idaho, these include uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.27 and 58.01.02.109-.02.160 in addition to citations for existing uses).

Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel dissolved oxygen, temperature).

Table 6. Lower Clark Fork Subbasin beneficial uses of streams that have not been assessed.

Water Body Name	Assessment Unit	Boundaries	Status	Beneficial Uses[a]
West Fork Elk Creek	17010213PN006_02	West Fork Elk Creek Source to Idaho/Montana Border	Not Assessed	CWAL, SS, SCR (Presumed)
West Fork Blue Creek	17010213PN007_02	West Fork Blue Creek source to Idaho/Montana border	Not Assessed	CWAL, SS, SCR (Presumed)
Gold Creek	17010213PN008_02	Gold Creek source to Idaho/Montana border	Not Assessed	CWAL, SS, SCR (Presumed)
Spring Creek	170213PN021_02	First and second order portions of Spring Creek from headwaters to confluence with Lightning Creek	Full Support Needs Verification	CWAL, SS, SCR (Presumed)
Cougar Creek	170213PN021_02a	Cougar Creek headwaters to Denton Slough	Not Assessed	CWAL, SCR (Presumed)
Johnson Creek delta area	17010213PN001_03	Johnson Creek – third order portion in the delta area of the Lower Clark Fork River	Not Assessed	CWAL, SS, PCR (Presumed)
Clark Fork River	17010213PN003_02	First and second order unnamed tributaries to Clark Fork River	Not Assessed	CWAL, SS, SCR (Presumed)
Dry Creek	17010213PN004_02a	First and second order portions of Dry Creek to its confluence with Twin Creek	Not Assessed	CWAL, SS, SCR (Presumed)
Derr Creek	17010213PN001_02	Derr Creek – source to Johnson Creek	Not Assessed	CWAL, SS, SCR (Presumed)

[a] CW – cold water, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, AWS – agricultural water supply, DWS – domestic water supply

Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of criteria, which include *narrative* criteria for pollutants such as sediment and nutrients and *numeric* criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity (IDAPA 58.01.02.250) (Table 7).

Excess sediment is described by narrative criteria (IDAPA 58.01.02.200.08): “Sediment shall not exceed quantities specified in Sections 250 and 252 or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Subsection 350.”

Narrative criteria for excess nutrients are described in IDAPA 58.01.02.200.06, which states: “Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses.”

Narrative criteria for floating, suspended, or submerged matter are described in IDAPA 58.01.02.200.05, which states: “Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may impair designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities.”

DEQ’s procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.053. The procedure relies heavily upon biological parameters and is presented in detail in the DEQ Water Body Assessment Guidance (Grafe et al. 2002). This guidance requires the use of the most complete data available to make beneficial use support status determinations.

Figure 7 provides an outline of the stream assessment process for determining support status of the beneficial uses of cold water aquatic life, salmonid spawning, and contact recreation.

Table 7. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards.

Designated and Existing Beneficial Uses				
Water Quality Parameter	**Primary Contact Recreation**	**Secondary Contact Recreation**	**Cold Water Aquatic Life**	**Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)**
Water Quality Standards: IDAPA 58.01.02.250				
Bacteria, ph, and Dissolved Oxygen	Less than 126 *E. coli*/100 ml[a] as a geometric mean of five samples over 30 days; no sample greater than 406 *E. coli* organisms/100 ml	Less than 126 *E. coli*/100 ml as a geometric mean of five samples over 30 days; no sample greater than 576 *E. coli*/100 ml	pH between 6.5 and 9.0 DO[b] exceeds 6.0 mg/L[c]	pH between 6.5 and 9.5 Water Column DO: DO exceeds 6.0 mg/L in water column or 90% saturation, whichever is greater Intergravel DO: DO exceeds 5.0 mg/L for a one day minimum and exceeds 6.0 mg/L for a seven day average
Tempera-ture[d]			22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average Bull trout: not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June – August; not to exceed 9 °C daily average in September and October
			Seasonal Cold Water: Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °C or less daily average	
Turbidity			Turbidity shall not exceed background by more than 50 NTU[e] instantaneously or more than 25 NTU for more than 10 consecutive days.	

Designated and Existing Beneficial Uses				
Water Quality Parameter	**Primary Contact Recreation**	**Secondary Contact Recreation**	**Cold Water Aquatic Life**	**Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)**
Ammonia			Ammonia not to exceed calculated concentration based on pH and temperature.	
EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR Part 131				
Tempera-ture				7 day moving average of 10 °C or less maximum daily temperature for June - September

[a] *Escherichia coli* per 100 milliliters
[b] dissolved oxygen
[c] milligrams per liter
[d] Temperature Exemption - Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the seven-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.
[e] Nephelometric turbidity units

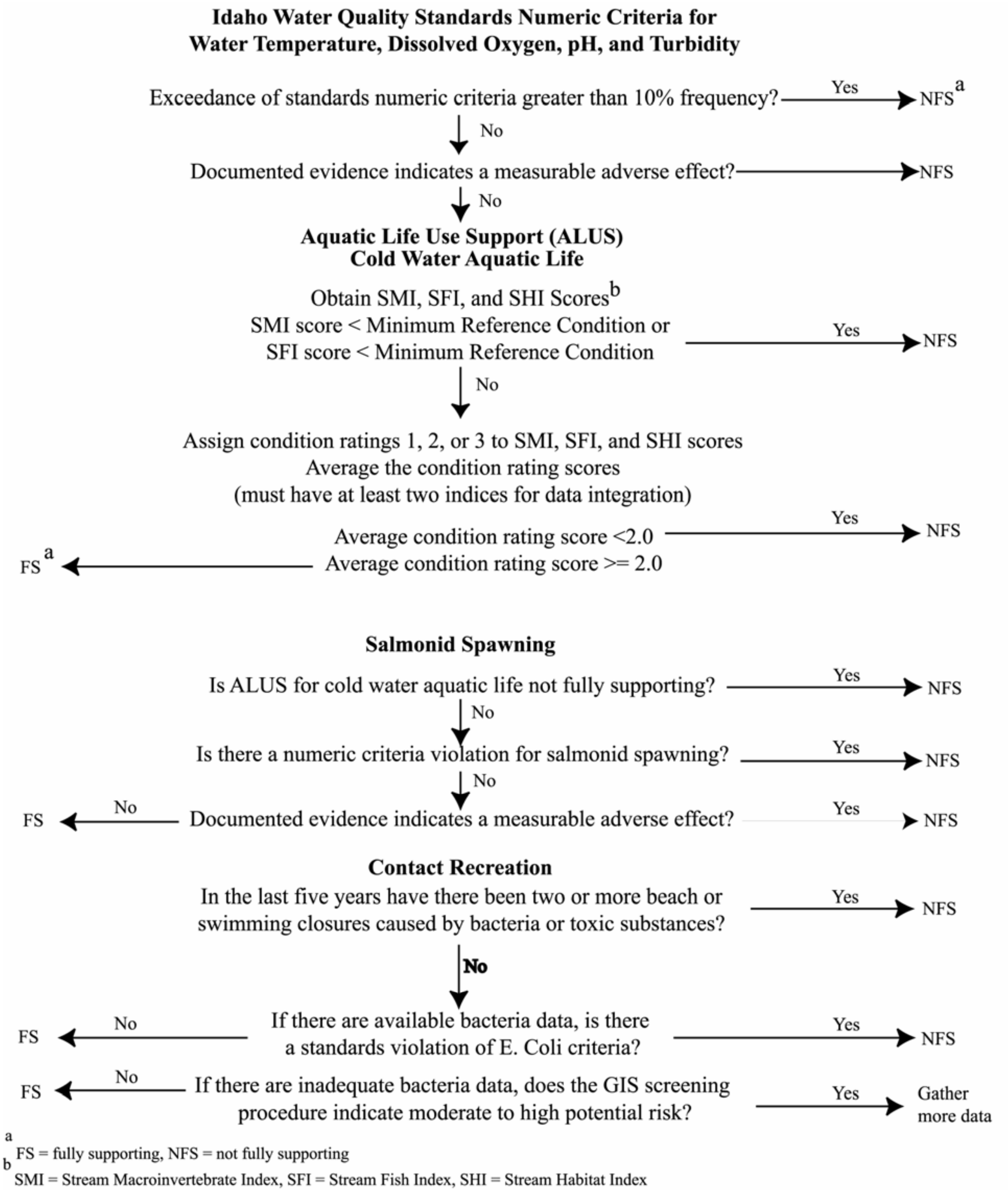


Figure 7. Determination Steps and Criteria for Determining Support Status of Beneficial Uses in Wadeable Streams: *Water Body Assessment Guidance,* Second Addition (Grafe et al 2002).

2.3 Pollutant/Beneficial Use Support Status Relationships

Some of the pollutants that impair beneficial uses in streams are naturally occurring stream characteristics that have been altered by humans. That is, streams naturally have sediment, nutrients, and the like, but when human-caused sources contribute these to reach unnatural levels, they are considered “pollutants” and can impair the beneficial uses of a stream.

The following section describes the most common pollutants in Idaho’s waters and the potential impacts on beneficial uses. While the discussion of temperature and sediment are the most relevant to the Lower Clark Fork subbasin, other pollutants covered by the state water quality standards are discussed for general informational purposes. (Note that most streams in the subbasin have not been assessed for many of these pollutants. For example, only the mainstem Lower Clark Fork River was assessed for nutrients.)

Temperature

Temperature is a water quality factor integral to the life cycle of fish and other aquatic species. Different temperature regimes also result in different aquatic community compositions. Water temperature dictates whether warm, cool, or coldwater aquatic species and communities are present. Many factors, natural and anthropogenic, affect stream temperatures. Natural factors include altitude, aspect, climate, weather, riparian vegetation (shade), and channel morphology (width and depth). Human influenced factors include heated discharges (such as those from point sources), riparian alteration, channel alteration, and flow alteration.

Elevated stream temperature can be harmful to fish at all life stages, especially if it occurs in combination with other habitat limitations such as low dissolved oxygen or poor food supply. Acceptable temperature ranges vary for different species of fish, with cold water species being the least tolerant of high water temperatures. Temperature as a chronic stressor to adult fish can result in reduced body weight, reduced oxygen exchange, increased susceptibility to disease, and reduced reproductive capacity. Acutely high temperatures can result in death if they persist for an extended length of time. Juvenile fish are even more sensitive to temperature variations than adult fish, and can experience negative impacts at a lower threshold value than the adults, manifesting in retarded growth rates. High temperatures also affect embryonic development of fish before they even emerge from the substrate. Similar types of effects may occur to aquatic invertebrates, amphibians and mollusks.

Dissolved Oxygen

Oxygen is necessary for the survival of most aquatic organisms and essential to stream purification. Dissolved oxygen (DO) is the concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water, usually expressed in milligrams per liter (mg/L), parts per million, or percent of saturation. While air contains approximately 20.9% oxygen gas by volume, the proportion of oxygen dissolved in water is about 35%, because nitrogen (the remainder) is less soluble in water. Oxygen is considered to be moderately soluble in water. A complex set of physical conditions that include atmospheric and hydrostatic pressure, turbulence, temperature, and salinity affect the solubility.

Dissolved oxygen levels of 6.0 mg/L and above are considered optimal for aquatic life. When DO levels fall below 6.0 mg/L, organisms are stressed, and if levels fall below 3.0 mg/L for a prolonged period, these organisms may die; oxygen levels that remain below 1.0-2.0 mg/L for a few hours can result in large fish kills. Dissolved oxygen levels below 1.0 mg/L are often referred to as hypoxic; anoxic conditions refer to those situations where there is no measurable DO.

Fish avoid areas with low DO when they are able. Juvenile aquatic organisms are particularly susceptible to the effects of low DO due to their high metabolism and low mobility (they are unable to seek more oxygenated water). In addition, oxygen is necessary to help decompose organic matter in the water and bottom sediments. Dissolved oxygen reflects the health and balance of the aquatic ecosystem.

Oxygen is produced during photosynthesis and consumed during plant and animal respiration and decomposition. Oxygen enters water from photosynthesis and from the atmosphere. Where water is more turbulent (e.g., riffles, cascades), the oxygen exchange is greater due to the greater surface area of water coming into contact with air. The process of oxygen entering the water is called aeration.

Water bodies with significant aquatic plant communities can have significant DO fluctuations throughout the day. An oxygen sag will typically occur once photosynthesis stops at night and respiration/decomposition processes deplete DO concentrations in the water. Oxygen will start to increase again as photosynthesis resumes with the advent of daylight.

Temperature, flow, nutrient loading, and channel alteration all impact the amount of DO in the water. Colder waters hold more DO than warmer waters. As flows decrease, the amount of aeration typically decreases and the instream temperature increases, resulting in decreased DO. Channels that have been altered to increase the effectiveness of conveying water often have fewer riffles and less aeration. Thus, these systems may show depressed levels of DO in comparison to levels before the alteration. Nutrient enriched waters have a higher biochemical oxygen demand due to the amount of oxygen required for organic matter decomposition and other chemical reactions. This oxygen demand results in lower instream DO levels.

Total Dissolved Gas

The Idaho water quality criterion for TDG is 110% saturation or less in order to protect aquatic life beneficial uses. TDG supersaturation can occur during spring runoff, when spill at hydroelectric facilities is at its highest. This spill activity causes supersaturation of gas when high volumes of water are passing over spillways because the river flows are exceeding the hydraulic capacity of the dams. Significant volumes of atmospheric gases become entrained by the increased pressure at the pools below dams, and can remain in the river for significant distances. Less turbulent reaches below dams are less-effective at dissipating the entrained gases than more turbulent river systems. TDG superstaturation can cause gas bubble disease in fish and other aquatic organisms, and may limit habitat due to the potentially lethal presence of elevated gas levels in prime habitat areas. As the bubbles dissipate and the water enters the downstream reach, excess TDG will remain in solution unless wind- or channel-induced turbulence causes more degassing.

Metals

Metals can be toxic to aquatic organisms and fish if absorbed into their systems. The uptake of metals by aquatic life is an active, rather than a passive, biological process. Because the primary pathway for most metal uptake by aquatic life is through respiratory organs of fish and aquatic invertebrates, and only ionic forms of metals can pass through cell membranes, the toxicity of most metals to aquatic life is a function of the concentration of dissolved ionic forms of metals in the stream. Consequently, particulate metals are not directly toxic to most forms of aquatic life.

Many toxic substances, including metals, have a tendency to leave the dissolved phase and attach to suspended particulate matter. The fractions of total metal concentration present in the particulate and dissolved phases depend on the partitioning behavior of the metal ion and the concentration of suspended particulate matter. The dissolved fraction may also be affected by complexing of metals with organic binding agents. Idaho water quality standards are based on the bioavailable dissolved forms of metals.

Trace metals, including cadmium and lead, have been demonstrated to be endocrine disrupters in fish. Dill et al (2002) cite a study by Fairchild et al. (1999) that shows endocrine disruptors are believed to disrupt hormone systems is Atlantic salmon affecting smoltification, the physiological processes necessary for seawater adaptation.

Sediment

Both suspended (floating in the water column) and bedload (moves along the stream bottom) sediment can have negative effects on aquatic life communities. Many fish species can tolerate elevated suspended sediment levels for short periods of time, such as during natural spring runoff, but longer durations of exposure are detrimental. Elevated suspended sediment levels can interfere with feeding behavior (difficulty finding food due to visual impairment), damage gills, reduce growth rates, and in extreme cases eventually lead to death.

Newcombe and Jensen (1996) reported the effects of suspended sediment on fish, summarizing 80 published reports on streams and estuaries. For rainbow trout, physiological stress, which includes reduced feeding rate, is evident at suspended sediment concentrations of 50 to 100 mg/L when those concentrations are maintained for 14 to 60 days. Similar effects are observed for other species, although the data sets are less reliable. Adverse effects on habitat, especially spawning and rearing habitat presumably from sediment deposition, were noted at similar concentrations of suspended sediment.

Organic suspended materials can also settle to the bottom and, due to their high carbon content, lead to low intergravel DO through decomposition.

In addition to these direct effects on the habitat and spawning success of fish, detrimental changes to food sources may also occur. Aquatic insects, which serve as a primary food source for fish, are affected by excess sedimentation. Increased sedimentation leads to a macroinvertebrate community that is adapted to burrowing, thereby making the macroinvertebrates less available to fish. Community structure, specifically diversity, of the aquatic macroinvertebrate community is diminished due to the reduction of coarse substrate habitat.

Settleable solids are defined as the volume (milliliters [ml]) or weight (mg) of material that settles out of a liter of water in one hour (Franson et al. 1998). Settleable solids may consist of large silt, sand, and organic matter. Total suspended solids (TSS) are defined as the material collected by filtration through a 0.45 µm (micrometer) filter (Standard Methods 1975, 1995). Settleable solids and TSS both contain nutrients that are essential for aquatic plant growth. Settleable solids are not as nutrient rich as the smaller TSS, but they do affect river depth and substrate nutrient availability for macrophytes. In low flow situations, settleable solids can accumulate on a stream bottom, thus decreasing water depth. This increases the area of substrate that is exposed to light, facilitating additional macrophyte growth.

Stream siltation caused by silviculture activities and related road construction can be especially damaging to spawning gravels. The reduction of interstitial space between gravels can make it difficult for the incubation of eggs and the survival of juvenile trout.

Sediment-Temperature Relationship

In addition to reducing shading, activities that remove streamside vegetation reduce bank stability, causing accelerated bank erosion and increased sediment loading. Bank erosion and other sources of increased sedimentation can result in wider and shallower streams, which increase the stream's heat load by increasing the surface area subject to solar radiation and heat exchange with the air. When addressing sediment pollution, it is useful to recognize the potential benefit to stream temperatures from sediment reduction activities as well. Conversely, when addressing temperature pollution by increasing riparian vegetation, it is useful to recognize the additional benefits of stabilized banks and reduced erosion.

Bacteria

Escherichia coli or *E. coli*, a species of fecal coliform bacteria, is used by the state of Idaho as the indicator for the presence of pathogenic microorganisms. Pathogens are a small subset of microorganisms (e.g., certain bacteria, viruses, and protozoa), which, if taken into the body through contaminated water or food, can cause sickness or even death. Some pathogens are also able to cause illness by entering the body through the skin or mucous membranes.

Direct measurement of pathogen levels in surface water is difficult because pathogens usually occur in very low numbers and analysis methods are unreliable and expensive. Consequently, indicator bacteria which are often associated with pathogens, but which generally occur in higher concentrations and are thus more easily measured, are assessed.

Coliform bacteria are unicellular organisms found in feces of warm-blooded animals such as humans, domestic pets, livestock, and wildlife. Coliform bacteria are commonly monitored as part of point source discharge permits (National Pollution Discharge Elimination System [NPDES] permits), but may also be monitored in nonpoint source arenas. The human health effects from pathogenic coliform bacteria range from nausea, vomiting, and diarrhea to acute respiratory illness, meningitis, ulceration of the intestines, and even death. Coliform bacteria do not have a known effect on aquatic life.

Coliform bacteria from both point and nonpoint sources impact water bodies, although point sources are typically permitted and offer some level of bacteria-reducing treatment prior to discharge. Nonpoint sources of bacteria are diffuse and difficult to characterize. Unfortunately, nonpoint sources often have the greatest impact on bacteria concentrations in water bodies. This is particularly the case in urban storm water and agricultural areas. *E. coli* is often measured in colony forming units (cfu) per 100 ml.

Nutrients

While nutrients are a natural component of the aquatic ecosystem, natural cycles can be disrupted by increased nutrient inputs from human activities. The excess nutrients result in accelerated plant growth and can result in a eutrophic or enriched system.

The first step in identifying a water body's response to nutrient flux is to define which of the critical nutrients is limiting. A limiting nutrient is one that normally is in short supply relative to biological needs. The relative quantity affects the rate of production of aquatic biomass. Either phosphorus or nitrogen may be the limiting factor for algal growth, although phosphorous is most commonly the limiting nutrient in Idaho waters. Ecologically speaking, a resource is considered limiting if the addition of that resource increases growth.

Total phosphorus (TP) is the measurement of all forms of phosphorus in a water sample, including all inorganic and organic particulate and soluble forms. In freshwater systems, typically greater than 90% of the TP present occurs in organic forms as cellular constituents in the biota or adsorbed to particulate materials (Wetzel 1983). The remainder of phosphorus is mainly soluble orthophosphate, a more biologically available form of phosphorus than TP that consequently leads to a more rapid growth of algae. In impaired systems, a larger percentage of the TP fraction is comprised of orthophosphate. The relative amount of each form measured can provide information on the potential for algal growth within the system.

Nitrogen may be a limiting factor at certain times if there is substantial depletion of nitrogen in sediments due to uptake by rooted macrophyte beds. In systems dominated by blue-green algae, nitrogen is not a limiting nutrient due to the algal ability to fix nitrogen at the water/air interface.

Total nitrogen to TP ratios greater than seven are indicative of a phosphorus-limited system while those ratios less than seven are indicative of a nitrogen-limited system. Only biologically available forms of the nutrients are used in the ratios because these are the forms that are used by the immediate aquatic community.

Nutrients primarily cycle between the water column and sediment through nutrient spiraling. Aquatic plants rapidly assimilate dissolved nutrients, particularly orthophosphate. If sufficient nutrients are available in stream sediments or the water column, aquatic plants will store an abundance of such nutrients in excess of the plants' actual needs; this is a chemical phenomenon known as luxury consumption. When a plant dies, the tissue decays in the water column and the nutrients stored within the plant biomass are either restored to the water column or the detritus becomes incorporated into the river sediment. As a result of this process, nutrients (including orthophosphate) that are initially released into the water column in a dissolved form will eventually become incorporated into the river bottom sediment. Once these nutrients are incorporated into the river sediment, they are available once again for uptake by yet another life cycle of rooted aquatic macrophytes and other aquatic plants. This cycle is known as nutrient spiraling. Nutrient spiraling results in the availability of nutrients for later plant growth in higher concentrations downstream.

Excess nutrient loading can be a water quality problem due to the direct relationship of high TP concentrations on excess algal growth within the water column, combined with the direct effect of the algal life cycle on DO and pH within aquatic systems. Therefore, the reduction of TP inputs to the system can act as a mechanism for water quality improvements, particularly in surface-water systems dominated by blue-green algae, which can acquire nitrogen directly from the atmosphere and the water column. Phosphorus management within these systems can potentially result in reduction of nutrients (phosphorus), nuisance algae, DO, and pH.

Sediment – Nutrient Relationship

The linkage between sediment and sediment-bound nutrients is important when dealing with nutrient enrichment problems in aquatic systems. Phosphorus is typically bound to particulate matter in aquatic systems and, thus, sediment can be a major source of phosphorus to rooted macrophytes and the water column. While most aquatic plants are able to absorb nutrients over the entire plant surface due to a thin cuticle (Denny 1980), bottom sediments serve as the primary nutrient source for most sub-stratum attached macrophytes. The USDA (1999) determined that other than harvesting and chemical treatment, the best and most efficient method of controlling growth is by reducing surface erosion and sedimentation.

Sediment acts as a nutrient sink under aerobic conditions. However, sediments release phosphorous into the water column when conditions become anoxic. Nitrogen can also be released, but the mechanism by which it happens is different. The exchange of nitrogen between sediment and the water column is for the most part a microbial process controlled by the amount of oxygen in the sediment. When conditions become anaerobic, the oxygenation of ammonia (nitrification) ceases and an abundance of ammonia is produced. This condition results in a reduction of nitrogen oxides (NO_x) lost to the atmosphere.

Sediments can play an integral role in reducing the frequency and duration of phytoplankton blooms in standing waters and large rivers. In many cases, there is an immediate response in phytoplankton biomass when external sources are reduced. In other cases, the response time is slower, often taking years. Nonetheless, the relationship is important and must be addressed in waters where phytoplankton is in excess.

Floating, Suspended, or Submerged Matter (Nuisance Algae)

Algae are an important part of the aquatic food chain. However, when elevated levels of algae impact beneficial uses, the algae are considered a nuisance aquatic growth. The excess growth of phytoplankton, periphyton, and/or macrophytes can adversely affect both aquatic life and recreational water uses. Algal blooms occur where adequate nutrients (nitrogen and/or phosphorus) are available to support growth. In addition to nutrient availability, flow rates, velocities, water temperatures, and penetration of sunlight in the water column all affect algae (and macrophyte) growth. Low velocity conditions allow algal concentrations to increase because physical removal by scouring and abrasion does not readily occur. Increases in temperature and sunlight penetration also result in increased algal growth. When the aforementioned conditions are appropriate and nutrient concentrations exceed the quantities needed to support normal algal growth, excessive blooms may develop.

Commonly, algae blooms appear as extensive layers or algal mats on the surface of the water. When present at excessive concentrations in the water column, blue-green algae often produce toxins that can result in skin irritation to swimmers and illness or even death in organisms ingesting the water. The toxic effect of blue-green algae is worse when an abundance of organisms die and accumulate in a central area.

Algal blooms also often create objectionable odors and coloration in water used for domestic drinking water and can produce intense coloration of both the water and shorelines as cells accumulate along the banks. In extreme cases, algal blooms can also result in impairment of agricultural water supplies due to toxicity. Water bodies with high nutrient concentrations that could potentially lead to a high level of algal growth are said to be eutrophic. The extent of the effect is dependent on both the type(s) of algae present and the size, extent, and timing of the bloom.

When algae die in low flow velocity areas, they sink slowly through the water column, eventually collecting on the bottom sediments. The biochemical processes that occur as the algae decompose remove oxygen from the surrounding water. Because most of the decomposition occurs within the lower levels of the water column, a large algal bloom can substantially deplete DO concentrations near the bottom. Low DO in these areas can lead to decreased fish habitat as fish will not frequent areas with low DO. Both living and dead (decomposing) algae can also affect the pH of the water due to the release of various acid and base compounds during respiration and photosynthesis. Additionally, low DO levels caused by decomposing organic matter can lead to changes in water chemistry and a release of sorbed phosphorus to the water column at the water/sediment interface.

2.4 Summary and Analysis of Existing Water Quality Data

Numerous sources of water quality data were used in this SBA and TMDL. DEQ monitoring (BURP) data were used as the baseline information. Several detailed studies of the Lightning Creek drainage, Forest Service information and Idaho Department of Lands Cumulative Watershed Effects (CWE) analyses were all used to summarize existing water quality in this section. Monthly and continuous water quality monitoring by the Tri-State Water Quality Council and the USGS were also used.

Data Sources

DEQ has collected Beneficial Use Reconnaissance Program (BURP) data on most of the larger streams in the subbasin. From 1994-2002, 33 BURP surveys were completed in the subbasin. Data sets reflected in BURP surveys include temperature, habitat, macroinvertebrate and fisheries information. Locations of BURP surveys are shown in Figure 8. The USGS operates two gaging stations in the subbasin. Stream flow and water quality samples were taken intermittently at the mouth of Lightning Creek and below Cabinet Gorge dam on the Lower Clark Fork River. Water quality samples collected by the USGS and Land and Water Consulting Inc. from 1993-2003 are considered in the following analysis. Discharge has been gauged since 1928 on the Clark Fork River below the Cabinet Gorge dam and since 1988 on Lightning Creek near Clark Fork, Idaho. Eleven temperature data loggers have been deployed in the subbasin by the DEQ to constantly monitor water temperature during the hottest period of the year. In addition, where it was available, other watershed specific data were used.

Biological data available for examination include macroinvertebrate, fish, and habitat data collected through BURP. The data are arranged in indices and scored to determine if the water body in question is supporting its beneficial uses. Three indices are considered when making a beneficial use support status determination. The indices are classified by ecoregion. For all the indices, the entire Lower Clark Fork River is considered to be located in the Northern Mountains ecoregion.

The first index is the Stream Macroinvertebrate Index (SMI). By recording the abundance of macroinvertebrates known to live only in specific temperature conditions, the index is used as a direct biological measure of cold water aquatic life (Grafe et al. 2002). A detailed description of this index can be found in Jessup and Gerritsen (2000). A high score (three) on the index indicates a healthy assemblage of species close to reference condition streams in the state.

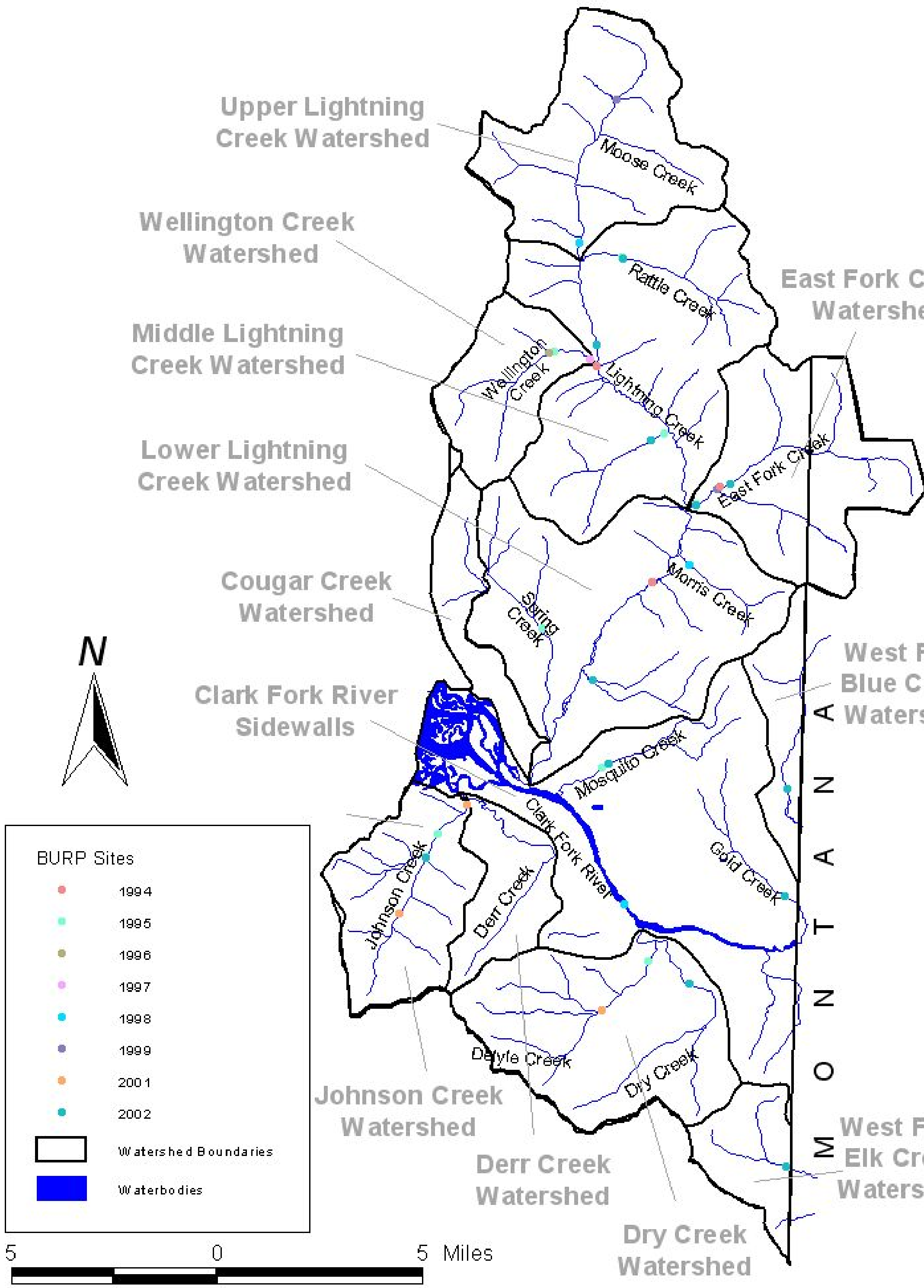


Figure 8. Locations of BURP monitoring sites, 1994-2002.

The second index is the Stream Fish Index (SFI). This index is also considered a direct biological measure of cold water aquatic life and is used to determine how close the stream is to achieving the Clean Water Act “fishable” goal. The details of the development of this index can be found in Mebane (2002). Mebane developed this index based on least impacted and stressed sites. Fish counts are taken in each watershed and the index relates data found to known index, or reference sites.

The last index considered when determining beneficial use support is the Stream Habitat Index (SHI). Details of this index can be found in Fore and Bollman (2000). The habitat index considers ten habitat metrics such as: instream cover, substrate composition, bank and canopy cover and zone of influence. SHI is not considered to be a direct biological measure, therefore it is recommended that it always be used in conjunction with at least one other index. This is due to significant variability in physical habitat measures (Grafe et al. 2002). Metrics tailored to forested areas were used for the SHI.

Each index uses a scale of one to three. The values resulting from each index are averaged to determine the support status of each waterbody as described in DEQ’s Water Body Assessment Guidance, Second Edition (Grafe et al. 2002). A score of three indicates the stream is most likely to fully support beneficial uses. Average values of two or greater indicate a water body that is in full support of its beneficial uses, however, the condition significantly varies from reference conditions and assessors can examine additional information, if available, to determine support status of the water body. Scores of less than two indicate that a water body is not supporting its beneficial uses. Scores from at least two indices are required to make a support status determination. If either the macroinvertebrate or fish score is zero, the water body is considered to not fully support beneficial uses. Index scores and the beneficial use support status for each water body in the subbasin are presented in summary tables in Appendix A.

In addition to BURP data, other sources of water quality data were compiled and summarized to give a snapshot of water quality in the subbasin. A detailed watershed analysis report for Lightning Creek and its tributaries was completed in 2004 by Philip Williams and Associates, Limited, with consultation from land and resource management agencies (referred to as PWA 2004 throughout the document). The report includes extensive field surveys, especially regarding road condition and mass wasting potential, and it summarizes existing data on the area. The report is extensive and while summary results are used to inform this analysis of water quality, there is a wealth of additional information. The report includes both an overview of watershed health and an implementation plan that prioritizes restoration opportunities in the Lightning Creek watershed. The reader is encouraged to review the *Lightning Creek Watershed Assessment* (PWA 2004) for additional information on that portion of the subbasin and to use it as a basis for TMDL implementation.

In addition to the Lightning Creek Watershed Assessment mentioned above, there are other documents and research funded by Avista Utilities as part of the federal relicensing process and the on-going settlement agreement to mitigate the impacts of its hydropower operations in the subbasin. A virtual library of information on fisheries and water quality status were compiled during the relicensing process in the 1990s, and over the last five-years additional monitoring and research reports have been compiled, especially in relation to impacts of hydropower development and native aquatic species restoration opportunities. Where applicable, these data are incorporated in this analysis as well.

The following section summarizes existing water quality data from BURP and other sources, used to determine the status of beneficial uses for each subwatershed in the basin.

Flow Characteristics

Flow characteristics are available for the Clark Fork River and Lightning Creek.

Clark Fork River

The mainstem Clark Fork River from Cabinet Gorge dam flows for about nine miles before it enters Lake Pend Oreille. In addition to the main channel, there is a side channel that starts at Foster Rapids and the river delta area, including Mosquito Creek. Unless otherwise noted, the information presented below pertains to the mainstem.

Due to the significantly altered flow regime from hydropower operations, all three mainstem AUs of the Clark Fork River in Idaho are considered impaired by flow alteration.

Stream flow data is collected by the USGS on the Clark Fork River below the Cabinet Gorge dam (Figure 9). Data collected at this station was also recorded under the name Whitehorse Rapids gaging station (O'Dell, pers comm). Data collected at this station represent flow conditions in 22,073 mi^2 of the watershed, the majority of which lies in Montana. Recording of data began in 1929. Mean annual runoff recorded at the station below the Cabinet Gorge Dam, through water year 2001, is 22,548 cfs.

The main river flows are influenced by the hydropower operation at Cabinet Gorge Dam. Under the current Clark Fork River Settlement Agreement, minimum flows will not be below 5,000 cfs.

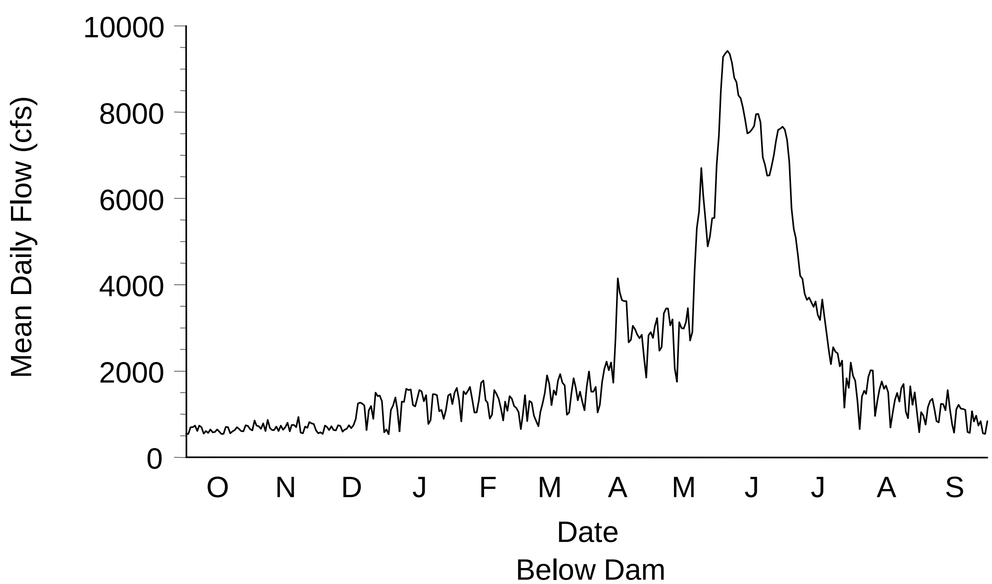


Figure 9. Mean Daily Flow of the Clark Fork River at USGS Gaging Station Below the Cabinet Gorge Dam.

Annual runoff in the Clark Fork River is produced mostly by melting snow, with peak flows typically occurring in May or June, but occasionally in April or July. Midwinter rain on snow events can result in a rapid snowmelt, and in some years, peak flow from tributary watersheds occurs during these events. Due to the effects of high precipitation, location in relation to Lake Pend Oreille, prevailing winds, and the tendency for warm winter storms to pick up moisture from the lake, Lightning Creek and other tributaries draining the Cabinet Mountains are particularly susceptible to rain on snow events.

Lightning Creek

Flows in the Lightning Creek watershed are driven by heavy seasonal variation in precipitation, and high flows often occur at times of rain on snow event. A USGS station is located on Lightning Creek at the city of Clark Fork. Mean daily flows are shown in Figure 10. This station records data from 115.2 mi^2 of watershed. Data have been recorded at Lightning Creek since 1989. Mean annual runoff at the Lightning Creek gaging station, through water year 2001, is 411 cfs. Peak flows are summarized in Table 8.

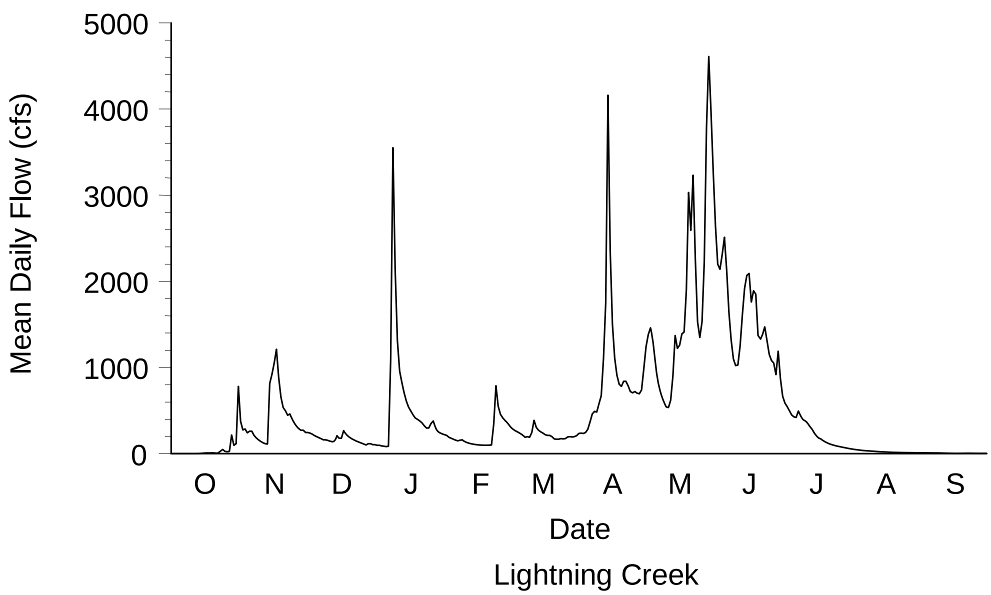


Figure 10. Mean Daily Flow of Lightning at USGS Gaging Station near Clark Fork, Idaho.

Table 8. Peak flows for Lightning Creek USGS gage by water year, 1989-2003. (Reproduced from PWA 2004)

Water Year	Date	Discharge (m^3/s)	Discharge (cfs)
1989	5/09/1989	81.0*	2,860*
1990	12/05/1989	85.8*	3,030*
1991	6/30/1991	39.6	1,400
1992	4/30/1992	72.2*	2,550*
1993	5/13/1993	92.9*	3,280*
1994	5/09/1994	79	2790
1995	2/20/1995	100.8*	3,560*
1996	2/09/1996	140.8*	4,970*
1997	5/15/1997	115.5*	4,080*
1998	5/27/1998	92.3	3,260
1999	5/25/1999	80.7	2,850
2000	5/22/2000	107.3*	3,790*
2001	4/28/2001	57.5	2,030
2002	4/14/2002	170.2	6,010
2003	5/25/2003	176.2	6,220

*****Maximum daily average

Water Column Data

Water column data are collected by the USGS below Cabinet Gorge dam and on Lightning Creek. BURP samples included bacteria testing, and no exceedances of bacteria standards were found.

Clark Fork River

Water column nutrient and pH data collected by USGS below Cabinet Gorge dam from 1998-2002 are presented in Appendix C. Nutrients and pH levels were within Idaho Water Quality Standards, but temperatures above the standard for Salmonid Spawning were recorded. Nutrient information was also collected by the Tri-State Water Quality Council and is reported in annual monitoring reports and summarized in a trend analysis report (PBS&J 2005). Levels of nutrients appear to meet Idaho Water Quality Standards in the Lower Clark Fork River. However, the WAG noted that excess algae growth is an increasing problem in the unassessed delta area (Lower Johnson Creek, Assessment Unit 17010213PN001_03).

General water quality information collected during the Clark Fork Project relicensing process includes water temperatures and information on total dissolved gas concentrations above and below the Cabinet Gorge Dam. Under the NPDES permit, wastewater discharge from the dam is monitored to insure that effluent limits for chlorine, bacteria, total suspended solids and biological oxygen demand are met.

Lower Lightning Creek

Periodic nutrient, pH and other water column data were collected in the water column at the USGS gaging station. These data are presented in Appendix C. All nutrient parameters measured were found to be within Idaho state WQS. Temperature data available from the USGS gaging station in addition to data collected by DEQ and the USFS indicate temperature exceedances throughout the Lightning Creek drainage.

Temperature

Tributaries

Nine temperature data logger data sets have been collected in the Idaho portions of the Lower Clark Fork River basin by DEQ (Table 9). Data were collected during the warmest summer months thru fall spawning periods. Data were collected during this time to identify periods of critical temperature criteria exceedances. All data recorded are in exceedance of Idaho water quality standard temperature criteria for fall salmonid spawning and one temperature data logger site (2001) on Lower Lightning Creek, .5 miles downstream of Morris Creek confluence, was also in exceedance of cold water aquatic biota criteria.

The following table outlines the number of days evaluated for cold water aquatic biota criteria, bull trout fall spawning 9ºC temperature criteria and the percent exceedance of each.

Table 9. Temperature criteria exceedances in the Idaho portion of the Lower Clark Fork HUC.

Stream name and Temperature Logger site ID	Cold Water Aquatic Biota Criteria		Fall Salmonid Spawning 9ºC Criteria		
	Days evaluated	*% Exceedance*	*Days evaluated*	*% Exceedance*	*Duration of Deployment*
Char Creek 1998SCDATL0011	67	0	76	61%	07/18/1998-11/11/1998
Porcupine Creek 1998SCDATL0013	67	0	76	83%	07/18/1998-11/11/1998
Rattle Creek 1998SCDATL0014	67	0	76	70%	07/18/1998-11/11/1998
Quartz Creek 1998SCDATL0015	67	0	76	63%	07/18/1998-11/08/1998
Wellington Creek 1998SCDATL0016	67	0	76	68%	07/18/1998-11/11/1998
Lightning Creek 1999SCDATL0032	68	0	57	49%	07/17/1999-09/26/1999
Morris Creek 1999SCDATL0038	68	0	76	70%	07/17/1999-10/17/1999
Johnson Creek 2001SCDATL0028	94	0	72	92%	06/20/2001-10/11/2001
Lightning Creek 2001SCDATL0042	81	20%	40	100%	06/21/2001-09/09/2001

Lower Clark Fork River

Periodic instantaneous temperature readings show that the Lower Clark Fork River itself exceeds numeric water quality criteria for Salmonid Spawning and bull trout. The Lower Clark Fork River is a large river system, and little data are available to evaluate whether current conditions are similar to natural background condition, or whether temperature cycles are being altered by human activities. Analyses done during the relicensing of Cabinet Gorge and Noxon Rapids dam did not show significant impacts to river temperatures from operation of these hydroelectric facilities (Beak Consultants 1997). The Lower Clark Fork River meets Montana water quality standards for temperature above the Idaho/Montana border.

Dissolved Oxygen

All dissolved oxygen samples met or exceeded water quality standards in the Lower Clark Fork River and Lightning Creek. These are the only areas of the subbasin where dissolved oxygen data were available.

Total Dissolved Gas

All three mainstem Clark Fork River Assessment Units show an exceedance of Total Dissolved Gas (TDG) levels.

Since 1995, Avista Utilities has been monitoring Total Dissolved Gas below Cabinet Gorge Dam during spring runoff periods (generally April – July). Below Cabinet Gorge Dam, peak hourly TDG levels were frequently 125-130% saturation in June. In 2002, levels exceeded 130% about 16% of the time. Because of frequent exceedances of the 110% saturation standard during peak flows, there is on-going total dissolved gas monitoring and a mitigation plan in place. Details are available in *The Gas Supersaturation Control Program for the Cabinet Gorge and Noxon Rapids Hydroelectric Projects* (Avista 2004b) as approved by the DEQ and USFWS as a part of the required water quality certification for the project operations and federal license.

In the assessment unit above Cabinet Gorge Dam near the Idaho/Montana border, TDG levels can reach 110-111% saturation during peak flows, violating Idaho water quality standards (Parametrix 1995-2004). At these same times, TDG is measured at the Noxon Rapids dam, and typically, the TDG levels are slightly lower at the Cabinet Gorge forebay area than at the Noxon Rapids forebay. This indicates that waters with elevated TDG are entering Idaho, with the source above Noxon Rapids dam. In order to fully address elevated TDG levels, especially at the critical peak flow times, reductions in TDG levels of the waters entering Idaho are necessary in addition to the extensive mitigation plan in place for below Cabinet Gorge dam.

Metals

Idaho's metals criteria are based on the bioavailable dissolved form of metals found in the water column. Numeric standards are set to be protective of aquatic life. The toxicity of the metals of concern in the Lower Clark Fork River (copper, zinc, arsenic, cadmium and lead) is directly related to the water's hardness[3]. Standards based on the minimum measured hardness values (64 mg/L) in the Lower Clark Fork River are presented in Table 10. To determine compliance with Idaho's metals criteria, a calculation that relates the flow at the time of the sampling is used. Water Quality Standards are expressed as both an acute value, Criterion Maximum Concentration (CMC), and a chronic value, Criterion Continuous Concentration (CCC). Per Idaho's water quality standards, the one-hour average concentration of a constituent is not to exceed the CMC more than once every three years, while the four-day average concentration of a constituent is not to exceed CCC more than once every three years. Due to the limited number of metals samples available for analysis, DEQ was not able to calculate one-hour and four-day average concentrations. Therefore, single sample values were used to determine whether the CCC and CMC standards were being met. This is a conservative assumption, however, given the expense and effort required to monitor dissolved metals, it is the only available data. Conservative assumptions regarding concentrations are also appropriate given Nimick et al. (2003) found diel cycles in metals at 14 sites across Montana and northern Idaho. Samples available have all been from daylight hours. Metals may be more bio-available in the Clark Fork system during times outside of the standard sampling collection hours for Clark Fork monitoring programs.

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[3] Hardness is a calculated value based on measured calcium and magnesium levels in the water at the USGS gaging station below Cabinet Gorge dam.

Data on dissolved metals concentrations are available for Lightning Creek and the Lower Clark Fork River.

Lightning Creek

USGS sampled the water column for arsenic, cadmium, copper, lead, mercury, and other trace metals at the Lightning Creek gaging station between 1999 and 2001 (Beckwith 2003). No exceedances of water quality standards in Lightning Creek were found.

Clark Fork River

The main stem of the Clark Fork River was added to the Idaho 303(d) list in 1994 and this listing has carried through to Section 5 of the 2002 Integrated Report. There are no known significant sources of metals pollution to the Lower Clark Fork subbasin in Idaho. The primary source of metals contamination is believed to be historic activities in the Upper Clark Fork River basin. The original listing is based on public comment and data showing that through the late 1980s, metals concentrations routinely exceeded standards. In 2001, DEQ deferred TMDL development for metals until more recent data were available for assessment (IDEQ 2001).

Periodic monitoring of dissolved metals occurred at the USGS gaging station below the Cabinet Gorge dam quarterly from 1990-1993, annually from 1994-1997, and monthly during 2001 (Hardy et al 2005). Results are summarized in Table 11 and complete data tables are presented in Appendix C. The results of samples dating from 1988 through 2003 were used in the problem assessment for this TMDL. (Earlier data are reported in IDEQ 2001.) Samples below Cabinet Gorge dam were collected by PBS&J Consulting (formerly Land and Water Consulting, Inc.) for the Tri State Water Quality Council from 2001 to the present. Results are summarized in Table 1 and complete data tables are presented in Appendix C. Constituents analyzed include arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc.

Since 1990, exceedances of the acute criterion (CMC) occurred for cadmium (1991), and copper (twice in 1992). Exceedances of the chronic criterion (CCC) for cadmium (1990, 1991, 2003), copper (1990, three times in 1992) and zinc (2003) have also occurred. Note that both criteria are evaluated using the best available data, which are single event samples.

Table 10. EPA approved standards for hardness dependent toxic metals at the minimum measured hardness level[4]. Standards were calculated using hardness based conversion formula outlined in IDAPA 58.01.02.210.02 (IAC 2005).

	Acute Exposure Criterion CMC[5] (ug/l)	Chronic Exposure Criterion CCC[6] (ug/l)
Cadmium	1.30	0.74
Chromium III	395	51
Chromium IV	15	10
Copper	11.2	7.8
Lead	40	1.54
Mercury	Fish tissue based standard	
Nickel	321	36
Silver	1.6	NA
Zinc	80.3	80.9

Table 11. Summary of available dissolved Cadmium, Zinc and Copper data in the Lower Clark Fork River.

	Source	**Dissolved Cadmium**	**Dissolved Copper**	**Dissolved Zinc**	**Date of Record**
Sample Size	USGS	33	33	33	Variable between 1989-1999; 2000-2001
	Tri-State	44	45	44	2001-2003 (sampling continued to present)
Number of Exceedances	USGS	2 CCC 1 CMC	4 CCC 2 CMC	0	
	Tri-State	1 CCC	0	1 CCC	
Minimum Value (ug/L)	USGS	< 0.04	<1.0	1	
	Tri-State	0.5 (U[7])	0.5 (U)	0.25 (U)	
Maximum Value (ug/L)	USGS	2	38	28	
	Tri-State	1	3	80.8	

[4]Minimum Value = 64 mg/l. Calculated from USGS calcium and magnesium values below the Cabinet Gorge Dam.

[5] Criterion Maximum Concentration

[6] Criterion Continuous Concentration

[7] U = Below laboratory detection limit. Reported as one-half the detection limit.

Table 12. Date, Flow and Data Source information for metals samples that exceeded Idaho Water Quality Standards.

Parameter	Measured Value (ug/l)	Date	Flow (cfs)	Data Source
Dissolved Cadmium	1	11/25/1990	27,100	USGS
	2	5/13/1991	34,200	USGS
	1	7/16/2003	18,200[8]	Tri-State
Dissolved Copper	38	5/12/1992	34,400	USGS
	12	11/16/1992	25,600	USGS
Dissolved Zinc	80.8	10/15/2003	6,040[1]	Tri-State

Because laboratory detection limits were often above the level of cadmium that is considered to impair beneficial uses, the cadmium data were particularly difficult to assess. More data with a sensitive level of detection are needed to determine conclusively the level of cadmium impairment. In its report to the state of Idaho on water quality trend monitoring sites, USGS (2004) trend analysis reports one exceedance of the CMC and that greater than 25% of the samples taken between 1989-1995 exceeded the CCC for cadmium. Especially with peak flows frequently in excess of 30,000 cfs, even very low concentrations of metals could represent significant human caused metals contributions to the system. The USGS data reported are censored based upon the level of confidence of the laboratory. If the metal is not detected at all in the sample, a designation of undetected is given to the value, and this was not the case with cadmium samples taken by the USGS. Samples reported as below laboratory reporting limits generally indicate that the material was detected, but at unquantifiable levels based on the laboratory reporting limit for the metal. Therefore, these values can not be considered to be at zero concentrations.

There was one exceedance of the lead CMC and two of the CCC in 1992. No exceedances have been measured since then, but limited data are available regarding lead levels as the USGS stopped sampling lead at this site in 1994. The Tri-State Water Quality Council sampled for lead below Cabinet Gorge dam in 2004 and in only one sample (n = 18 for the year), was lead detected, and it was measured at the detection limit (.001 mg/l), but not in exceedance of the water quality standard (PBS&J 2005). In 2005, no lead was detected below Cabinet Gorge dam (n=18). In addition, data from two sites upstream of Cabinet Gorge showed levels of lead below the detection limit (PBS&J 2006) during both 2004 and 2005 indicating low lead levels in the Lower Clark Fork River system overall. (This is contrary to other metals analyzed for this TMDL, where samples generally are below the Idaho water quality standard, but some concentrations of the metals are consistently measured in the system.) Therefore, no TMDL is recommended for lead at this time. While there does not seem to be excess lead in the Lower Clark Fork River system, it is assumed that by developing TMDLs for the other metals, lead levels will also be controlled. Lead will

[8] Flows were not recorded at the time of sample. USGS station below Cabinet Gorge Dam reported daily mean flow as shown in table.

continue to be monitored by the Tri-State Water Quality Council, and a TMDL will be developed in the future if lead levels are found to exceed Idaho Water Quality Standards.

In 1993, there was an exceedance of the total recoverable mercury standard in place at that time, however, the detection limit was equal to the exceedance level, making measurement difficult. The last total recoverable mercury samples were taken in 1994. Idaho's mercury standard has since been updated to be a methyl-mercury fish tissue standard. Some studies have been done in the area to assess the level of mercury in fish. In 1986, Barnard and Vashro determined that bioaccumulation of copper and mercury was comparable to other non-contaminated waters elsewhere in the region. They found elevated levels of zinc (55 to 166 ppm) in the 68 fish sampled. In 1993, a limited study of fish tissue indicated that mercury levels were high in pike minnow and that further research was necessary. In 2005, a mercury advisory on Lake Pend Oreille was issued by the Idaho Department of Health and Welfare based on fish tissue analysis of trout and whitefish by Idaho Fish and Game (Jin 2005). Montana Fish Wildlife and Parks completed a fish tissue analysis of fish in Cabinet Gorge reservoir in 2005 and results will be available for review in the near future. Recent studies have shown that sources of mercury are prevalent in the atmosphere throughout the United States and may be difficult to pinpoint. It is likely that future monitoring will occur to determine the accumulated level of mercury in area fish, as well as potential contributions from atmospheric sources of mercury. When data are available, the Clark Fork River should be re-evaluated for potential mercury impairment.

Biological and Other Data

Lower Clark Fork River

The Lower Clark Fork is an eighth order river by the time it enters Idaho. As such, the BURP wadeable stream monitoring methods are not appropriate. No macroinvertebrate data are available from Idaho DEQ sampling. Extensive fisheries information and other indicators of the biological status of the river are available from other sources.

Since the construction of the Cabinet Gorge and other hydropower facilities, native fish populations have been declining in the area. The Bull Trout Problem Assessment ranks the Clark Fork River as a high priority for bull trout restoration. The largest impact to bull trout and other fisheries populations comes from the Cabinet Gorge dam upstream of the Lake and Albeni Falls dam downstream of the Lake. Impacts include loss of access to upstream habitat, artificially high lake levels, fluctuating flows and total dissolved gas levels that are in exceedance of Idaho WQS the majority of the time. Delta conditions have been altered over time by operation of the Albeni Falls and Cabinet Gorge projects, increasing erosion and decreasing sediment deposition from upstream (PBTTAT 1998).

When constructed, the Cabinet Gorge Dam cut off access to 46 percent of bull trout spawning and rearing habitat available at the time of construction. (The earlier construction of Thompson Falls dam cut off a much larger portion of the habitat in the early 1900s). Current efforts through the Clark Fork Settlement Agreement studied possible fish passage methods, and “trap and haul” operations are being tested and developed to move fish upstream and downstream of Noxon Rapids and Cabinet Gorge dams (Avista 2005).

Recent studies by Avista in coordination with resource and regulatory agencies have explored the impacts of Total Dissolved Gas supersaturation on fisheries populations. While it is clear there is some displacement, there is still some question as to the extent of impact the increased gas levels have on fish populations in the river. It is known that levels above 110 percent saturation, the current Idaho WQS, can be detrimental to fish populations and fish exposed to high total dissolved gas levels for extended periods of time can be harmed or killed (PBTTAT 1998). Site specific studies that have examined TDG include Weitkamp et al (2003a, 2003b).

Lightning Creek

Biological data are available for those streams assessed by BURP crews, with index scores presented in Table 13, and relative condition ratings are presented in Table 14.

Macroinvertebrate sampling was done at several BURP sites on mainstem Lightning Creek and its tributaries (Figure 8). Relatively healthy populations of cold water specific macroinvertebrates were found in the samples. BURP sampling was done in 1994, 1995, 1998 and 2002 on the mainstem and throughout the tributaries.

BURP data are considered reconnaissance and the indices applied give a coarse screen assessment on whether a water body is impaired or thought to be fully supporting its beneficial uses. Where other data are available, they may be used to assess the support status of an assessment unit. This was the case for the majority of the Lightning Creek watershed. DEQ utilized extensive field information from PWA (2004), the Avista relicensing process, IDFG and staff observation of extreme bank destabilization to determine the impaired status of Lightning Creek and its tributaries. While some of the BURP indices indicated possible support of beneficial uses (with mid-range scores), often all three indices were not available. DEQ relied heavily upon IDFG redd counts for bull trout that show a declining trend in redds despite a reduction in land management activities that impact water quality in the Lightning Creek drainages. The WAG agreed with DEQ’s assessments of data showing Lightning Creek and its tributaries are impaired by excess sediment and TMDL development was recommended.

Table 13. BURP Sites and Index Scores for Lower Clark Fork River subwatersheds.

STREAM NAME	Assessment Unit (17010213PN _____)	BURP Site ID	Stream Macro-invertebrate Index (SMI)	Stream Fish Index (SFI)	Stream Habitat Index (SHI)
Cascade Creek	09_02	2002SCDAA027	41.27	47.17	59
East Fork Lightning Creek	14_02	1994SCDAA024	39.32	89.43	30
		2002SCDAA012	51.45	85.51	74
East Fork Lightning Creek	14_03	2002SCDAA013	49.37	89.76	77
		1995SCDAB025	69.43	NA	41
Gold Creek	08_02	2002SCDAA054	Dry		
Johnson Creek (Upper)	02_02	2002SCDAA025	Dry		
		2001SCDAA048	Dry		
		1995SCDAA020	27.01	NA	60
Johnson Creek (Lower)	02_03	2001SCDAA049	58.93	78.62	68
		1995SCDAA019	38.12	94.61	61
Lower Lightning Creek	13_04	1994SCDAA023	57.69	NA	25
Lightning Creek	16_03	1994SCDAA025	75.13	NA	35
Lightning Creek (above Quartz)	19_02	1999SCDAA009	47.78	70.79	80
Lightning Creek (Upper)	19_03	1998SCDAA013	63.51	NA	69
Lightning Creek (mid)	17_03	2002SCDAA026	68.95	48.43	59
Lightning Creek (Morris Creek)	13_02	1998SCDAA014	50.61	97.7	71
Mosquito Creek	09_02	2002SCDAA028	70	42.83	63
		1995SCDAA053	46.08	NA	30
Lightning Creek (Porcupine Creek)	16_02	2002SCDAA015	57.28	83.66	75
		1995SCDAA021	68.01	NA	58
Rattle Creek	18_02	2002SCDAA014	56.72	85.26	78
		1995SCDAB019	56.48	NA	44
Savage Creek	15_02	1999SCDAA008	49.06	NA	85
Spring Creek (Upper)	21_02	1995SCDAB012	54.98	NA	45
Twin Creek	04_03	2001SCDAA050	66.46	80.62	81
		1995SCDAA055	45.51	57.62	59
Dry Creek	04_02	2002SCDAA024	Dry		
Wellington Creek	20_02	1996SCDAB033	49.07	NA	71
		1995SCDAB017	67.87	NA	52
		1997SCDAA041	NA	NA	67
West Fork Blue Creek	07_02	2002SCDAA055	Dry		
West Fork Elk Creek	06_02	2002SCDAA023	Dry		

Table 14. SMI, SFI and SHI scores for BURP monitoring data.

Condition Category	SMI (Northern Mountains)	SFI (Forest)	SHI (Northern Rockies)	Condition Rating
Above the 25th percentile of reference condition	≥65	≥81	≥66	3
10th to 25th percentile of reference condition	57-64	67-80	58-65	2
Minimum to 10th percentile of reference condition	39-56	34-66	<58	1
Below minimum of reference condition	<39	<34		Minimum Threshold

Scoring criteria are based upon known values of streams in Idaho that are considered to be functioning, or reference condition streams. A condition rating of three indicates that the index values do not significantly differ from index scores of reference streams. Condition ratings of two or one do significantly vary from index scores associated with reference conditions, however a condition rating of two is considered likely to still support beneficial uses (Grafe et al. 2002).

IDFG regularly conducts redd counts for bull trout in the Lower Clark Fork River subbasin. The trend (1983-2001) has generally been a flat line throughout all tributaries to Lake Pend Oreille and the Clark Fork River. However, comparing the 1980s with the 1990s in Lightning Creek drainage, there was a drop in redds, with the last several years having erratic, but somewhat stabilized counts (DuPont et al. 2004). IDFG attributes erratic redd counts to unstable habitat conditions in the drainage. Redd counts are one of the best tools for estimating overall population status and these data were used as an indication of lack of full support of salmonid spawning in the Lightning Creek drainage when IDEQ kept Lightning Creek AUs listed as impaired in the 2002 integrated report.

The Lower Clark Fork River assessment units are considered impaired by habitat alteration. Delta conditions have been altered over time by operation of Albeni Falls and Cabinet Gorge projects, increasing erosion and decreasing sediments from upstream (PBTTAT 1998). At the second vehicle bridge (no longer used), varying lake levels begin to impact the water velocities, depth and hydrologic conditions of the river channel and delta (PBTTAT 1998).

A spawning channel created in the early 1960s as mitigation for impacts of Cabinet Gorge Dam continues to provide spawning and rearing habitat, though the number of bull trout redds has declined over the years (DuPont et al. 2004).

Summary tables of water quality data used to inform TMDL are presented in Appendix B. The WAG reviewed and supplemented information in these tables.

Status of Beneficial Uses

The basis for the status of beneficial use determinations was BURP data collected from1995 to 2002. Figure 8 shows the locations of BURP monitoring sites, and Table 13 documents index scores for each site, results of which are discussed above. Of the 33 records, 16 sites were not assessed due to lack of data, while the other 19 sites were evaluated for their support of beneficial uses based upon reference condition indices. Johnson Creek BURP data indicated that the water body is not fully supporting cold water aquatic life and salmonid spawning and it is listed as impaired by sediment and temperature. BURP data are intended to be reconnaissance data and additional data were used to determine beneficial use support status in many of the Lightning Creek Assessment Units. While BURP scores indicated full support for several water bodies in the Lightning Creek drainage, there is a margin of error inherent in the indices, and often not all three indices were used to determine the score due to limited data sets. Extensive field information from the Forest Service and DEQ led to the Lightning Creek Assessment Units being listed as impaired by an unknown biological impairment in the 2002 Integrated Report. The available data summarized in the Lightning Creek Watershed Assessment (PWA 2004) indicate that the unknown biological impairment can most logically be attributed to sediment pollution, and therefore, sediment TMDLs will be developed for the Lightning Creek drainage. The Lower Clark Fork River WAG supports this determination of sediment impairment, primarily due to excessive bedload evident in the system.

In addition, temperature data were collected by DEQ and other entities and show exceedances in every water body measured. Eleven watersheds in the subbasin are listed for temperature impairment in the 2002 Integrated Report (IDEQ 2005).

The unassessed sites were spread throughout the subbasin and generally were not assessed due the site being dry when the BURP crew visited the site. BURP data from Spring Creek were collected in 1995 when DEQ used a different macroinvertebrate index, and reassessment was recommended to accurately determine the support status of the water body. Updated BURP data were collected in 2006 and will be considered in the five year review of this TMDL.

Conclusions

Existing data indicate continued impairment on the Lower Clark Fork River mainstem by temperature and total dissolved gas, as well as flow and habitat alteration. A TMDL will address TDG. Metals TMDLs will be developed for the three Lower Clark Fork Assessment Units, and on-going monitoring should continue. It is believed that the reservoirs act as metal and nutrient sinks, and the water quality in the mainstem below Cabinet Gorge dam is generally better than further upstream, however future monitoring and a TMDL are necessary to restore water quality during the critical peak flow seasons.

Temperature exceedances occur throughout the watershed. Critical times for exceedance follow seasonal temperature and native fish requirements. East Fork Creek and Johnson Creek were found to need further monitoring and a TMDL is developed to address the level of sediment pollutants which are known. Cascade Creek is listed for temperature impairment, however the BURP data indicate there may be other biological impairments. A stressor identification report identified sediment as a possible impairment (Clyne 2006). A sediment TMDL was considered, but is not recommended at this time. It is recommended that further information be collected on Cascade Creek to determine if sediment or other pollutants beyond temperature are causing impairment. Cascade Creek received a sediment reduction allocation to reduce its contribution to sediment impairment in Lightning Creek.

The instability of stream structure in Lightning Creek and its tributaries, and their ability to support healthy bull trout populations is a critical indicator of impairment and subsequent restoration that will be targeted in the TMDLs. Middle Lightning Creek, as the major depositional reach in the drainage, demonstrates the level of aggradation and stream channel alteration due to excess sediment. Currently, the Lightning Creek system does not have the capacity to assimilate the amount of bedload material moved through the system, resulting in a widening channel structure and water going underground in the lower reaches, sometimes creating fish passage barriers during critical fall spawning periods. The goal of the sediment TMDL is to return Lightning Creek to a condition that will fully support beneficial uses, and reduce excess sediment contributions to the stream. Because of the dynamic nature of Lightning Creek and its tributaries, a long time frame to recovery is expected.

2.5 Data Gaps

The beneficial use status of Spring Creek needs verification. Due to a change in BURP indexing and changes in the watershed, it is unknown whether the previous support status determination is still valid. Two factors influencing water quality are the non-operational status of the Clark Fork hatchery, which is expected to improve water quality, and changed land use activities due to increased development that may be impacting water quality in Spring Creek. Additional BURP monitoring of Spring Creek to reassess its support status was conducted in 2006 and will be reviewed in the next assessment cycle.

BURP data collected on Cascade Creek indicate biological impairment. A stressor identification report indicated that sediment may be an impairment. Limited data on harvest or other sediment generating activities on private lands are available to fully assess whether sediment is impairing beneficial uses on Cascade Creek.

Exceedances of water quality standards for metals have decreased since the Lower Clark Fork River was first listed for metals in 1994. This can be attributed to on-going remediation efforts upstream in Montana and changes in upstream dam operations that impact the timing and magnitude of peak flows that may transport metals. Continued monitoring is necessary in the Lower Clark Fork River to determine progress toward the TMDL target and to monitor potential excursions from the standards due to the proposed Rock Creek mine directly upstream of the Idaho/Montana border, and remediation efforts at the Milltown dam site.

As TDG mitigation projects progress, continued assessment to ensure desired conditions are reached is necessary.

While exceedances of the numeric water quality standard for temperature have been measured in the mainstem Lower Clark Fork River Assessment Units, information on upstream temperature influences from reservoirs in Montana and overall natural background conditions for temperature are not known. It is possible to model natural background temperatures and the potential for heating in reservoirs and from other sources, but this effort has not been attempted to date. Therefore, no TMDL for temperature will be completed on the mainstem Lower Clark Fork River in Idaho until additional information on background conditions is understood. It is anticipated that this review will occur before 2011, when the five-year review of TMDLs in the subbasin will be completed, and Montana DEQ will be working on other TMDLs for the Lower Clark Fork River. At this time, the Lower Clark Fork River has not been determined to exceed Montana water quality standards for temperature.

3. Subbasin Assessment–Pollutant Source Inventory

This section discusses known sources of sediment, temperature, total dissolved gas, and metals – the pollutants of concern in this subbasin. Information on point and nonpoint sources is summarized and data gaps are identified for future research and monitoring.

3.1 Sources of Pollutants of Concern

While there are two point sources permitted to discharge pollutants into the Lower Clark Fork River, nonpoint sources of pollution are the major contributor to impairment in this Subbasin. Generally, pollution within the Lower Clark Fork Subbasin is related to land use and is primarily from excess sediment and high temperatures as a result of historic timber harvest, fires and associated road building on the highly unstable soils of the region.

Point Sources

There are two active National Pollutant Discharge Elimination System (NPDES) point source permits in the Subbasin, and one inactive permit. In addition, there is a general permit for construction that is applicable to areas greater than one acre in the Subbasin. Table 15 summarizes discharge limits and permit information for each location. While there are no other point sources in the Idaho portion of the Subbasin, it should be noted that upstream in Montana, there is a large Superfund site encompassing much of the Lower Clark Fork River basin and extensive metals clean-up efforts are underway.

There are several NPDES permits issued by Montana DEQ above the Idaho/Montana border. These include Butte, Deer Lodge, and Missoula wastewater treatment facilities and Smufit-Stone Container. Specific nutrient and other pollutant reduction targets are outlined in these permits.

Table 15. NPDES permitted discharges into the Lower Clark Fork River in Idaho.

Facility	Water body	Permit Number	Expiration Date	Permit Limits	Discharge Volume
Cabinet Gorge Hatchery	Lower Clark Fork River	ID0026611	Currently being administratively renewed annually	Will be covered under EPA general aquaculture permit	
Cabinet Gorge Power Station	Lower Clark Fork River	ID-002799-5	5-Jan-07	Biochemical Oxygen Demand (BOD5) and Total Suspended Solids (TSS) 30 mg/L or 0.3 lb/day (average monthly limit) 45 mg/L or 0.5 lb/day (average weekly limit) Fecal Coliform Bacteria 200/100 ml (average weekly limit) E. Coli Bacteria 126/100 ml (average weekly limit) 406/100 ml (daily maximum limit) Total Residual Chlorine 0.5/ mg/L (average monthly limit) 0.75 mg/L (average weekly limit) pH range shall be between 6.5-9.0 standard units	224 gallons/day
Clark Fork Fish Hatchery	Spring Creek	Not currently under operation			

Nonpoint Sources

Sediment

Sediment occurs naturally as a geologic process. Streams function to move sediment from source areas of high gradient and friable soil material through intermediate elevations and gradients to depositional reaches where sediment is incorporated into the flood plain or transported to larger waters and ultimately to the ocean. Land management practices have the potential to accelerate erosion or to alter depositional processes. This is when sediment becomes pollution. Sediment in excess of a stream's ability to transport it is pollution. Sediment pollution interferes with natural processes that aquatic life depends on and it can result in increased instability of natural stream channels further accelerating erosion. Both fine sediment, and excessive bedload (or larger sediment) can be a pollutant.

Land conditions that result from silvicultural practices and roads in the area are the primary nonpoint sources of sedimentation. Timber harvest and associated road construction can intercept water flows and alter peak flows, as well as provide trigger points for mass wasting events. These altered flows and sediment delivery mechanisms influence stream function. Altering the dimension, pattern and profile of stream channels changes the transport and deposition of sediment as well as morphology of streams and rivers. For instance, the widening of a channel can contribute to higher temperatures in the stream. To address one aspect of sediment pollution without regard to others on a watershed scale has little potential to successfully reduce sediment or improve water quality or fisheries on a meaningful scale.

Initiating an increase in erosion or change in flow pattern can have grave consequences over many years. Many of the processes that are creating excessive amounts of sediment were initiated before these relationships were understood. Today, a number of land management practices are perpetuating the problems of the past and contributing to an increasing deficit of water quality and fisheries values.

Road densities in a watershed are a known indicator of fisheries habitat quality. In particular, with increased road densities, bull trout populations tend to decline due to the added risk of sediment delivery and potential alternations to ground water flow and peak flows from roading that influence water temperature. Stream crossings provide added sources of sediment and can alter the channel and flow. Detailed analysis of road densities, stream crossings and road impacts on streams throughout the Lightning Creek drainage, as well as areas identified for restoration are available in PWA (2004).

Mass wasting is a natural process in the Lower Clark Fork Subbasin, in particular in the Lightning Creek watershed. Frequently in landslide prone areas, human activities can increase both the occurrence of landslides and the potential for these mass wasting events to deliver sediment to streams. An illustrative example of the impacts mass wasting events in logged and roaded versus unlogged terrain in the Subbasin is given in the PWA (2004). Morris Creek is a relatively undisturbed watershed, and has had several mass wasting events occur that are not linked to human activities. The structure in Morris Creek is considered more stable than its counterpart – East Fork Creek, which has had substantially more road related mass wasting events. This indicates that streams in this watershed have a certain capacity to assimilate mass movement of material; however, there is also a threshold where the system can no longer process increased amounts of material delivered to the stream, and the structure in altered, frequently causing impairment to beneficial uses.

Temperature

The primary disturbance causing stream temperatures to rise is reduced canopy cover and riparian function by silvicultural practices and in the lower stretches of some of the southern tributaries, agricultural practices.

Roads located close to streams limit stream shaping in some areas, and the widening of the channel due to changes in sediment delivery can impact the amount of temperature loading that occurs in the stream.

Total Dissolved Gas (TDG)

The courts have characterized dams as point sources for which NPDES permits will not be issued for certain parameters. Therefore, TDG is addressed through TMDL allocations, instead of through the NPDES permit process. Cabinet Gorge dam has a capacity of about 38,000 cfs, when river flows exceed this powerhouse capacity, excess flow spills, entraining gases in the water at supersaturated levels. While spill gates are operated to reduce the entrainment of gases, as flows increase and spill increases, typically during spring snow melt, TDG pollution is created. These entrained gases can remain in the water column into Lake

Pend Oreille and the Pend Oreille River, impacting habitat availability to fisheries in particular.

Metals

There are no significant known sources of metals in Lower Clark Fork subbasin in Idaho. A century of mining and smelting, tailings disposal, and other mine wastes have left the Upper Clark Fork and its tributaries severely polluted with toxic metals and other chemicals. Four Superfund sites exist in the upper Clark Fork: 1) Silver Bow Creek and the upper Clark Fork from Butte to Milltown (metals residues from mining and smelting); 2) the Montana Pole plant in Butte (creosote and pentachlorophenol from wood treatment); 3) the Anaconda smelter (smelter wastes and widespread deposition of airborne contaminants; and 4) the Milltown Reservoir, which has accumulated toxic metals from upstream sources. Since 1982, EPA, Montana DEQ, industries and other agencies have worked to investigate, prescribe and implement clean-up procedures. Most notably, in 2006, removal of contaminated sediment from the Milltown reservoir will begin, followed by removal of the dam and a long-term remediation and monitoring program (EPA 2005).

Pollutant Transport

Sediment

Delivery of large material through the system is episodic during the winter and spring months when high flows and/or rain on snow events occur. The road system frequently encroaches on the riparian areas resulting in some chronic delivery. Due to the soil characteristics of the subbasin, roads intercept water and increase the potential for mass wasting. In a 1989 study of landslides in the Lightning Creek drainage, Cacek found that more than 75% of the sediment volume of landslides reaching streams originated from roads or roads and clearcuts. Anthropogenic increases in mass wasting are very evident in the Lightning Creek drainage and are a significant source of sediment pollution through both stream alteration and direct delivery to the stream.

Temperature

Temperature exceedances in the Lower Clark Fork River Subbasin are exclusively from nonpoint sources. Some increases in temperature can be attributed to reduced canopy cover due to fire or harvest. Alterations in stream structure, in particular, stream widening due to excessive erosion or large sediment delivery can also influence temperatures. Therefore, it is possible for temperature pollution to be related to sediment transport and deposition areas, because wider, shallower streams typically have more solar gain.

Total Dissolved Gas

Total Dissolved Gas supersaturation caused by the entrainment of gas in the water when spill occurs at a hydroelectric facility can remain high for significant distances from one hydroelectric project to the next downstream project, absent opportunities for the water to degas (e.g., rapids or other gas releasing flow situations).

Metals

Measurable sources of metals to the Clark Fork River are thought to be entirely upstream of the Cabinet Gorge and Noxon Rapids dams. Most metals settle and bind to sediment particles, generally accumulating in the reservoirs along the Clark Fork River, including

Noxon Reservoir and Cabinet Gorge to a lesser extent. A catastrophic flood event may remobilize these bottom sediments and affect beneficial uses in downstream waters; however, at this point it is highly speculative without further study. Studies of stratification in Noxon reservoir have been conducted to determine if anoxic conditions are occurring, and this condition has not be recorded to date (Land and Water Consulting 2001). Future monitoring will occur during extreme low flow years when these conditions could occur.

3.2 Data Gaps

On-going activities to improve bull trout habitat are likely to have a positive impact on water quality. It will be important to monitor the impact of these activities, in particular sediment input reductions and stream-side canopy enhancement.

Point Sources

There are only two NPDES permitted point sources of pollution, both on the Lower Clark Fork River. Because of the Lower Clark Fork River's influence on Lake Pend Oreille, it is important to continue monitoring for nutrient input from these sources. (Lake Pend Oreille nearshore areas have a TMDL and implementation plan in place for reducing nutrient inputs into the lake.)

Since both the Lower Clark Fork River and Lightning Creek are designated Special Resource Waters, no new point sources of pollution are allowed.

Nonpoint Sources

Water quality information is unavailable for some of the smaller tributaries in the area and should be collected. Given the number of temperature exceedances and on-going data collection, more analysis of background temperature conditions in the watershed may be warranted.

4. Subbasin Assessment – Summary of Past and Present Pollution Control Efforts

There are active bull trout restoration efforts in many parts of the Subbasin. In particular, since the Clark Fork Settlement Agreement, there have been staff and funds dedicated to restoration by Avista Utilities and prioritization of native fisheries protection and restoration efforts by the Water Resources Technical Advisory Committee established by the Settlement Agreement.

Point Source Pollution Permits

There are two permitted point sources of pollution in the Lower Clark Fork Subbasin – the Cabinet Gorge Fish Hatchery and the Cabinet Gorge Power station. In addition, if a construction project disturbs more than one acre of land (or is part of a larger common development that will disturb more than one acre), the operator is required to apply of a pollution permit from EPA after developing a site-specific Storm Water Pollution Prevention Plan. A Construction General Permit has been issued by EPA, so that construction operators in Idaho that meet specific requirements to control sediment and other best management practices, document these measures in their Storm Water Pollution Prevention Plan and monitor their implementation for the life of project, will receive coverage in this permit.

Cabinet Gorge Hatchery (Permit number ID-002661-1) is currently being revised and will be covered under a general Aquaculture permit for Idaho. No TMDL pollutants are expected from the hatchery.

Idaho Fish and Game’s Clark Fork Hatchery was covered under the Aquaculture Facilities in Idaho General NPDES Permit No. ID-G-13-0021 until the permit expired in September 2004, when the permit was placed on administrative hold due to a temporary shutdown of the hatchery that went into effect in August 2000. Effluent inputs from the hatchery went directly into Spring Creek. Since the hatchery is not in operation, some water quality improvements can be expected. If/when the hatchery begins operation again, a revised permit would account for the information presented in this TMDL.

A Voluntary Nutrient Reduction Program (VNRP) is in place for the Clark Fork River in Montana. This agreement calls for site-specific measures to be taken by the four major point-source dischargers (Butte, Deer Lodge, and Missoula wastewater treatment facilities and Smufit-Stone Container) and for significant reductions by key non-point sources. In 2002, the State of Montana adopted the nutrient and algae targets of the VNRP as water quality standards for the Clark Fork River, making the VNRP targets applicable to all point sources. Some $62 million will be spent by the VNRP signatories to meet the agreement. Actions taken include:

- The City of Butte augmented flows with clean water from a nearby lake, and has applied its nutrient-rich wastewater onto a sod farm.
- The City of Deer Lodge removed its entire discharge from the river during critical summer months and has applied its wastewater onto hayfields at a nearby ranch.

- The City of Missoula installed a biological nutrient removal system at its wastewater treatment facility, which is meeting nutrient reduction targets.
- Smurfit-Stone Container has regulated its discharge to coincide with higher river flows and reduced seepage from its storage ponds near the river.
- Missoula County has taken the lead in an aggressive schedule to address non-point loading from septic systems in the Missoula valley. (Tri-State Water Quality Council 2006).

Nonpoint Source

Forested Land/Roads

Due to the importance of the Lower Clark Fork, and the Lightning Creek watershed in particular, to bull trout, extensive efforts are underway to improve water quality and restore habitat in the Lower Clark Fork drainage. In the past ten years, significant data collection and planning for restoration have occurred, and several projects are underway or have been completed over the past five years with many more in the works. Restoration projects in the Lightning Creek watershed focus primarily on reducing the impacts of the road system on the streams in the watershed. This includes decommissioning roads and culvert repair, as well as improved maintenance. Over time, efforts such as these will reduce sediment pollution both directly from roads and as a reduction in road related mass wasting. Reductions in sediment pollution will also increase the potential of reaching shade targets and cooling efforts because of the relationship of excessive sediment to stream widening.

All forested land managed the Forest Service and the Bureau of Land Management must meet INFISH (the federal Inland Native Fish Strategy) guidelines. These guidelines prescribe 300-foot buffers for fish-bearing streams. These buffers contribute to increases in shade and to reaching temperature TMDL targets. Current and proposed timber sales within the basin include road projects aimed at improving water quality and reducing landslide risk and delivery of sediment to streams. In 2007, a new Forest Management Plan that removed INFISH requirements for Forest Service lands was proposed. While a court order has put the new Forest Plan guidance on hold, INFISH is still in practice. The revised plan does not specify riparian buffer widths, but does specify protection of ecological function in riparian areas. Regardless of which plan is in place, both plans contain USFS commitments to implementing the Clean Water Act and continued protection and enhancement of stream shading is expected.

Agricultural

On agricultural lands under federal management, the attention is being given to road impacts. On private land, a stream realignment project and conservation easement to restore riparian areas in lower Twin Creek was completed in 2001. The project was a partnership between the landowner, Idaho Fish and Game and the Technical Committee implementing the Clark Fork Settlement agreement. The conservation easement limits development in the riparian area of lower Twin Creek, and there is continued maintenance and riparian plantings in the restoration area.

In 1979 the original Idaho Agricultural Pollution Plan (Ag Plan) was developed in response to Section 208 of the Clean Water Act and represents the agricultural portion of the State

Water Quality Management Plan. Subsequently, the plan was revised in 1983 and 1991. The most current Ag Plan, *Idaho Agriculture Pollution Abatement Plan, 2003,* sets goals and provides guidance for the management of all nonpoint source related activities throughout the state.

Bull Trout Restoration Projects

As a result of the Avista Clark Fork Settlement Agreement, there have been numerous projects completed to benefit bull trout populations, many of which are directly related to improving water quality in the Subbasin (Avista 2003-2006). The projects fall into several general categories. Land parcels in prime bull trout habitat have been acquired in Idaho and Montana. Placement of lands in conservation easements or ownership reduces pressures from development in these areas and protects critical riparian areas. A native salmonid restoration strategy is in place, which includes genetic studies, telemetry and development of methods to pass fish upstream and downstream of the dams. Extensive monitoring of tributary and mainstem fish population abundance and habitat use is ongoing. Several watershed councils and Montana and Idaho fish and game agencies are supported for on-the-ground restoration and education projects.

Nutrient Reduction Projects

The states of Idaho and Montana, facilitated by the Tri-State Water Quality Council, have a Memorandum of Agreement that documents the parties' commitments and intent to protect and maintain water quality in Pend Oreille Lake by establishing and attaining nutrient loading goals and targets for the Clark Fork watershed in Montana and local sources in Idaho. Specific loading targets are set to reduce the amount of nitrogen and phosphorus in the Clark Fork - Pend Oreille system. These targets are discussed more fully in the TMDL Section 5.7.

Total Dissolved Gas Reduction Projects

The Clark Fork Settlement Agreement required development of a *Final Gas Supersaturation Control Program for the Clark Fork Project* (GSCP, Avista 2004b). This plan was approved by Idaho DEQ and the USFWS and submitted to the Federal Energy Regulatory Commission as a condition of the project license. It outlines activities that will reduce production of excess TDG at the Cabinet Gorge Dam in Idaho. With the establishment of the Settlement Agreement, operations at Noxon dam upstream of Cabinet Gorge in Montana were altered so that there is little to no elevated TDG production from the Noxon facility. Increases in flows through the Cabinet Gorge powerhouse and the change in spillgate operations are examples of efforts that “reduce, offset, or otherwise mitigate the increase in TDG due to spill at the Cabinet Gorge Dam,” as required by the GSCP. The 2004 GSCP also proposes a bypass tunnel that will reduce TDG production at Cabinet Gorge dam, however, this plan is currently under review by Avista for its feasibility.

In addition, numerous studies to examine TDG’s impact on fish populations have been conducted and are available in the Clark Fork Settlement Agreement Project record (Parametrix 1997, 1998, 1999, 2000).

Summaries of these reports are in Avista (2004b, p. 24-25), and conclusions include:

> Avista and Parametrix have both expressed the opinion that the results of the biological studies support the conclusion that the elevated TDG levels occurring

downstream of Cabinet Gorge Dam are likely having little, if any, effect on fish populations, and almost no effect on individual fish when levels are below 120 to 125 percent of saturation. The IDEQ, IDFG, and USFWS have indicated that they view the biological studies as somewhat limited in scope, and the results of questionable value for determining the actual impacts of elevated TDG levels on fish populations because of various sampling limitations. The USFWS has indicated on several occasions that because there are very few downstream migrating juvenile bull trout or westslope cutthroat trout available below Cabinet Gorge HED, an important segment of the potentially affected fish species were not available for study (L. Lockard, pers comm.; USFWS comments on GSCP review draft, mark-up dated August 25, 2001). They note that downstream migrating juvenile bull trout are known to move along the margins of large rivers where water depths are shallow (Mulfield et al. 2002). Pointing out that substantial efforts are underway to restore and enhance these fish populations and increased numbers of fish are likely in the future, they have stated that the potential effects of elevated TDG levels on these fish remains “a major concern”. Avista has suggested however that releases of hatchery reared fish into the river (kokanee fry and juvenile cutthroat trout) indicate that downstream migrating fish are likely to exit the relatively short reach of river below the Cabinet Gorge HED and disperse into Lake Pend Oreille rather quickly, particularly during the high flow periods when elevated TDG levels occur. Their potential exposure to elevated TDG levels might be minimal, and any symptoms that do develop are ameliorated if they seek only moderately deeper water within the lake.

5. Total Maximum Daily Load(s)

A TMDL prescribes an upper limit on discharge of a pollutant from all sources so as to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation (WLA); and nonpoint sources, each of which receives a load allocation (LA). Natural background (NB), when present, is considered part of the LA, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR Part 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the margin of safety is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to human-made pollutant sources. This can be summarized symbolically as the equation: LC = MOS + NB + LA + WLA = TMDL. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First the load capacity is determined. Then the load capacity is broken down into its components: the necessary margin of safety is determined and subtracted; then natural background, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation are completed the result is a TMDL, which must equal the load capacity.

Another step in a loading analysis is the quantification of current pollutant loads by source. This allows the specification of load reductions as percentages from current conditions and considers equities in load reduction responsibility. The load capacity must be based on critical conditions – the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

A load is fundamentally a quantity of a pollutant discharged over some period of time, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for "other appropriate measures" to be used when necessary. These "other measures" must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow "gross allotment" as a load allocation where available data or appropriate predictive techniques limit more accurate estimates.

Water quality targets for temperature, metals and sediment are detailed in the following section for water bodies currently not fully supporting beneficial uses. The goal of the targets is to restore "full support of designated beneficial uses" (Idaho Code 39.3611, 3615). Select the measurable target(s) for in-stream water quality and the loading analysis.

5.1A Cadmium, Copper and Zinc In-stream Water Quality Targets

Because of exceedances of the cadmium, copper, and zinc water quality standards as detailed in Section 3, TMDLs are presented below for the Lower Clark Fork River. These TMDLs apply to all three mainstem Assessment Units and the point of compliance is the Cabinet Gorge USGS gaging station. The Water Quality Standards used in this TMDL are approved by EPA. However, in April 2006, the state of Idaho adopted updated Cadmium standards. These standards are not yet approved by EPA. Until the updated standards for Cadmium are approved by EPA, the calculations in this section remain in effect. TMDL calculations that reflect the updated Idaho Water Quality Standard for cadmium are reported in Appendix D. If these standards are approved by EPA, then the calculations in the Appendix will become the TMDL.

Design Conditions

While high flows tend to show the most sediment transport, and therefore have the greatest potential to transport metals, lower flows may show exceedances more readily due to the lower threshold of metals that can be absorbed into the system. All seasons are considered in the following analysis. The water quality standards for the metals of concern are hardness based. A conservative standard is set by developing the TMDLs based on the lowest measured hardness values at the USGS Cabinet Gorge gaging station. Also, high flows generally relate to lower hardness levels.

Target Selection

Water Quality Standards include numeric standards for metals, dependent on the hardness value. Because hardness varies with flows and measures are not always available, a conservative approach to developing targets is undertaken. The minimum hardness level measured from all records at the USGS gaging station below Cabinet Gorge dam is 64 mg/l, based on measured Calcium and Magnesium values.

Monitoring Points

Idaho DEQ will continue to participate as a member of the Tri-State Water Quality Council monitoring committee to coordinate monitoring efforts in the Lower Clark Fork River. The existing monitoring location below Cabinet Gorge dam will be used as a compliance point for the cadmium, copper and zinc TMDLs. Data from the monitoring site at Noxon Bridge is also an indicator of the water quality in the assessment unit above Cabinet Gorge dam. Dissolved metals (arsenic, cadmium, copper, lead, zinc) are monitored monthly and six times during peak flows. This monitoring program is in place from 2002-2007, with a five-year review and analysis of the data throughout the Clark Fork River to be completed in 2008 by the Tri-State Water Quality Council. Monitoring protocols are reported in the Quality Assurance Protection Plan for the Tri-State Water Quality Council Program (PBS&J 2005). In 2005, the Quality Assurance Project Plan was updated to include a laboratory detection limit for cadmium that is below Idaho's water quality standard to allow for better assessment of compliance with Idaho water quality standards.

5.2A Cadmium, Copper and Zinc Load Capacity

The load capacity is the amount of pollutant that each water body can accommodate and still meet the water quality standard. This must be a level to meet "...water quality standards with season variations and a margin of safety which takes into account any lack of knowledge...” (Clean Water Act § 303(d)(C)). Since flows can vary significantly in the watershed, load capacity has been determined based on flow to account for seasonality. Hardness has not been adjusted based on flow due to lack of information and to account for a margin of safety in the calculations.

The State of Idaho adopted revised cadmium standards in April 2006. These standards were submitted to EPA for approval in July 2006, but have not been approved. Therefore, the TMDL was calculated based on the current version of Idaho’s water quality standards that were approved by EPA (IAC 2005). Calculations showing the April 2006 Idaho standard for cadmium are presented in Appendix D. If these standards are approved by EPA, then the calculations presented in Appendix D will become the TMDL targets. However, until that time, the cadmium TMDL presented in this section will remain in effect. It is important to note that Idaho’s revised standards set a lower allowable load capacity for Cadmium, and future monitoring will aid the state in determining whether these standards are being met. In addition, with either standard in place, there is also the Special Resource Water standard that prevents additional, measurable point source pollutants from being added to the system, setting the water quality threshold regardless of which Cadmium standard is in effect.

Table 16. Load Capacity of the Lower Clark Fork River for Cadmium.

	Flow (cfs)	Cadmium CCC (ug/L)	Load Capacity (lb/day)
7Q10[9]	6,054	0.74	24
10th percentile[10]	8,400	0.74	34
50th percentile	16,900	0.74	67
90th percentile	44,600	0.74	178

Table 17. Load Capacity of the Lower Clark Fork River for Copper.

	Flow (cfs)	Copper CCC (ug/L)	Load Capacity (lb/day)
7Q10	6,054	7.8	255
10^{th} percentile	8,400	7.8	353
50th percentile	16,900	7.8	711
90th percentile	44,600	7.8	1,876

[9] 7Q10 is the minimum 7-day average flow over a ten year period. Data from 1994-2004 were used to better reflect current operations at the Cabinet Gorge and Noxon Rapids dams.
[10] 10^{th}, 50^{th}, and 90^{th} percentile flows are based on USGS dataset below Cabinet Gorge Dam from 1960-2004.

Table 18. Load Capacity of the Lower Clark Fork River for Zinc.

	Flow (cfs)	Zinc CCC (ug/L)	Load Capacity (lb/day)
7Q10	6,054	80.3	2622
10th percentile	8,400	80.3	3638
50th percentile	16,900	80.3	7320
90th percentile	44,600	80.3	19317

5.3 A Estimates of Existing Pollutant Loads of Cadmium, Copper and Zinc

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR § 130.2(I)). There are no known point sources of metals in the Lower Clark Fork River subbasin in Idaho. The primary nonpoint sources are assumed to be historical mining sites upstream in Montana, including four superfund sites. Background loads, current permitted sources in Montana, and impacts of historic mining activity are considered together in the total load allocation at the border.

Current loads vary with flows, but the measured concentrations are summarized in Table 12, section 3 and all measured values are shown in Appendix C. Because of the episodic nature of metals loading, it is difficult to quantify existing loads. The following tables show the loading conditions at the most recent measured exceedances for cadmium and copper. Existing loads of zinc are likely at or below the water quality standard.

Table 19. Existing Cadmium Load at time of exceedance.

Sample Date	Flow (cfs)	Dissolved Cadmium (ug/L)	Existing Load (lb/day)
7/16/2003	18200	1	98

Table 20. Existing Copper Load at time of exceedance.

Sample Date	Flow (cfs)	Dissolved Copper (ug/L)	Existing Load (lb/day)
11/16/1992	25600	12	1657.0

Zinc loads were measured at 80.8 ug/L on October 15, 2003 by the contractor to the Tri-State Water Quality Council. During initial analysis, DEQ determined that this level was above Idaho water quality standards, and therefore, developed a TMDL for zinc. Subsequently, the contractor has reported some small zinc contamination in its sampling methodology (PBS&J 2007). Because of the uncertainty in relying upon this data, DEQ kept the load capacity and TMDL developed for zinc in this document, but acknowledges that it is probable that the Lower Clark Fork River in Idaho is meeting water quality standards. Data collection continues, and DEQ will review data collected since 2003 in its 2011 review of this TMDL to more accurately determine whether zinc TMDL load capacities are being met.

5.4A Load Allocation for Cadmium, Copper and Zinc

Waste Load Allocation

There are no known point sources of metals in Idaho; the waste load allocation (WLA) in Idaho is zero.

Load Allocation

The entire flow-based load capacities for cadmium, copper and zinc are allotted as total load allocations at the Montana-Idaho border. It is the responsibility of the state of Montana to meet the load capacity and Idaho water quality numeric and special resource water standards at the border. The total allocations are equivalent to the load capacities shown in Table 16 to Table 18.

If conditions are recorded that exceed the load capacities shown in Tables 16-18, reductions in loading upstream will be required.

Load reductions may be required under certain conditions. For example, at the flows and concentrations present at the most recent measured exceedances load reductions would be required as shown in Table 21 and Table 22 . Sample loading calculations are shown in Appendix D.

Table 21. Example cadmium load reductions at exceedance conditions.

Measured Flow (cfs)	Dissolved Cadmium Existing Load (lb/day)	Dissolved Cadmium Load Capacity (lb/day)	Load Reduction Required (lb/day)	Percent Reduction
18,200	98	73	26	26%

Table 22. Example copper load reduction at exceedance conditions.

Measured Flow (cfs)	Dissolved Copper Existing Load (lb/day)	Dissolved Copper Load Capacity (lb/day)	Load Reduction Required (lb/day)	Percent Reduction
25,600	1657	1077	580	35%

Margin of Safety

There are three levels of implicit Margin of Safety in the TMDL calculations. The standards used (and associated allowable loads) were based on the minimum hardness level measured in the area. Use of the minimum hardness value provides a margin of safety since as the hardness of the water increases, the toxicity of the hardness dependent metals decreases, allowing a higher concentration of metals to still meet water quality standards. Because it is a part of the margin of safety, even if a different hardness level is measured at the time a sample is taken, 64 mg/l will be used to calculate the standard. In addition, the natural background load for the system is not known, therefore it is assumed to be zero. The recent exceedances of standards were based on the chronic criteria. Since only one event was available, these are the data that were evaluated by the chronic standard. This is a conservative assessment, since in practice, the chronic criteria are considered toxic when exceeded over a period of time, not just on one occurrence.

Seasonal Variation

Seasonal variation is accounted for in the assignment of a flow based load capacity.

Reasonable Assurance

Significant resources and legal commitments are tied to several major Superfund clean-up efforts in the Clark Fork River Basin in Montana. In addition, TMDLs and load reductions are being completed in the Upper Clark Fork River by Montana DEQ. Because the sources of metals in Idaho are believed to be the same that are causing metals impairment in Montana, the on-going remediation efforts in Montana should also help to meet Idaho Water Quality Standards. The State of Montana is committed to bringing metals levels in the Clark Fork River into compliance with Montana Water Quality Standards, which, when achieved, should assure that Idaho’s standards will be met at the border.

Background

Background levels are not known, therefore there is no allocation for background.

Reserve

No part of the load capacity is held for future sources. Even when the target loads are met, the Clark Fork River is designated as a Special Resource Water and no measurable increase in the existing levels of pollutants from point sources is allowed.

Remaining Available Load

There is no available load at the Idaho border for Cadmium, Copper, Zinc or other metals. Even when the TMDL targets are met, no measurable discharge of metals is allowed into the Lower Clark Fork River in Idaho because it is a designated Special Resource Water.

Current water column concentrations range from non-detection to exceedances of the water quality standards for cadmium and copper under specific flow and transport conditions. The TMDL goal is to meet numeric Idaho water quality standards at all flows and conditions for all metals. The Special Resource Water provision in Idaho standards also applies. When reduced to the target load, meeting Idaho Water Quality Standards, no measurable increase in pollutants is allowed. Baseline numbers, when below the flow-based water quality standards, shall then be the target.

Table 23. Sources of cadmium, copper and zinc load allocations for Lower Clark Fork River Assessment Units in Idaho.

<table>
<tr><th>Source</th><th>Pollutants</th><th>Allocation</th><th>Time Frame for Meeting Allocations</th></tr>
<tr><td rowspan="2">Combination of all point, nonpoint and background sources in Montana upstream of the border</td><td rowspan="2">Cadmium, Copper, Zinc</td><td>Load Capacities are flow based, with examples shown in Table 16 - Table 18.</td><td rowspan="2">2011</td></tr>
<tr><td>No measurable increases in pollutants from point sources allowable in Idaho waters.</td></tr>
</table>

5.5A Implementation Strategies for Cadmium, Copper and Zinc

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals. However, current monitoring shows that at most flows and conditions, targets based on water quality standards are being met.

Time Frame and Approach

It is anticipated that the targets will be met within five years due to on-going and past efforts to reduce metals that should continue to show improvements. In the 1980s, there were frequent exceedances in metals (IDEQ 2001). A noticeable decrease in metals exceedances has occurred since the early 1990s. While it is not anticipated (Envirocon 2005), the removal of the Milltown dam beginning in 2006 may increase the potential for metals transport downstream and increase metals concentrations in the future. This is not expected to slow progress toward achievement of TMDL targets. If unexpected transport of metals downstream is discovered through monitoring, mitigation efforts at the project site will be triggered and additional monitoring will be conducted to track and reduce pollutant impacts downstream.

Responsible Parties

Because all known significant metals sources are outside of Idaho, the allocation of load reductions is the responsibility of Montana DEQ.

Monitoring Strategy

Monitoring by the Tri-State Water Quality Council will continue to record levels of metals on a monthly basis and during peak flows in the mainstem Clark Fork River above and below Cabinet Gorge dam. In addition, monitoring by other entities occurs periodically. This includes a Clark Fork/Pend Oreille monitoring program by the Army Corps of Engineers implemented during 2005-2006. Because of public interest in the potential impacts of additional mining activity in Montana and the removal of Milltown dam, the Idaho legislature funded DEQ to conduct additional monitoring of biological parameters in the Lower Clark Fork River from 2006-2008 to determine baseline metals levels, in addition to water column sampling. This information will be used to evaluate TMDL targets and will help define baseline levels.

5.1B Temperature In-stream Water Quality Targets

For the Lower Clark Fork Subbasin tributary temperature TMDLs we utilize a potential natural vegetation (PNV) approach. According to Idaho Water Quality Standards, if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered to be a violation of water quality standards (IDAPA 58.01.02.200.09). In these situations, natural conditions essentially become the water quality standard, and the natural level of shade and channel width become the target of the TMDL. By using the PNV approach, the in stream temperature which results from attainment of PNV conditions is consistent with the water quality standards, even though it may exceed numeric temperature criteria. See Appendix E for further discussion of water quality standards and background provisions. The PNV approach is described below. Additionally, the procedures and methodologies to develop PNV target shade levels and to estimate existing shade levels are described in this section. For a more complete discussion of shade and its affects on stream water temperature, the reader is referred to the South Fork Clearwater Subbasin Assessment and TMDL (DEQ 2004).

Potential Natural Vegetation Method

There are a several important contributors of heat to a stream including ground water temperature, air temperature and direct solar radiation (Poole and Berman 2001). Of these, direct solar radiation is the source of heat that is most likely able to be controlled or manipulated. The parameters that affect or control the amount of solar radiation hitting a stream throughout its length are shade and stream morphology. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high banks. Stream morphology affects how closely riparian vegetation grows together and water storage in the alluvial aquifer. Streamside vegetation and channel morphology are the factors influencing shade which are most likely to be impacted by anthropogenic activities, and which can be most readily addressed by a TMDL.

Depending on how much vertical elevation surrounds the stream, vegetation further away from the riparian corridor can provide shade. However, riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity. We can measure the amount of shade that reaches a stream in a number of ways. Effective shade, that shade provided by all objects that intercept the sun as it makes its way across the sky, can be measured in a given spot with a solar pathfinder or with optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and the stream's aspect. In addition to shade, canopy cover is a similar parameter that affects solar radiation. Canopy cover is the vegetation that hangs directly over the stream, and can be measured using a densiometer, or estimated visually either on site or on aerial photography. All of these methods tell us information about how much the stream is covered and how much of it is exposed to direct solar radiation.

Potential natural vegetation along a stream is the shade produced by an intact riparian plant community that has grown to its fullest extent and has not been disturbed or reduced in anyway. The riparian vegetation can be removed by disturbance either naturally (wildfire, disease/old age, wind-blown, wildlife grazing) or anthropogenically (domestic livestock grazing, vegetation removal, logging, streambank failure due to erosion). The idea behind PNV as targets for temperature TMDLs is that PNV provides a natural 'mature state' level of solar loading to the stream. Any less shade than that provided by PNV results in an increase in water temperatures from either naturally created or anthropogenically created additional solar inputs. We can estimate PNV shade from models of plant community structure (shade curves for specific riparian plant communities), and we can measure existing vegetative cover or shade. Comparing the two will tell us how much excess solar load the stream is receiving, and what potential there is to decrease solar gain. Streams that have been disturbed by human activity may require additional restoration above and beyond natural recovery (e.g., addition of biologs or other restoration efforts that supplement natural recovery).

Existing shade or cover was estimated for all the major water bodies seen on a 1:100K hydrography from visual observations of aerial photos. These estimates were field verified by measuring shade with a solar pathfinder at systematically located points along the streams (see below for methodology). PNV targets were determined from an analysis of probable vegetation at the creeks and comparing that to shade curves developed for similar vegetation communities in other TMDLs. A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, the shade decreases as the vegetation has less ability to shade the center of wide streams. As the vegetation is taller, the more shade the plant community is able to provide at any given channel width.

Existing and PNV shade were converted to solar load from data collected on flat plate collectors at the nearest National Renewable Energy Laboratory (NREL) weather stations collecting these data. In this case, an average of the Spokane, WA and Kalispell, MT stations was used. The difference between existing and potential solar load, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards (see Appendix F). PNV shade and loads are assumed to be the natural condition, thus stream temperatures under PNV conditions are assumed to be natural (so long as there are no point sources or any other anthropogenic sources of heat in the watershed), and are thus considered to be consistent with Idaho water quality standards, even though they may exceed numeric temperature criteria.

Solar Pathfinder Methodology

The solar pathfinder is a device that allows one to trace the outline of shade producing objects on monthly solar path charts. The percentage of the sun's path covered by these objects is the effective shade on the stream at the spot that the tracing is made. In order to adequately characterize the effective shade on a reach of stream, ten traces should be taken at systematic or random intervals along the length of the stream in question.

At each sampling location the solar pathfinder should be placed in the middle of the stream about one foot above the water or at a level consistent with the bankfull water line. Follow the manufacturer's instructions (orient to true south and level) for taking traces. Systematic sampling is easiest to accomplish without biasing the location of sampling. To systematically choose sampling locations, start at a unique location such as 100 m from a bridge or fence line and then proceed upstream or downstream stopping to take additional traces at fixed intervals (e.g. every 100m, every half-mile, every degree change on a GPS, every 0.5 mile change on an odometer). Points of measurement also can be randomly located by generating random numbers to be used as interval distances.

It is a good idea to take notes while taking solar pathfinder traces, and to photograph the stream at several unique locations, paying special attention to changes in riparian plant communities and noting the plant species present (the large, dominant, shade producing ones).

Existing Shade Estimation

Aerial photo interpretation is used to estimate existing shade cover on a stream. Canopy coverage estimates or expectations of shade based on plant type and density are provided for natural breaks in vegetation density, marked out on a 1:100K hydrography. Each interval is assigned a single value representing the bottom of a 10% canopy coverage or shade class as described below (adapted from the CWE process, IDL 2000). For example, if we estimate that canopy cover for a particular stretch of stream is somewhere between 50% and 59%, we assign the value of 50% to that section of stream. The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and the width of the stream. The typical vegetation type (below) shows the kind of landscape a particular cover class usually falls into for a stream 5 m wide or less. For example, if a section of a 5 m wide stream is identified as 20% cover class, it is usually because it is in agricultural land, meadows, open areas, or clearcuts. However, that does not mean that the 20% cover class cannot occur in shrublands and forests, because as we look at wider sections of stream, it may.

Existing Cover Class Category	Typical vegetation type on 5m wide stream
0 = 0 – 9% cover	agricultural land, denuded areas
10 = 10 –19%	ag land, meadows, open areas, clearcuts
20 = 20 – 29%	ag land, meadows, open areas, clearcuts
30 = 30 – 39%	ag land, meadows, open areas, clearcuts
40 = 40 – 49%	shrublands/meadows
50 = 50 – 59%	shrublands/meadows, open forests
60 = 60 – 69%	shrublands/meadows, open forests
70 = 70 – 79%	forested and headwaters areas
80 = 80 – 89%	forested and headwaters areas
90 = 90 –100%	forested and headwaters areas

By assigning the low value in the range of cover estimates when calculating existing solar load provided to the stream, a conservative estimate of existing shade is applied to the stream.

It is important to note that the visual estimates made from the aerial photos are of canopy cover, not shade. DEQ assumes that canopy coverage and shade are similar based on research conducted by Oregon DEQ (OWEB 2001). The visual estimates of shade in this TMDL were field verified with a solar pathfinder. The pathfinder measures effective shade and takes into consideration other physical features that block the sun from hitting the stream surface (e.g. hillsides, canyon walls, terraces, man-made structures). The estimate of shade made visually from an aerial photo does not always take into account topography or any shading that may occur from physical features other than vegetation. However, research has shown that shade and cover measurements are remarkably similar (OWEB 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade.

Stream Width Determination

Stream morphology, the form and structure of a stream, impacts function of a stream. The width of the steam is one characteristic of its morphology. Measures of existing bankfull width or near stream disturbance zone width may not reflect widths that were present under PNV conditions. As impacts to streams and riparian areas occur, width-to-depth ratios tend to increase as streams become wider and shallower. Shadow length produced by vegetation covers a smaller percentage of the water surface in wider streams. Widened streams can also have less vegetative cover if shoreline vegetation has been eroded away.

Shade target selection, which involves evaluating the amount of shade provided at PNV conditions, necessitates determination of natural stream widths as well. In this TMDL appropriate stream widths for shade target selection were determined from analysis of existing stream widths and the relationship between drainage area and bankfull width on regional curves (Rosgen 1996).

The only factor not developed from the aerial photo work is channel width (i.e., Near Stream Disturbance Zone or Bankfull Width). Accordingly, this parameter must be estimated from available information. DEQ uses two known relationships of width and drainage area to estimate bankfull width from drainage area size. The first figure (Figure 11) was developed by Peter Lienenbach of EPA for the Crooked Creek TMDL (IDEQ 2002). This figure was consulted where existing width-depth data were available as a check on estimates created using the Salmon River curve in Figure 12. Figure 12 is a combination of regional curves published by various researchers and combined by Rosgen (1996).

For each stream evaluated in the loading analysis, natural bankfull width is estimated based on drainage area using Figure 12. Additionally, existing width is evaluated from available data. If the stream’s existing width is wider than that predicted by these two figures, then the figure estimate of natural bankfull width is used to calculate target loading, while the measured, existing width is used to calculate the existing temperature load. If existing width was not available, existing temperature loads were calculated assuming existing width was equivalent to natural width.

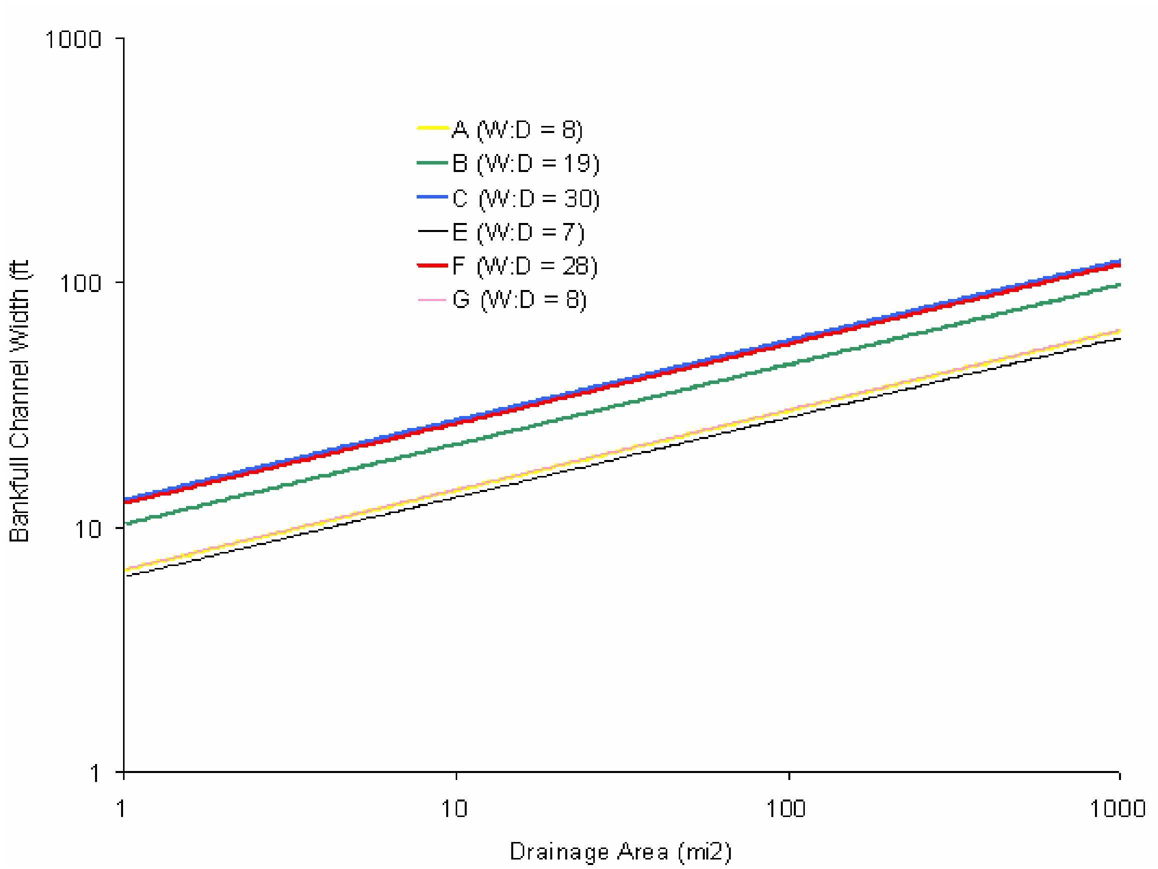

Figure 11. Bankfull Width as a Function of Width to Depth Ratio and Drainage Area.

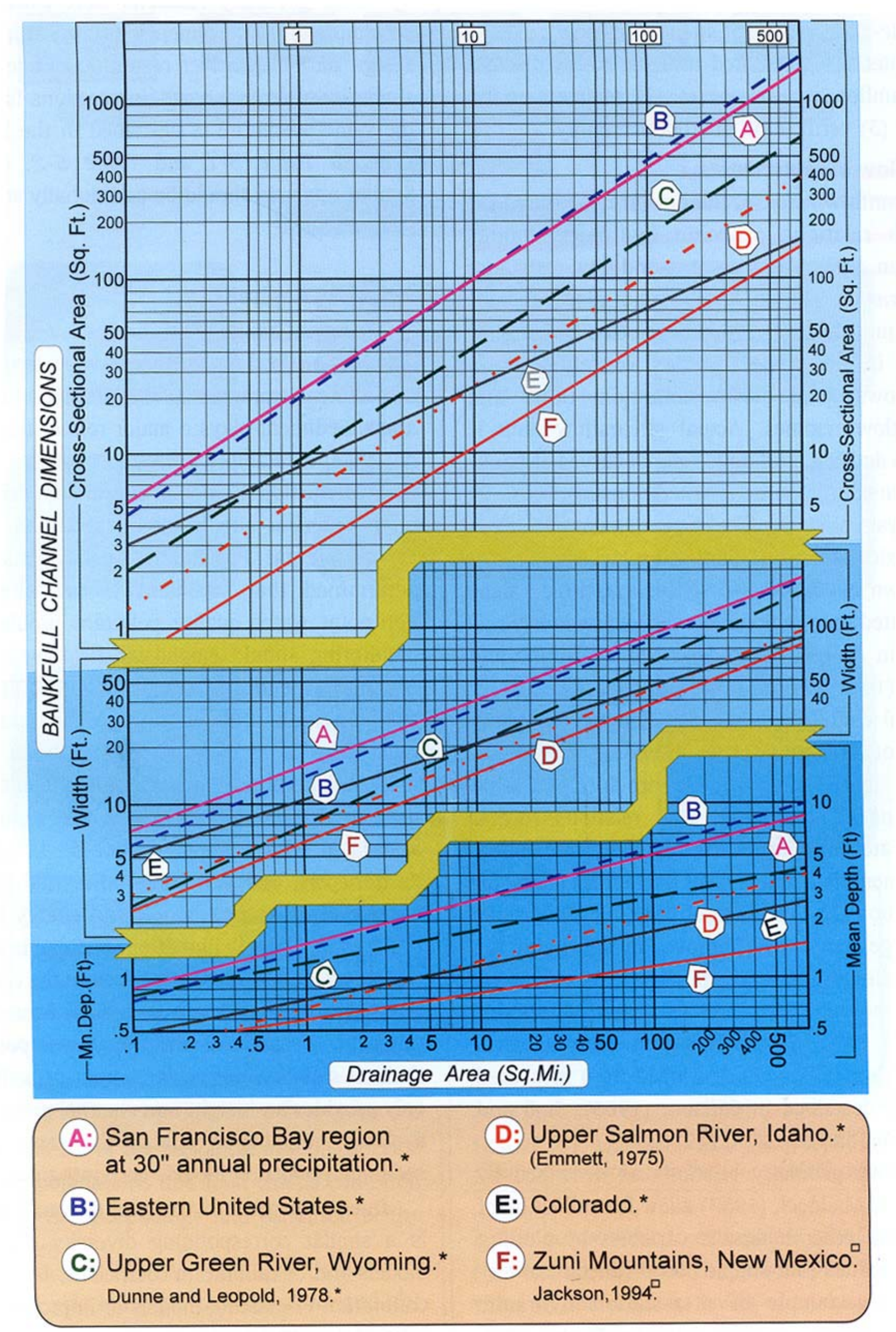

Figure 12. Bankfull Channel Dimensions as a Function of Drainage Area (Rosgen 1996).

Regional drainage area curves representing the Lower Clark Fork River were not available at the time this TMDL was developed. Of the curves available, the Upper Salmon River Basin curve best reflected the geology and precipitation of the Lower Clark Fork drainage. Based on available historic information and a nearby reference stream, IDEQ determined that the Upper Salmon River curve underestimated the natural stream width. By applying the Upper Salmon River curve to Trestle Creek, a neighboring watershed considered to be fully supporting its beneficial uses and a recommended reference condition stream by the Watershed Advisory Group, a 35% correction factor for the Upper Salmon River basin curve was created. Natural stream widths were first determined for all streams from regional curves available from the Upper Salmon River basin in central Idaho. Then upper Trestle Creek in the adjacent Pend Oreille subbasin was used as an example of near natural conditions to test the regional curve estimates. Stream widths were estimated from regional curves for Trestle Creek and compared to existing stream width data for Trestle Creek. The rating curve estimates were consistently 35% lower than actual stream widths in Trestle Creek. Therefore, natural stream widths for all streams in the Lower Clark Fork analysis determined by the Upper Salmon River curve were corrected by increasing each estimate by 35% to better reflect conditions consistent with Trestle Creek.

Resulting natural stream widths on the forested tributaries vary from 2 m wide in the headwaters to 54 m wide at the mouth of Lightning Creek. (Note: Existing stream widths at the mouth of Lightning Creek may be as high as 180 m.) Tributary streams in the lowland areas (primarily on the south side of the Clark Fork River) have natural stream widths that vary from 7 m where forested tributaries enter lowlands to 40 m at backwater areas adjacent to Lake Pend Oreille.

Design Conditions

Forested Tributaries

The forest tributaries include the Lightning Creek drainage, the Johnson Creek drainage, Gold Creek, West Fork Blue Creek, Dry Creek, and the upper portions of Twin Creek, Derr Creek, Mosquito Creek, and an unnamed tributary near Cabinet. Soils are assumed to be primarily glacial tills with finer grained glaciofluvial or glaciolacustrine deposits in valley bottoms and lower slope reaches (PWA 2004). The soil survey of Bonner County suggests that the bulk of the soils on lower slopes are of the Pend Oreille-Treble complex on deep, well drained rolling to steep foothills and mountainsides, although other soils such as Colburn and Capehorn on glacial outwash, alluvial and low floodplain terraces may occur at lower elevations (Weisel 1982). The soil survey suggests that the vegetation type was based on mixed conifer species such as western red cedar (*Thuja plicata*), western white pine (*Pinus monticola*), grand fir (*Abies grandis*), and Douglas fir (*Psuedotsuga menziesii*) (Weisel 1982). Other conifers such as western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*) and ponderosa pine (*Pinus ponderosa*) may be locally important. PWA (2004) indicated that riparian areas and floodplains throughout the lower Pend Oreille basin historically supported old growth stands of western redcedar. In Lightning Creek, at lower elevations the dominant species is western hemlock (*Tsuga heterophylla*) with western redcedar in moist to wet areas and grand fir on dry, warm slopes (PWA 2004). Black cottonwood (*Populus trichocarpa*) and western white pine were also locally important. At higher elevations in the watershed, subalpine fir (*Abies lasiocarpa*) and mountain hemlock (*Tsuga mertensiana*) were dominant (PWA 2004). Shrub communities in riparian areas were dominated by alders (*Alnus spp*.) and willows (*Salix spp*.) (PWA 2004).

One mixed conifer (western red cedar and others) vegetation type is assumed for all forested tributaries with the exception of several small forest meadows on Gold Creek, which are addressed separately. The WAG asked that the model incorporate the difference in growth potential and species composition by elevation. The USFS identified this transition point between "high elevation forest" and "low elevations forest" communities to occur at about 4000 feet elevation in the Lower Clark Fork Subbasin.

Lower Clark Fork River and Associated Low Gradient Stream Sections

The predominant soils along the Lower Clark Fork River are (from east to west): Pend Oreille silt loam; Bonner silt loam; and Colburn very fine sandy loam (Weisel 1982). Of these, only the Colburn soil has any agricultural value. Other soils represented in this area in smaller patches include Mission, Vay, Hoodoo, Treble, and Wrencoe. With the exception of Hoodoo soils which may have been largely meadow grass dominated, all of these soils were likely dominated by conifers such as western red cedar, western white pine, grand fir, and Douglas fir.

It is not known to what extent deciduous vegetation like cottonwoods or alders played a role in the natural riparian vegetation along the Lower Clark Fork River. Many of the low lying areas along the Clark Fork that have been cleared for hay and pasture or other uses tend to have dense, deciduous shrubby vegetation returning to riparian areas that may preclude the development of coniferous vegetation (Weisel 1982).

A forest/shrub vegetation type with a mixture of deciduous and conifer vegetation is assumed for the lowland areas of several tributaries (e.g. Twin, Derr, and Mosquito Creeks). Along the Lower Clark Fork River mixed deciduous/conifer forest vegetation type is assumed to be natural. The river may originally have been bordered by conifers, however heights and densities, and thus shade, are likely to be similar for a mixed forest type as well.

Target Selection

To determine potential natural vegetation shade targets for all streams, effective shade curves from the South Fork Clearwater River TMDL were examined. From the available shade curves, those produced for the South Fork Clearwater River were chosen as targets because vegetation communities were considered most similar to the Lower Clark Fork River basin by the WAG. For the forested tributary vegetation type described above, curves for the most similar vegetation type by elevation were selected for shade target determinations. Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis. As a stream becomes wider, a given vegetation community provides less shade. For the forest/shrub mix, an average of four shade curves from vegetative communities that have growth patterns representative of communities in the Lower Clark Fork were selected and averaged to represent the forest/shrub community.

The effective shade calculations are based on a six month period from April through September. This coincides with the critical time period when temperatures affect beneficial uses, which typically occur in April through June and again in September when spring and fall salmonids spawning temperatures criteria may be exceeded, and in July and August when cold water aquatic life criteria may be exceeded. Late July and early August typically represent a period of highest stream temperatures. Solar gains can begin early in the spring and affect not only the highest temperatures reached later on in the summer, but solar loadings affect salmonids spawning temperatures in spring and fall. Thus, solar loading in these streams is evaluated from spring (April) to early fall (September). While bull trout are known to spawn into October, the TMDL was created for the times when these streams are most likely to exceed temperature standards.

Forest Tributaries

Shade curves for the Lower Clark Fork Subbasin do not exist; therefore DEQ initially developed targets based upon an average of four shade curves to represent tree density and height similar to the community in the Subbasin. Over a series of meetings, the Watershed Advisory Group reviewed these average shade curve targets and recommended that the average approach was not accurately representing shade communities in this area. Therefore, the WAG recommended using two specific shade communities from the South Fork Clearwater River basin as representative of the higher elevation forested areas, and one for the lower elevation (below 4000 feet) forested areas. The effective shade curves used were:

1) Lower elevation forest (below 4000 feet): South Fork Clearwater River (IDEQ 2004) VRU 8 (stream breaklands, cedar and grand fir); and

2) Higher elevation forest (above 4000 feet): South Fork Clearwater River (IDEQ 2004) VRU 10 (uplands, alder, grand fir, and subalpine fir).

The shade curves used to derive the target shade values in the Lower Clark Fork Subbasin temperature TMDL were calculated by a computer model developed by the Oregon DEQ. This shade calculator uses trigonometric functions to calculate effective shade as a function of vegetation height and vegetation density with results varying according to stream aspect and channel width. A variety of terms are used to describe how density was determined including stream buffer width and buffer density, branch overhang, and community composition. Sometime overall stand density is given, and sometimes one has to infer density based on descriptions of these associated parameters.

There is considerable variation in the vegetation descriptions; however, the general trend is towards a mixed conifer community with possibly some local deciduous vegetation. In order to capture this grouping of species described above, the WAG and DEQ selected shade curves for communities that represent a range in heights and densities similar to the Lower Clark Fork Subbasin vegetation community. The two shade curves used to derive targets for the forested tributaries are described below in order of decreasing shade values for a given stream width.

1) Low elevation forested areas (below 4000 feet): Vegetation Response Unit #8 (VRU8) from the South Fork Clearwater TMDL was used. This plant community is described as being stream breaklands with cedar and grand fir. The dominant trees are grand fir and Douglas fir with other trees in the community including western larch, western redcedar, western white pine, Engelmann spruce, pacific yew, ponderosa pine, and lodgepole pine. This community is comprised of 30% large trees, 50% medium trees, and 20% non-forest type plants. Average height is derived

from a weighted averaging approach where the dominant species carry 80% of the weight and the other vegetation carries the remaining 20%. Branch overhang was determined by taking 10% of the overall weighted height. This overall height was not described, however, the average height used for grand fir was 148 feet and Douglas fir average height was 115 feet. With an 80% weighting towards these two species we suspect that the overall height would be near 100 feet.

2) High elevation forested areas (above 4000 feet): Vegetation Response Unit #10 (VRU10) from the South Fork Clearwater TMDL was used. This vegetation type is described as uplands, alder, grand fir and subalpine fir. The dominant tree species are grand fir, subalpine fir, Engelmann spruce, and sitka alder. The community is comprised of 25% large trees, 40% medium trees, 10% pole trees, and 25% non-forest vegetation. Average height for the dominant trees was 82 feet, overall weighted height is likely to be closer to 50 feet.

The resulting forested shade target development is shown below in Table 24.

Table 24. Effective Shade Targets for the Forest Tributaries Vegetation Type.

Effective Shade Curves	Stream Width (m)													
	2	4	5	8	10	12	14	18	19	21	24	28	40	54
Below 4000 feet Elevation (VRU 8)	95	92	89	85	81	75	72	65	63	58	56	49	40	31
Above 4000 feet elevation (VRU 10)	90	89	80	73	68	62	54	45	46	42	39	35	36	20

The forested meadow vegetation type occurred in one small area on Gold Creek, thus was not developed as a separate vegetation type. Stream widths in the area were relatively narrow and these areas would have received a 92% or 95% target based on the Forest Tributaries vegetation type and elevation. To compensate for the open meadow nature of these areas on Gold Creek the target was adjusted to 70% for those areas.

Forest/Shrub Mix

For the forest/shrub mix shade targets IDEQ averaged four shade curves to represent the density and height in the Lower Clark Fork lower elevation forest/shrub areas. The following curves were selected because they represent communities that have a higher deciduous vegetation component. They are listed in order from the highest shade producing community to the most open.

1) Mattole River TMDL – Douglas fir forest and mixed hardwood-conifer forest: This shade curve is representative of either a Douglas fir forest or a mixed hardwood-conifer forest both at 90% of potential height. The buffer height was 40m (131.2 ft) and the buffer width was 30m (98.4 ft.). Of the four shade curves examined for the LCF forest/shrub mix community this one has the highest and possible most dense forest canopy.
2) Walla Walla River Temperature TMDL – Deciduous-Conifer Zone: This particular plant community was dominated by quaking aspen, black cottonwood, mixed willow species, mixed alder species, and dogwoods for the deciduous component, and grand fir, Douglas fir, and ponderosa pine for the coniferous portion. Percent of stream

length with trees was reported at 100% with no accounting for natural disturbance. Tree heights varied from 22m (72 ft) to 28m (92 ft). Canopy density was set at 80%.

3) Qalf Geomorphic Province from the Willamette Basin TMDL: The Qalf province had 52% forest types ranging from ash/alder wetlands, black cottonwood forest, white oak forest, to Douglas fir forest with bigleaf maple and grand fir inclusions. Twenty eight percent (28%) of the vegetation types were savanna types that included white oak savanna, thinly timbered Douglas fir/white oak woodlands, and white oak/ponderosa pine savannas. The remaining 20% were prairie vegetation types including seasonally wet prairies and dry upland prairies. Average heights used included 70.6 feet for the forest, 72 feet for the savanna, and 3 feet for the prairie for a resulting overall average height of 57.5 feet. Stand density was set at 68%.
4) Alvord Lake Temperature TMDL – Black cottonwood-Pacific willow community: This particular community comes from the East Steens Mountain headwaters ecological province. Dominant species include black cottonwood, pacific willow, quaking aspen, Scouler's and other willows, and common snowberry. Overall average height was 40 feet and stand density was 80%. Because the curve presented in the TMDL only extended to 50-ft (15.3m) stream widths, no extrapolation was done to include it in the 40m stream width of the Lower Clark Fork TMDL.

The resulting shade targets for the forest/shrub mixed areas are presented in Table 25. While not precisely mimicking tree species in the Lower Clark Fork Subbasin, the four shade curves described above represent a range of plant community characteristics similar to forest/shrub plant communities in the Lower Clark Fork Subbasin. This range spans from a relatively tall and dense coniferous or coniferous/deciduous forest to a shorter all deciduous plant community. By averaging these curves, IDEQ is attempting to represent the range of conditions in the forest/shrub community areas of the Lower Clark Fork River. After averaging, target values were assigned similar to 10% class existing shade categories. (i.e., an average of 77 falls in the 70-79 class. While the low end of target class (70) was used in calculations, the actual target shade is somewhere between 70-79% shade.)

The forest/shrub vegetation type was applied on only a few stream segments in lower Mosquito Creek, Derr Creek, lower Twin Creek and on an unnamed tributary near the Montana border.

Table 25. Effective Shade Targets for the Forest/Shrub Mix Vegetation Type.

Effective Shade Curves	Stream Width (m)			
	7	8	11	40
Alvord Lake	62	64	51	-
Walla Walla	86	85	78	25
Mattole River	91	89	86	31
Willamette	67	65	53	23
Target Class	**70**	**70**	**60**	**20**

Monitoring Points

Effective shade monitoring can take place on any reach and be compared to estimates of existing shade seen in Figure 13, Figure 16, and Figure 19 and presented numerically in

Appendix F. Those areas with the lowest existing shade estimates should be monitored with solar pathfinders to verify the existing shade levels and to determine progress towards meeting shade targets. It is important to note that many existing shade estimates have not been field verified, and may require adjustment during the implementation process. Stream segments for each change in existing shade vary in length depending on land use or landscape that has affected that shade level. It is appropriate to monitor within a given existing shade segment to see if that segment has increased its existing shade towards target levels. Five to ten equally spaced solar pathfinder measurements within that segment should suffice to determine new shade levels in the future. Clyne (2006) provides a sample pathfinder verification monitoring plan.

5.2B Temperature Load Capacity

The load capacity for a stream is the solar loading that would occur if potential natural vegetation was fully present. The shade targets are the load capacity, and are based on natural stream width estimates and the shade curves for the applicable vegetation community specified for the reaches within each stream. Shade targets are shown in Figure 14, Figure 17, and Figure 20. These loads are determined by multiplying the solar load to a flat plate collector (under full sun) for a given period of time by the fraction of the solar radiation that is not blocked by shade (i.e. the percent open or 1-percent shade). In other words, if a shade target is 60% (or 0.6), then the solar load hitting the stream under that target is 40% of the load hitting the flat plate collector under full sun.

We obtained solar load data for flat plate collectors from near by National Renewable Energy Laboratory (NREL) weather stations. In this case, an average of two NREL weather stations is used, one at Spokane, WA and the other at Kalispell, MT. The solar loads used in this TMDL are spring/summer averages, thus, we use an average load for the six month period from April through September. These months coincide with time of year that stream temperatures are increasing and when deciduous vegetation is in leaf.

Appendix F shows the calculated PNV shade targets (identified as Target or Potential Shade) and their corresponding potential summer load (in $kWh/m^2/day$ and kWh/day) that serve as the load capacities for the streams.

5.3B Estimates of Existing Pollutant Loads Temperature

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Since there are no known point sources of temperature on the tributaries modeled, wasteload allocations are zero. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads.

Existing loads in this temperature TMDL come from estimates of existing shade as determined from aerial photo interpretations shown in Figure 13, Figure 16, and Figure 19. Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat plate collector at the NREL weather stations. Existing shade data tables are presented in Appendix F. For example, existing shade on Lightning Creek varies from the 0-9% class at the mouth to 90-100% class in the headwaters (Table F-27). Existing shade on the remainder of the forested portions of tributaries generally varies from 60-69% class to 90-100% class (Tables F-1 through F-26). Existing shade for forest/shrub mix areas can vary anywhere from 0-9% to the 90-100% class (Tables F-18, F-23, F-24, and F-26).

The locations where solar pathfinder data were taken for field verification are shown on the tables in bold and italics in Appendix F. The field verification resulted in little changes in the overall existing shade estimates. The average of the solar pathfinder results was consistent with the average of the matching aerial photo estimates (Table 26). Only those stream sections where pathfinder data were taken were corrected based on that data. All other stream sections were assumed to average out, however, that does not preclude that some stream sections may have aerial photo estimates that are incorrect.

Table 26. Solar Pathfinder Field Verification Results.

	Initial Estimated Shade Class	Pathfinder Actual	Pathfinder Class	Difference
	70	67.9	60	10
	90	90.9	90	0
	80	56.9	50	30
	40	54.1	50	-10
	90	91.9	90	0
	80	86.9	80	0
	70	90.8	90	-20
	80	87.6	80	0
	0	7.1	0	0
	10	25.7	20	-10
	90	78.5	70	20
	10	50.3	50	-40
	90	73.3	70	20
	70	71.3	70	0
	60	68.4	60	0
Average	62	67	62	0

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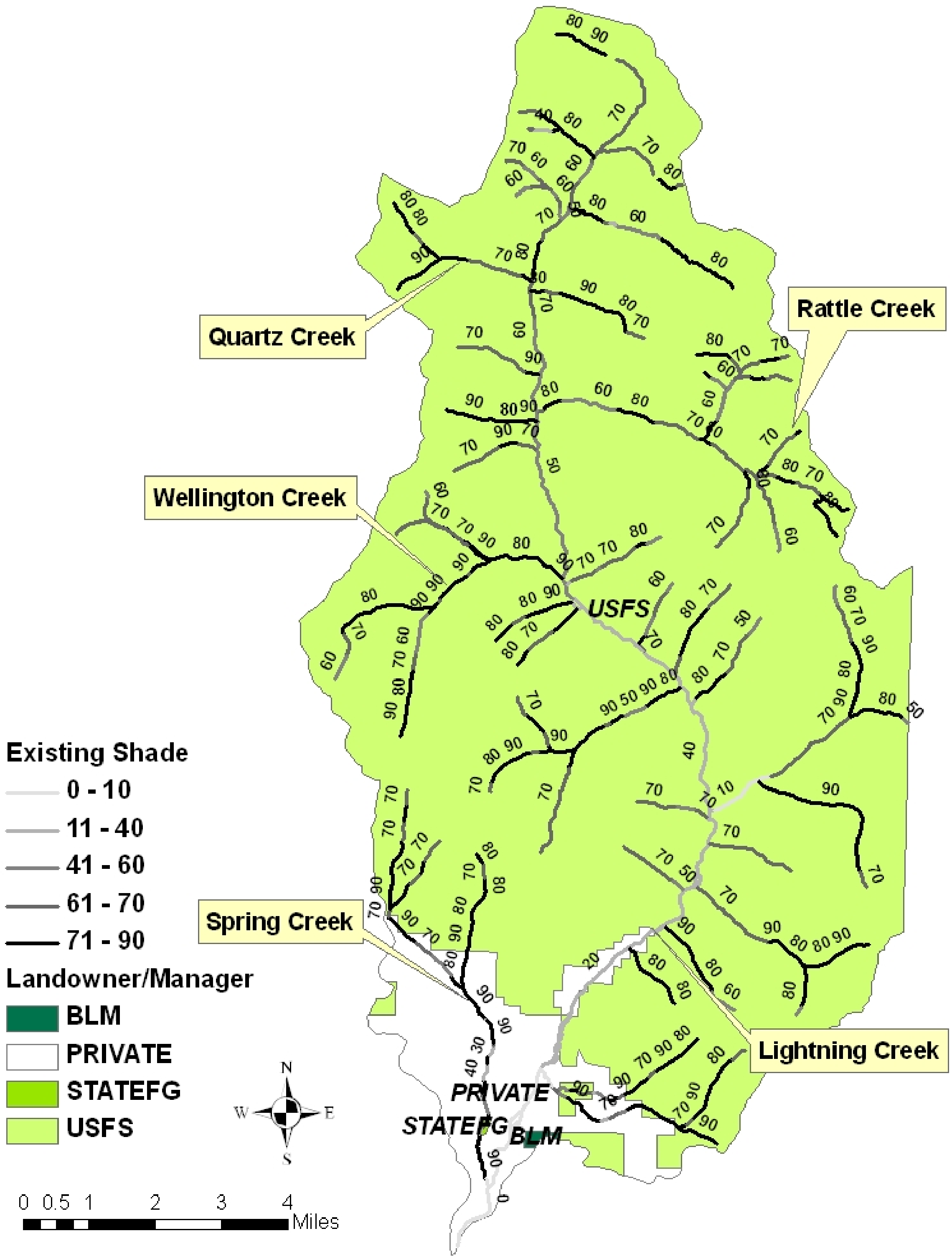


Figure 13. Estimated Existing Shade (%) in the Lightning Creek drainages.

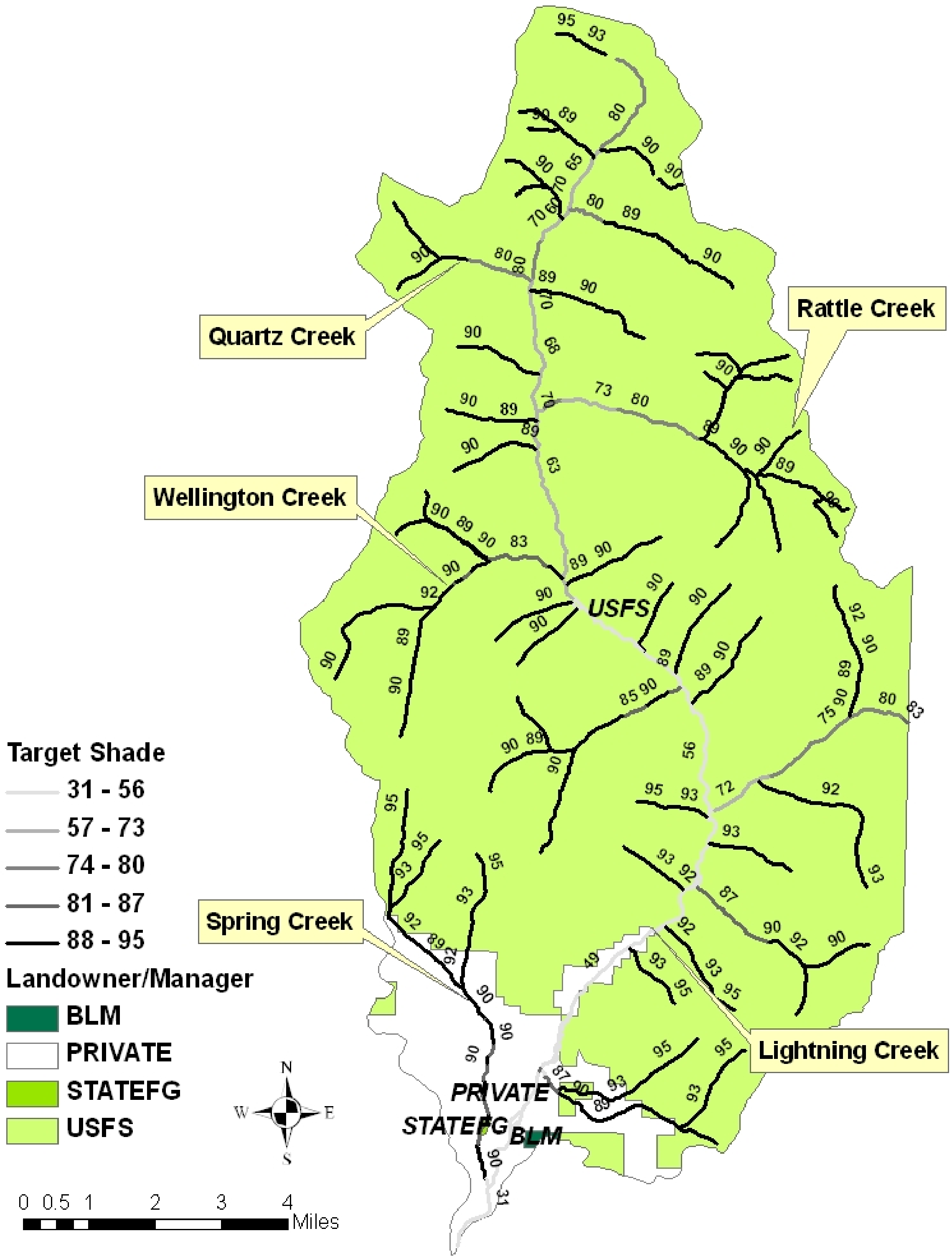


Figure 14. Target Shade (%) for the Lightning Creek Drainage.

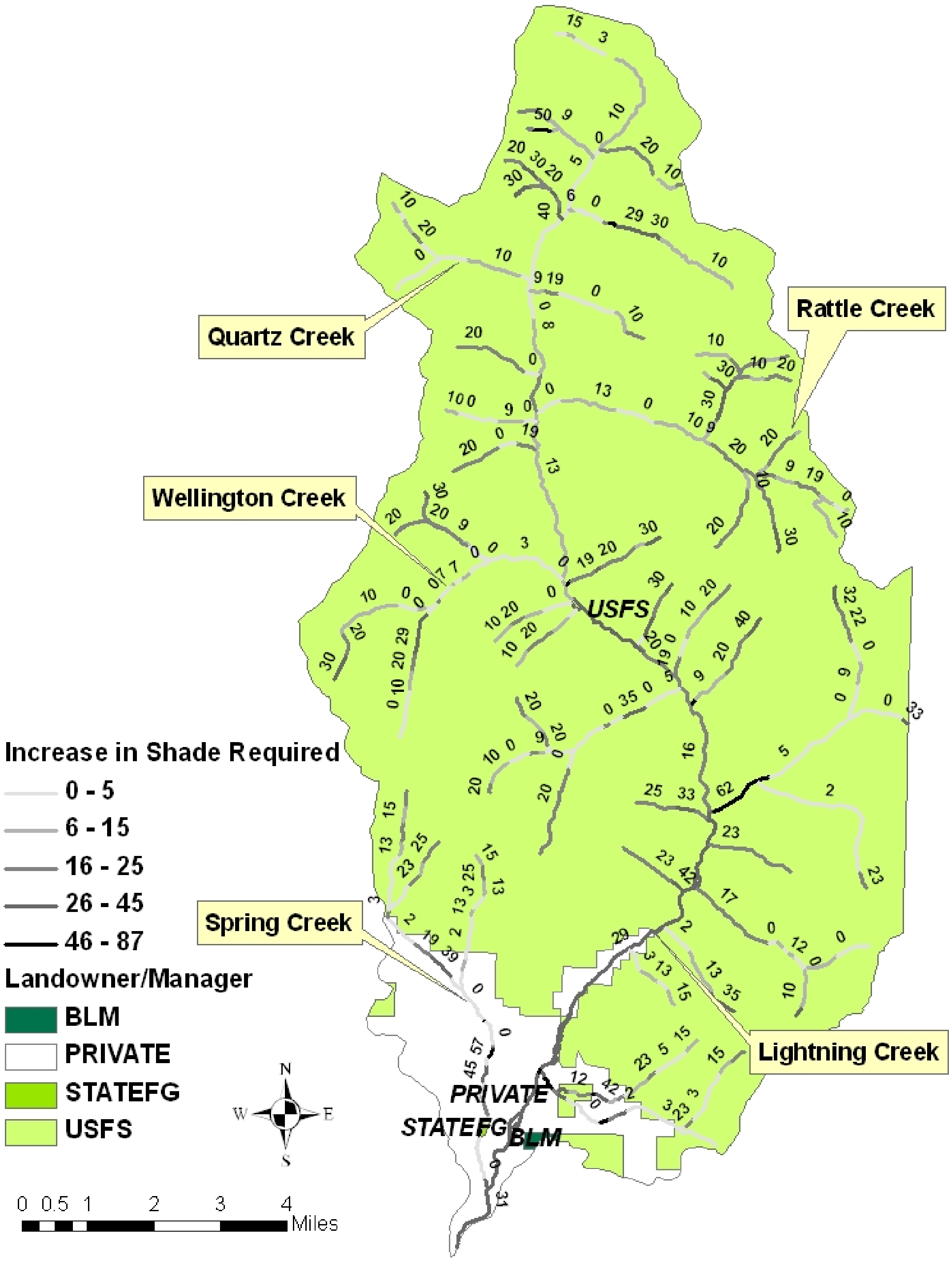


Figure 15. Estimated Increase in Shade (%) Required to Meet TMDL Targets in the Lightning Creek Drainage.

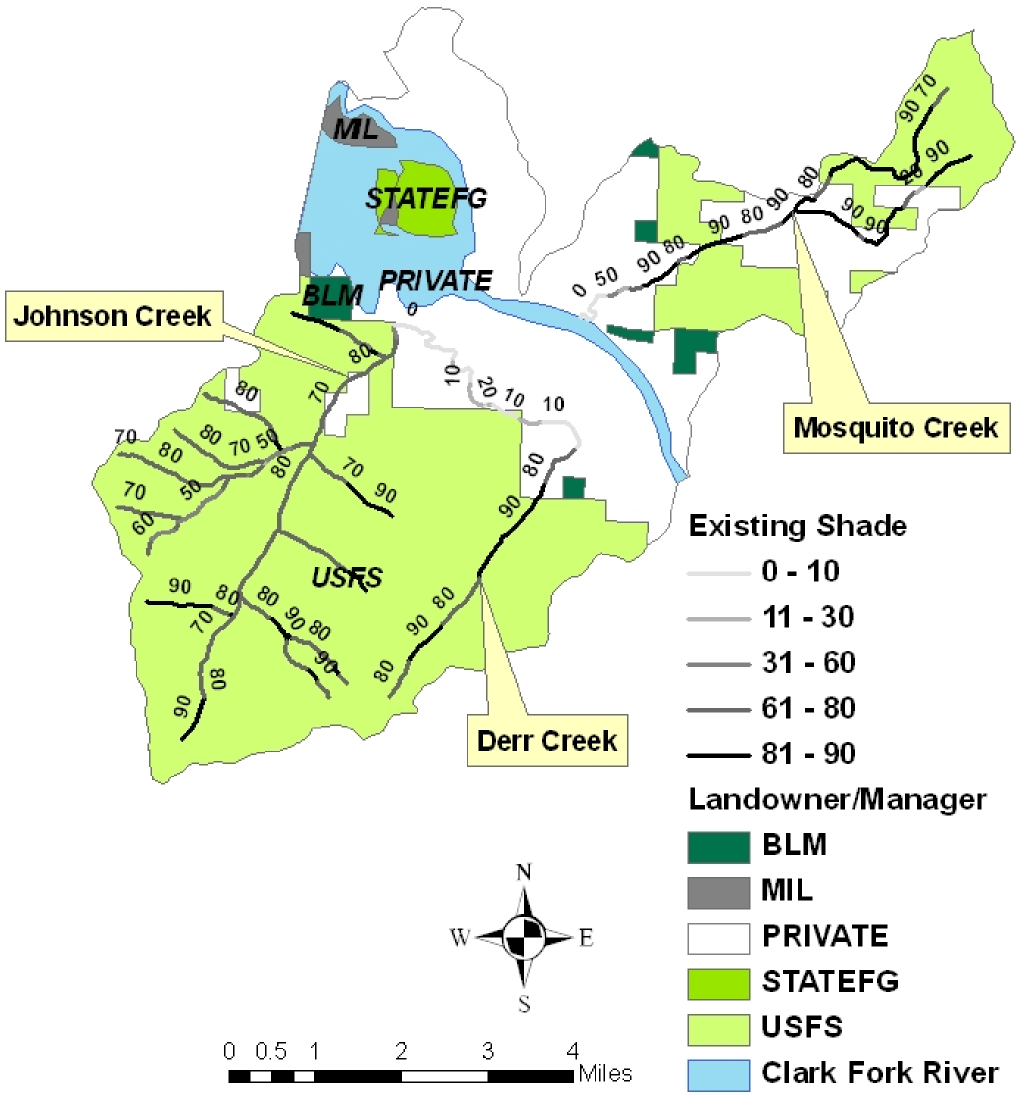


Figure 16. Existing Shade (%) Estimated Johnson Creek, Derr and Mosquito Creeks by Aerial Photo Interpretation.

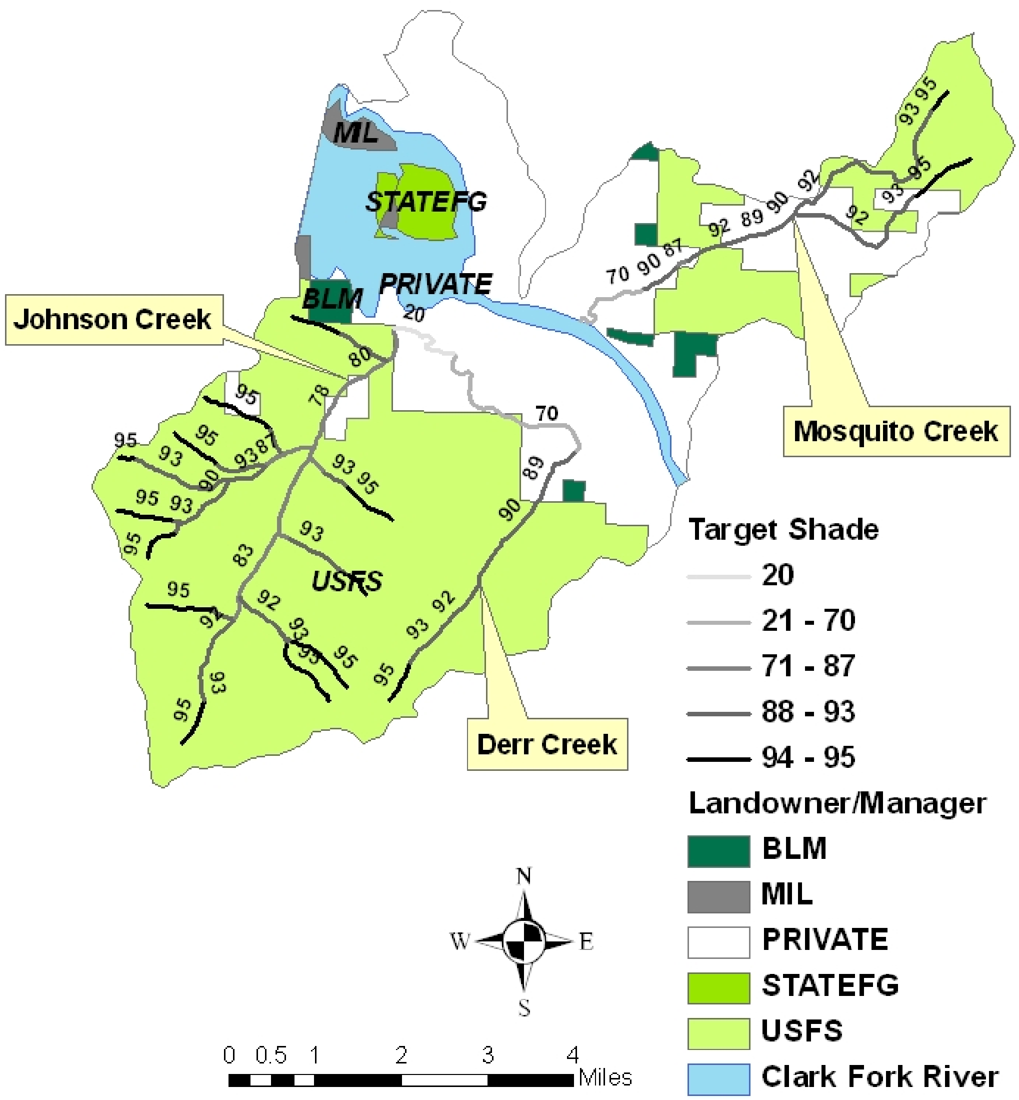


Figure 17. Target Shade (%) for Johnson, Derr and Mosquito Creeks.

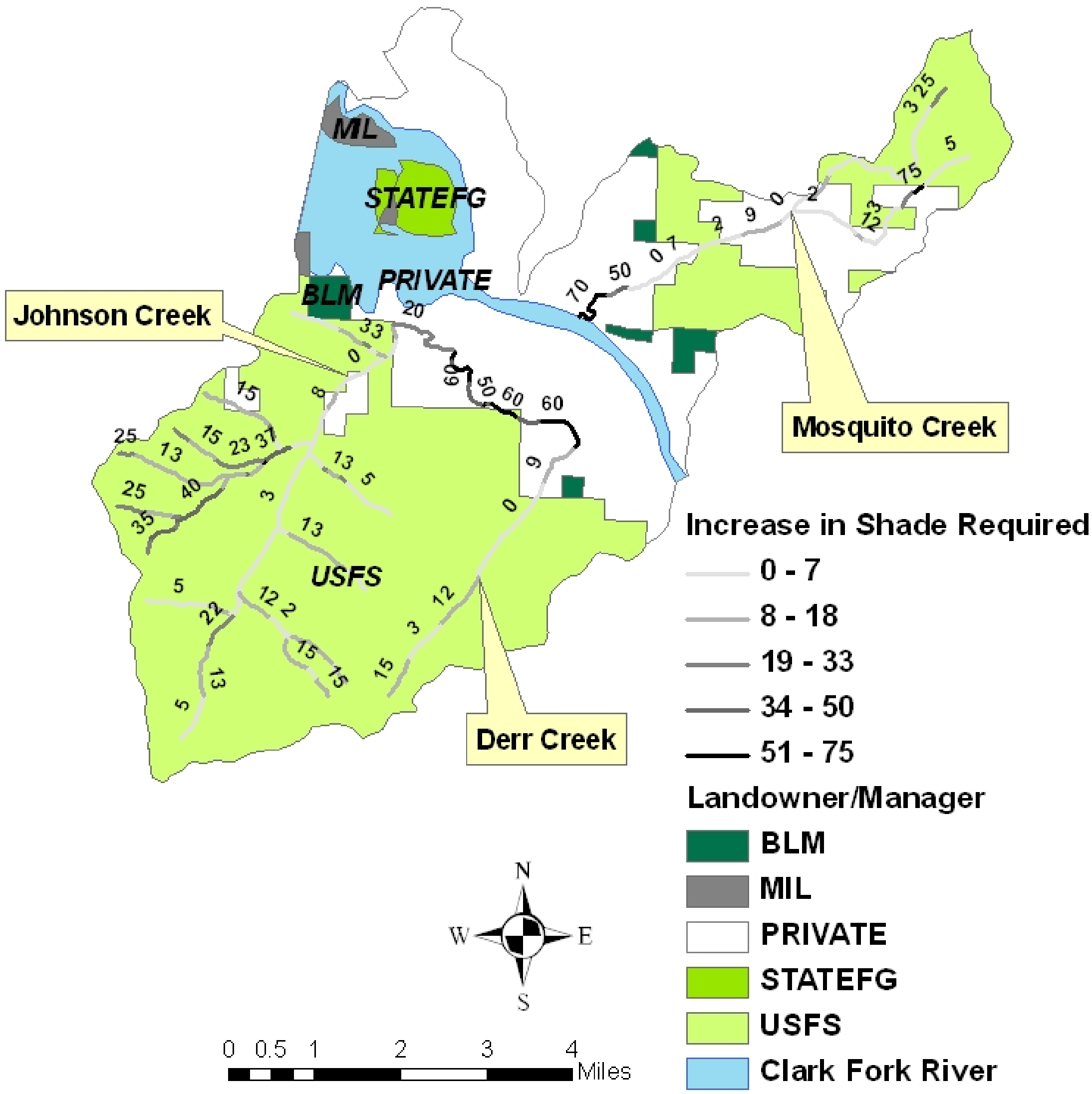


Figure 18. Estimated Increase in Shade (%) to Meet TMDL target in Johnson, Derr and Mosquito Creeks.

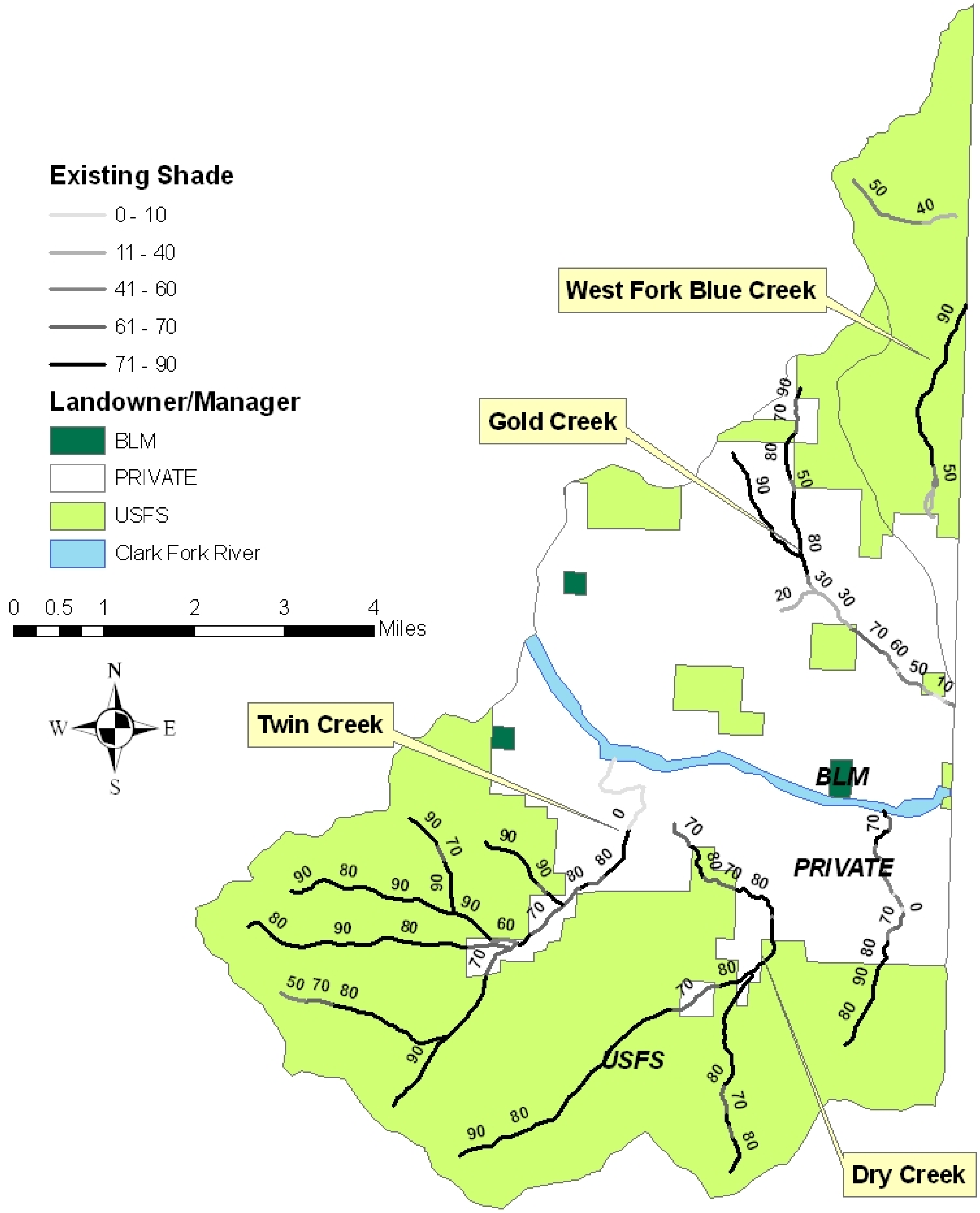


Figure 19. Existing Shade (%) Estimated for Twin, Gold and Dry Creeks by Aerial Photo Interpretation.

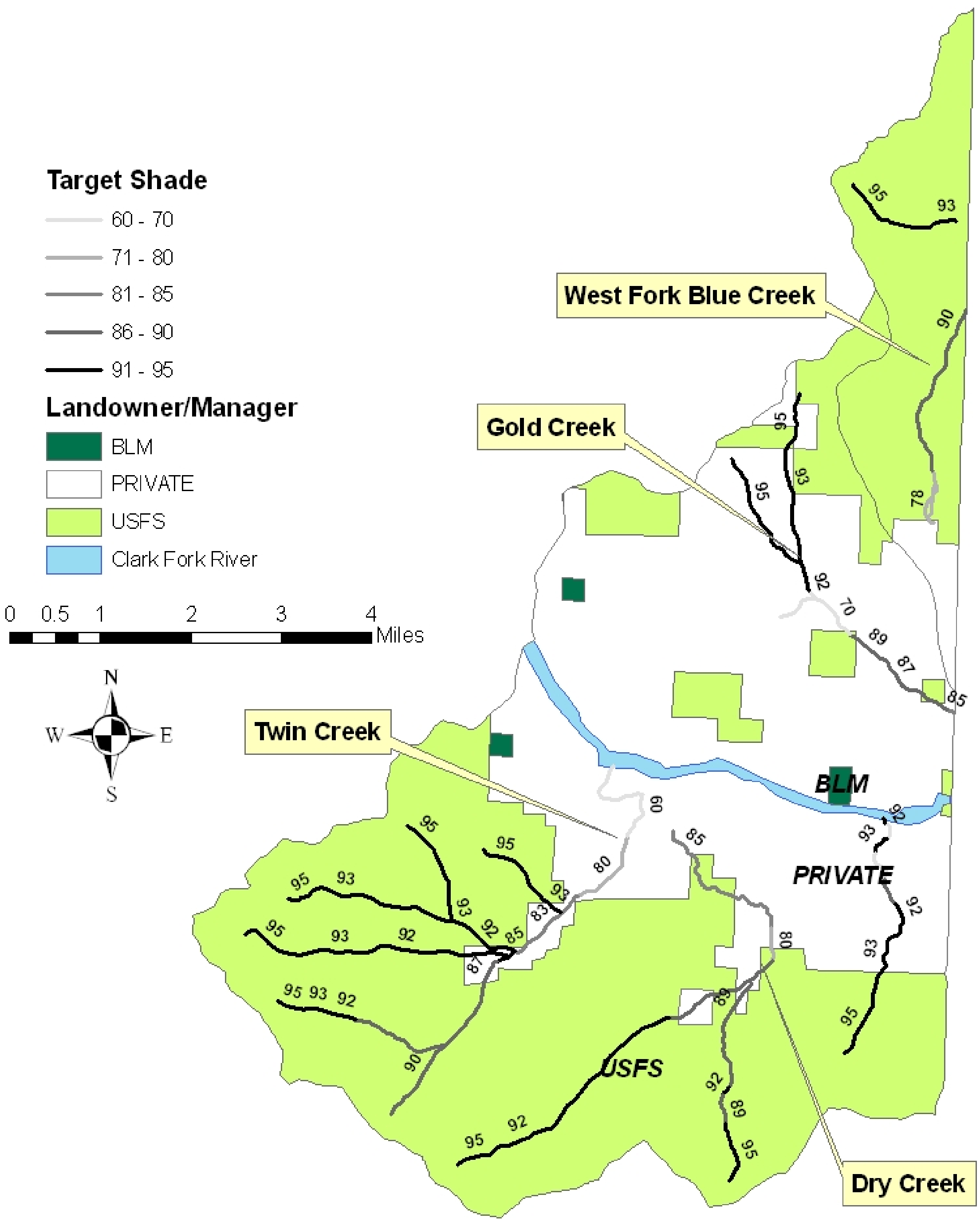


Figure 20. Target Shade (%) Estimated for Twin, Gold and Dry Creeks.

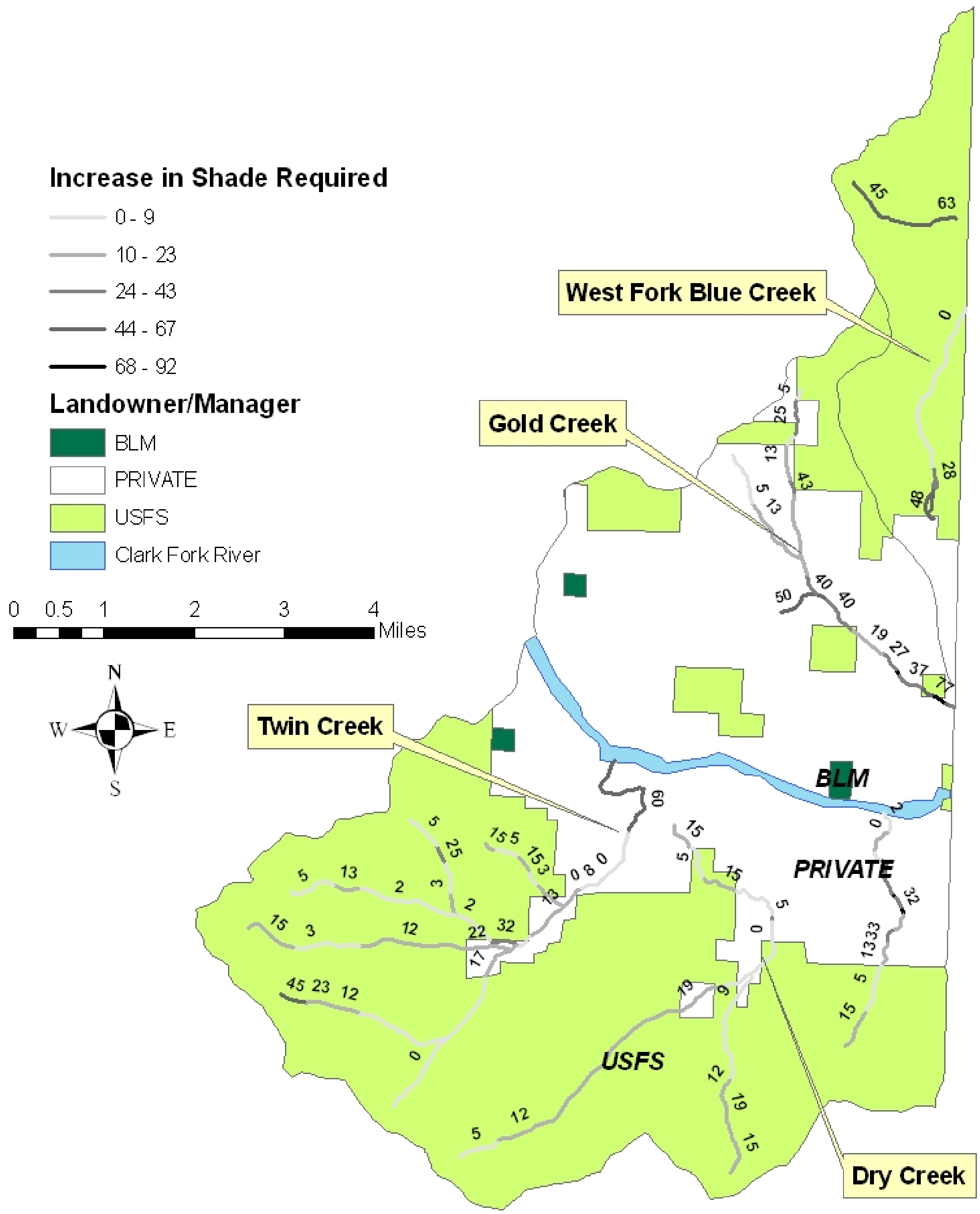


Figure 21. Estimated Increase in Shade (%) Needed to Meet Target for Twin, Gold and Dry Creeks.

5.4B Temperature Load Allocation

Because this TMDL is based on potential natural vegetation, which is equivalent to background loading, the load allocation equates to background shading conditions. However, in order to reach that objective, load allocations are assigned to nonpoint source activities that have or may affect riparian vegetation and shade. Load allocations are therefore stream reach specific and are dependent upon the target load for a given reach. Figure 15, Figure 18, and Figure 21 show the differences between existing shade estimates and target shade, which are equal to the estimated increase in shade needed to meet target shade levels. Appendix F shows the target or potential shade which is converted to a potential summer load by multiplying the inverse fraction (1-shade fraction) by the average loading to a flat plate collector for the months of April through September. That is the load capacity of the stream necessary to achieve background conditions. There is no opportunity to allocate shade removal to an activity.

All streams examined had excess solar loads and require reductions to achieve load capacity (Table 27 and Table 28). Because all streams vary in size, thee percent reduction does not necessarily reflect the amount of excess solar load received by the water body. The excess load to Lightning Creek is the largest at 4.8 million kWh/day, with a corresponding 64% reduction required (Table F-27). Conversely, the small headwaters tributaries (Gem, Gordon, Lunch Creeks) to Lightning Creek have some of the smallest excess loads yet their percent reductions are still in the 60-70% range.

Table 27. Excess Solar Load and Percent Reduction to Achieve Loading Capacity for the Lower Clark Fork River Tributaries.

Stream Name	Assessment Unit	Excess Load (kWh/day)	Percent Load Reduction Required
Derr Creek*	ID17010213PN001_02	183,840	30%
Twin Creek	ID17010213PN004_02 ID17010213PN004_03	124,344	51%
Dry Creek	ID17010213PN004_02a	38,830	48%
Gold Creek*	ID17010213PN008_02	73,635	67%
Mosquito Creek	ID17010213PN009_02	54,548	54%
Unnamed Tributaries near MT border*	ID17010213PN003_02 ID17010213PN006_02	21,606	55%
WF Blue Creek (ID only)*	ID17010213PN007_02	37,661	52%
West Johnson Creek	ID17010213PN002_02	36,571	73%
Johnson Creek	ID17010213PN002_03	33,147	30%

* These Assessment Units are not identified as impaired by temperature on the 2002 Integrated Report. The shade analysis was completed for advisory purposes only.

Lightning Creek has the highest excess load, which is influenced by its size, and relatively wide existing stream widths compared to estimated natural stream widths. The wider existing stream widths offer less potential for shade than would naturally occur, and therefore create a relatively large excess temperature load. The large difference between existing and natural stream widths creates relatively high temperature contributions to the stream.

Table 28. Excess Solar Load and Percent Reduction to Achieve Loading Capacity for Lightning Creek and Associated Tributaries.

Stream Name	Assessment Unit	Excess Load (kWh/day)	Percent Load Reduction Required
Mainstem Lightning Creek	ID17010213PN010_04 ID17010213PN011_04 ID17010213PN013_04 ID17010213PN016_03 ID17010213PN017_03 ID17010213PN019_03 ID17010213PN019_02	4,802,544	64%
Lunch Creek	ID17010213PN019_02	7,158	73%
Quartz Creek		5,352	27%
Moose Creek		12,140	52%
Gem Creek		5,830	66%
Gordon Creek		8,221	59%
Deer Creek		3,633	40%
Fall Creek		13,719	53%
Sheep Creek	ID17010213PN017_02		
Bear Creek			
Rattle Creek	ID17010213PN018_02	86,076	57%
Steep Creek	ID17010213PN016_02	30,101	61%
Jost Creek			
Mud Creek			
Silvertip Creek			
Trapper Creek			
Unnamed between Mud and Trapper Creeks			
Wellington Creek	ID17010213PN020_02	30,465	44%
Porcupine Creek	ID17010213PN016_02	36,545	58%
East Fork Creek	ID17010213PN014_02 ID17010213PN014_03	198,640	61%
Savage Creek	ID17010213PN015_02		
Morris Creek	ID17010213PN013_02	32,734	67%
Regal Creek		6,064	58%
Unnamed between East Fork And Morris Creeks		22,828	79%
Cascade Creek	ID17010213PN012_02	37,981	67%
Spring Creek*	ID17010213PN021_02	57,736	56%

* This Assessment Unit is not identified as impaired by temperature on the 2002 Integrated Report. The shade analysis was completed for advisory purposes only.

Other streams with substantial excess loads include Derr Creek, Twin Creek, East Fork Creek, Gold Creek, and Rattle Creek.

It is assumed that if shade targets shown in the previous figures are achieved on these water bodies, then excess loads will be reduced to zero and streams will be at background solar loads as expected under potential natural vegetation conditions. Nonpoint source activities in the subbasin are allocated by location in the water body, not by activity. Thus, each watershed needs to be examined for all activities that influence riparian conditions, and shade in particular.

This temperature loading analysis assumes there are no point sources in the affected watersheds. Thus, there are no wasteload allocations. Wasteload allocations for any existing or future point source discharge should be developed based on a mass balance approach. Thus, the permitted temperature of the discharge will depend on the volume of water discharged, the volume of the receiving water and applicable water quality standards. Should a point source that would have thermal consequence on these waters be proposed after shade targets are achieved, then background provisions addressing such discharges in Idaho water quality standards (IDAPA 58.01.02.200.09 & IDAPA 58.01.02.401.03) should be applied (see Appendix E). Because of the nature of the tributaries and a high percentage of public land, as well as the Special Resource Water designated use in Lightning Creek and the Lower Clark Fork River, it is highly unlikely that point sources that impact water temperature in these watersheds will occur.

Because existing shade estimates are done conservatively, reductions may be calculated in areas already meeting the target. Implementation (and verification) should be prioritized with this modeling anomaly in mind. For instance, in the headwaters of Lightning Creek existing shade is estimated in the 90-100% category and calculated using 90% shade coverage, but actual shade coverage is between 90-100%. The shade target for this area is 93%. A solar load decrease of 3% is calculated in the model, while on the ground, the target may be met. It is recommended that areas with greater than 20% difference between existing shade estimates and target shade by prioritized for verification and restoration efforts.

Margin of Safety

The margin of safety in this temperature TMDL is considered implicit in the design. Because the target is essentially background conditions, there are no loads allocated to sources or activities. Although the loading analysis used in this TMDL involves gross estimations that are likely to have large variances, there are no load allocations that may benefit or suffer from that variance. Also, wherever existing conditions were estimated to be higher than target shade levels, the existing conditions were assigned as the target.

Seasonal Variation

This temperature TMDL is based on average summer loads. All loads have been calculated to be inclusive of the six month period from April through September. This time period was chosen because it represents the time period when the combination of increasing air and water temperatures coincides with increasing solar inputs and increasing vegetative shade. The critical time period is June when spring salmonids spawning is occurring, July and August when maximum temperatures may exceed cold water aquatic life criteria, and

September during fall salmonid spawning. Water temperature is not likely to be a threat to beneficial uses outside of this time period because of cooler weather and lower sun angle.

5.5B Temperature Implementation Strategies

While there are many activities that can help reach TMDL shade targets such as riparian plantings and road relocation away from streams, protection of existing areas that meet the target may be one of the most achievable strategies. Re-growth in burned and previously harvested areas will also contribute to achieving temperature goals. Where existing stream widths are wider than natural stream widths, bank stabilization and movement toward sediment reduction goals will be necessary before target shade levels can be fully achieved.

Time Frame

The time frame for implementation of the temperature TMDLs is likely very long. Within 30 years, significant progress toward temperature reduction goals and re-growth of burned areas and historic clearcut areas will provide additional shade. Maintenance of target shade levels where they already exist will contribute to achieving TMDL targets at the earliest possible time.

Approach

TMDLs will be implemented through the continuation of ongoing pollution control activities in the Subbasin. The Watershed Advisory Group, Designated Management Agencies and other appropriate public processes, are expected to:

- Develop best management practices (BMP's) to achieve load allocations.
- Give reasonable assurance that management measures will meet load allocations through both quantitative analyses of management measures.
- Adhere to measurable milestones for progress.
- Develop a timeline for implementation, with reference to costs and funding.
- Develop a monitoring plan to determine if BMPs are being implemented, if individual BMPs are effective, if load allocations and waste load allocations are being met and whether or not water quality standards are being met.

The designated management agencies will recommend specific control actions and will then submit the implementation plan to DEQ. DEQ will act as a repository for approved implementation plans and conduct five year reviews of progress toward TMDL goals.

Responsible Parties

In addition to the designated management agencies, the public, through the WAG and other equivalent processes or organizations, will be provided with opportunities to be involved in developing the implementation plan.

Monitoring Strategy

Monitoring will be conducted using the DEQ approved monitoring procedure at the time of sampling. Designated management agencies and landowners are encouraged to work with DEQ to collect additional solar pathfinder data to both validate existing temperature load estimates and to monitor progress toward achieving TMDL targets.

5.1c Sediment In-stream Water Quality Targets

This sediment TMDL addresses sediment limited water bodies in the Lower Clark Fork River Subbasin. The goal of the sediment TMDL is to restore impaired water to "full support of designated beneficial uses" (Idaho Code 39.3611.3615). Specifically, sedimentation must be reduced to a level where full support of beneficial uses is demonstrated using the current assessment method accepted by DEQ at the time the water body is reassessed.

The sediment TMDL will develop loading capacities in terms of mass per area per unit time (tons/acre/year). Daily load targets are included in Appendix I. The interim goals will be set based on conditions in watersheds thought to be functioning and supportive of native fish populations. The final goal will be established when biomonitoring demonstrates full support of the cold water uses and positive trends in fisheries populations are seen. Sources contributing sediment can be reduced, but a substantial period (perhaps up to 100 years) will be required before beneficial use recovery is noticeable.

Design Conditions

Modeled sources of sediment to water bodies within the Lower Clark Fork River Subbasin are all nonpoint sources. This TMDL addresses the nonpoint sediment yield to surface water. Sediment from nonpoint sources is loaded episodically, primarily during high discharge events. High discharge events typically occur between November and May, but may not occur for several years. These events typically coincide with critical conditions. The typically return time of the largest events is 10-15 years.

Target Selection

Throughout the state, the load capacity rate at which full support is exhibited has been set at various levels in TMDLs developed by DEQ. These have ranged from setting an interim load capacity at the background level for some watersheds in the Coeur d'Alene Lake Subbasin and the Pend Oreille basin, to more that 200% above background in some areas of the state. Evidence suggests that a target of 54% above background is protective of the beneficial uses in the Idaho portions of the Lower Clark Fork River Subbasin. This target is consistent with load capacities of other Idaho Panhandle TMDLs.

Although it is well understood that streams have the ability to process sediment levels above natural background levels, it is not well understood to what level this is possible before impairment occurs. A multitude of options were explored when developing the sediment model and sediment target used in this TMDL. To determine the most appropriate target, each subbasin must be evaluated on an individual basis.

Sediment Model Development

A paired watershed approach was utilized in selecting the sediment target used in this section. Reference watersheds, watersheds supporting beneficial uses or those assumed to be biologically functioning, were selected using local knowledge, Watershed Advisory Group (WAG) input and a watershed analysis in the Lightning Creek drainage (PWA 2004). Headwater streams of Lightning Creek, Savage, Morris and Trestle Creek were selected as reference watersheds. Conditions in these watersheds are discussed in more detail in Appendix G.

To determine the existing sediment conditions all known sediment contributing land uses were identified and mapped. Stringent attempts were made to characterize all land use types by using satellite imagery, field verified GIS data, local knowledge and WAG input. Characterizing all known land use types will allow for land use specific allocations and help to guide implementation actions.

Once all desired land uses were mapped the area for each land use was determined using GIS. Sediment yield coefficients were then applied to the appropriate land use and multiplied by the associated acreage. A pre-anthropogenic value was determined by multiplying the acreage of the watershed by the natural background sediment coefficient. Percentage above natural background was derived by determining the difference between current condition and natural conditions divided by natural conditions. Percentage above natural background values for reference conditions were then comparable to adjacent watersheds within the basin.

The current sediment yield condition (percentage above natural background) of the reference watersheds were analyzed to determine the most appropriate sediment yield target for the Lower Clark Fork River Subbasin. Once the sediment yield target was selected, all other sub-watersheds within the Lower Clark Fork River Subbasin were analyzed to determine sediment yield reductions.

The sediment yield target was derived from percentile categories of the reference condition, a process similar to the one used to determine stream macroinvertebrate index scores (Grafe et al. 2002). The seventy-fifth percentile of reference conditions was chosen as the sediment target. The target used is 54% above background. Refer to Appendix G for further discussion on sediment model development.

Monitoring Points

The points of compliance for watersheds exceeding the sediment target are listed in Table 29. Beneficial use support status will be determined using the current assessment methodology accepted by DEQ at the time the water body is assessed. Monitoring will be completed using BURP protocols and DEQ will utilize redd counts and other habitat assessments by the IDFG and the USFS to help assess support status of beneficial uses. When the final sediment load capacity is determined by these appropriate measures of full cold water aquatic life support, the TMDL will be revised to reflect the established supporting sediment yield, if necessary.

Table 29. Points of compliance for sediment limited watersheds in the Lower Clark Fork River Subbasin.

Stream name	Assessment unit	Point of Compliance (Previous BURP location)
Lightning Creek & East Fork Creek	ID17010213PN010_04 ID17010213PN011_02 ID17010213PN011_04 ID17010213PN013_02 ID17010213PN013_04 ID17010213PN016_02 ID17010213PN016_03 ID17010213PN017_02 ID17010213PN017_03 ID17010213PN019_02 ID17010213PN019_03	Near USGS gaging station in Lower Lightning Creek
Johnson Creek	ID17010213PN002_02 ID17010213PN002_03	2001SCDAA049
Twin Creek	ID17010213PN004_02 ID17010213PN004_03	1995SCDAA055
Quartz Creek	ID17010213PN019_02	Near confluence with Lightning Creek
Wellington Creek	ID17010213PN020_02	1997SCDAA041
Rattle Creek	ID17010213PN018_02	1995SCDAB019

5.2 c Load Capacity Sediment

The load capacity of a TMDL designed to address sediment caused water quality impairment is complicated by the fact that the state's water quality standard is a narrative standard rather than a quantitative standard. Sediment interfering with beneficial uses is most likely large bed load material within waters of the Lower Clark Fork River Subbasin. Adequate quantitative measurements of the effect of excess sediment have not been developed. Given this difficulty, an exact sediment load capacity for the TMDL is difficult to ascertain. Attempts to model sediment yield within the basin are designed to achieve relative rather than exact sediment estimates.

The natural background sediment rate is the sediment yield within a watershed prior to anthropogenic influences. It was calculated by multiplying watershed acres by the natural background coefficient. The natural background sediment yield coefficient applied within the Lower Clark Fork River Subbasin was developed assuming a predominately belt supergroup geology. The natural background estimate assumes that the entire watershed was vegetated by coniferous forest prior to anthropogenic activities.

The load capacity (target condition) was developed by adding an additional 54% sediment yield to the modeled natural background sediment yield, based on the modeled target discussed in Appendix G. Table 30 shows current sediment load, background load and load capacity for the TMDL watersheds.

Table 30. Current sediment load, background load and load capacity (target loads) for sediment impaired watersheds.

Watershed	Assessment Unit	Watershed acreage	Modeled % above background	Estimated existing load (tons/year)	Natural background (tons/year)	Load capacity at 54% above natural background (tons/year)	Load Reduction Required (tons/year)[1]	% Load Reduction Required	Estimation Method
Rattle Creek	17010213PN018_02	6,770	228%	636	194	299	337	174%	Modeled
Wellington Creek	17010213PN020_02	6,405	177%	407	147	226	181	123%	Modeled
Quartz Creek	17010213PN019_02	3,226	122%	122	56	86	36	68%	Modeled
Savage Creek	17010213PN015_02	2,485	83%	413	225	347	66	29%	Modeled
Lightning Creek Mainstem*	See AU list in Table 39	54,181	67%	4,144	2,459	3,787	357	13%	Modeled
Twin Creek	17010213PN004_02 17010213PN004_03a	7,567	71%	297	174	268	29	17%	Modeled
Johnson Creek	17010213PN002_02 17010213PN002_03	9,166	66%	352	212	326	26	12%	Modeled

* In addition to Lightning Creek itself, the Lightning Creek allocation includes the sidewalls in Lower Lightning Creek, Spring, Cascade, Porcupine, East Fork, Char Creeks, and Lightning Creek headwater streams above Moose Creek.

[1] See Appendix H for load reductions expressed on a daily basis.

5.3 C Estimates of Existing Pollutant Loads Sediment

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads.

Point sources of sediment do not exist within the Idaho portions of the Lower Clark Fork River Subbasin. All sources of sediment to surface water within the basin are nonpoint sources. Loading rates were based on modeled land use type. Forest roads, canopy removal and mass wasting events were the land use types which were modeled to contribute the largest amount of material to surface waters. Estimated sediment loads for those areas requiring a TMDL: Rattle, Wellington, Quartz, Johnson, Savage, Twin Creek and Lightning Creek are detailed in Table 31 - Table 37.

Table 31. Current loads from nonpoint sources in Rattle Creek.

Land Use Type	Acres of land use type and number of slides	Load (tons/acre/year)	Estimation Method
High Canopy Removal	244	51	Modeled
Medium Canopy Removal	1,015	71	Modeled
Low Canopy Removal	389	10	Modeled
Forest (natural background)*	4,710	108	Modeled
Forest road	82	34	Modeled
Forest road within 200 feet of stream	20	160	Modeled
Historic fire*	310	8	Modeled
Recent fire*	1	<1	Modeled
Natural slide*	4	38	Modeled
Anthropogenic slide	27	156	Modeled
Total Acres	**6,771**	**636**	**-**

* Naturally occurring, contributing load not allocated.

Table 32. Current loads from nonpoint sources in Wellington Creek.

Land Use Type	Acres of land use type and number of slides	Load (tons/acre/year)	Estimation Method
High Canopy Removal	403	85	Modeled
Medium Canopy Removal	1,392	97	Modeled
Low Canopy Removal	112	3	Modeled
Forest (natural background)*	4,356	101	Modeled
Forest road	110	21	Modeled
Forest road within 200 feet of stream	11	61	Modeled
Recent fire*	21	2	Modeled
Anthropogenic slide	14	37	Modeled
Total Acres	**6,405**	**407**	**-**

* Naturally occurring, contributing load not allocated.

Table 33. Current loads from nonpoint sources in Quartz Creek.

Land Use Type	Acres of land use type and number of slides	Load (tons/acre/year)	Estimation Method
High Canopy Removal	265	56	Modeled
Medium Canopy Removal	320	9	Modeled
Forest (natural background)*	1,726	42	Modeled
Forest road	66	3	Modeled
Forest road within 200 feet of stream	5	3	Modeled
Anthropogenic slide	1	7	Modeled
Recent fire*	1	<1	Modeled
Total Acres	**2,383**	**122**	**-**

* Naturally occurring, contributing load not allocated.

Table 34. Current loads from nonpoint sources in Savage Creek.

Land Use Type	Acres	Load (tons/acre/year)	Estimation Method
Medium Canopy Removal	235	16	Modeled
Forest (natural background)*	2,216	51	Modeled
Forest road	32	1	Modeled
Forest road within 200 feet of stream	3	1	Modeled
Anthropogenic slide	11	175	Modeled
Natural slide	5	169	Modeled
Total Acres	**2,486**	**413**	**-**

* Naturally occurring, contributing load not allocated.

Table 35. Current loads from nonpoint sources in Johnson Creek.

Land Use Type	Acres	Load (tons/acre/year)	Estimation Method
High Canopy Removal	604	127	Modeled
Medium Canopy Removal	196	14	Modeled
Forest (natural background)*	8,118	188	Modeled
Forest road	220	10	Modeled
Forest road within 200 feet of stream	29	13	Modeled
Total Acres	**9,167**	**352**	**-**

* Naturally occurring, contributing load not allocated.

Table 36. Current loads from nonpoint sources in Twin Creek.

Land Use Type	Acres of land use type and number of slides	Load (tons/acre/year)	Estimation Method
High Canopy Removal	106	22	Modeled
Medium Canopy Removal	1,290	90	Modeled
Low Canopy Removal	188	5	Modeled
Forest (natural background)*	5,716	132	Modeled
Agriculture	76	4	Modeled
Forest road	171	12	Modeled
Forest road within 200 feet of stream	19	21	Modeled
Anthropogenic slide	3	12	Modeled
Total Acres	**7,566**	**297**	**-**

* Naturally occurring, contributing load not allocated.

Table 37. Current loads from nonpoint sources in Lightning Creek mainstem.

Land Use Type	Acres of land use type and number of slides	Load (tons/acre/year)	Estimation Method
High Canopy Removal	1,406	295	Modeled
Medium Canopy Removal	4,931	345	Modeled
Low Canopy Removal	481	12	Modeled
Forest (natural background)*	39,339	975	Modeled
Agriculture	449	25	Modeled
Forest road	756	41	Modeled
Forest road within 200 feet of stream	94	67	Modeled
Urban	102	25	Modeled
Recent fire*	943	94	Modeled
Historic fire*	3	<1	Modeled
Lower Lightning Creek sidewalls	290	na	Modeled
Natural slide*	24 slides	1,267	Modeled
Anthropogenic slide	97 slides	998	Modeled
Total Acres	**48,794 acres 121 slides**	**4,144**	**-**

* Naturally occurring, contributing load not allocated.

Modeled land use types within the Idaho portions of the Lower Clark Fork River Subbasin are shown in Figure 22. See Appendix G for watershed specific modeled land use type maps.

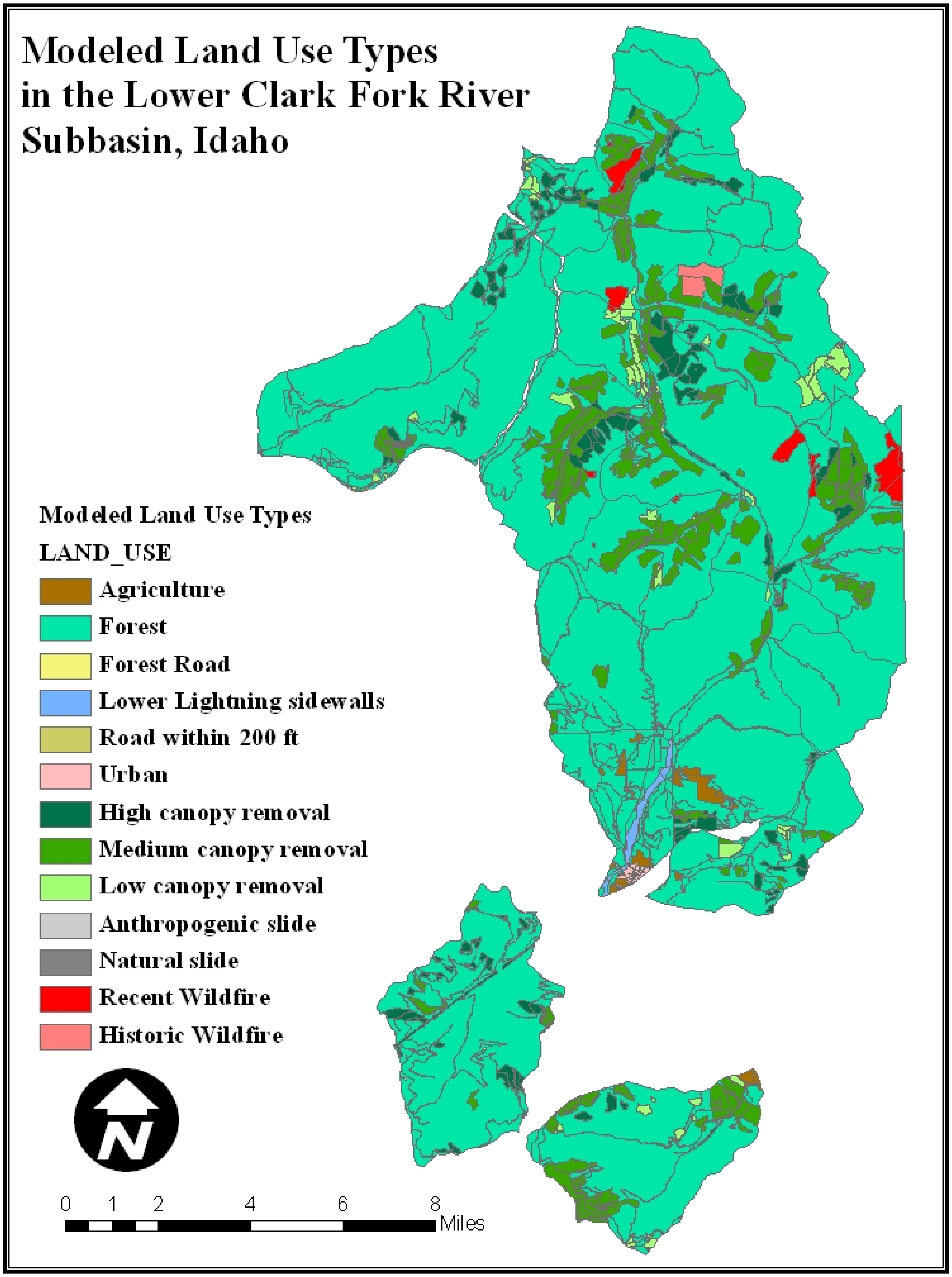


Figure 22. Modeled land use types in the Lower Clark Fork River Subbasin, Idaho.

5.4 C Load Allocations Sediment

The pollutant load allocation is the load capacity minus the margin of safety and the background. A pollutant allocation is comprised of the WLA of point sources and the load allocation of nonpoint sources.

Waste load Allocation

Since there are no point sources defined in these watersheds, the wasteload allocation (WLA) is zero. The sediment TMDLs include load allocations for nonpoint sources only.

Load Allocation

The load allocations and reductions are shown in Table 38 for the watersheds which were modeled in the Lower Clark Fork River Subbasin. Further discussion on steps taken to allocate sediment load amongst land owners and managers along with a detailed breakdown of modeled land use type contribution can be found in Appendix H. The allocations are based on the modeled estimate of nonpoint source sediment contribution and a reduction to 54% above natural background conditions. The load reduction required for each land owner/manager is based on the difference between the existing sediment contribution and the load capacity at 54% above natural background.

Table 38. Sediment load allocations and load reductions required within the Lower Clark Fork River Subbasin, Idaho.

Stream	Owner/Manager	Load allocation (tons/year)	Load reduction required (tons/year)	Time frame for meeting allocations
Rattle Creek	USFS	636	337	30 years
Wellington Creek	USFS	407	181	30 years
Quartz Creek	USFS	122	36	30 years
Savage Creek	USFS	413	66	30 years
Twin Creek	USFS	232	20	30 years
	Private	65	9	30 years
	Total	297	29	30 years
Johnson Creek	USFS	337	26	30 years
	Private	11	<1	10 years
	Military	<1	0	Meets Target
	BLM	4	0	Meets Target
	Total	352	26	30 years
Lightning Creek mainstem and tributaries	USFS	3,947	339	30 years
	Private	194	18	30 years
	IDFG	1	<1	10 years
	BLM	2	<1	10 years
	Total	4,144	357	30 years

A detailed breakdown of load reductions by land use and land owner is presented in the tables below (Table 40- Table 52). Watersheds that have reductions required to meet sediment TMDL targets are shown in Figure 23. A list of assessment units included in the Lightning Creek Allocation is shown in Table 39.

Table 39. Assessment Units contributing to the Lightning Creek TMDL.

Streams	Assessment Units	Watershed acreage	Load Reduction (tons/year)	% Load Reduction Required
Lightning Creek Allocation				
Mainstem Lightning Creek	ID17010213PN010_04 ID17010213PN011_04 ID17010213PN013_04 ID17010213PN016_03 ID17010213PN017_03 ID17010213PN019_03 ID17010213PN019_02	54,181	357	13%
Lunch Creek	ID17010213PN019_02 (excluding Quartz Creek)			
Moose Creek				
Gem Creek				
Gordon Creek				
Deer Creek				
Fall Creek				
Sheep Creek	ID17010213PN017_02			
Bear Creek				
Steep Creek	ID17010213PN016_02			
Jost Creek				
Mud Creek				
Silvertip Creek				
Trapper Creek				
Unnamed tributaries between Mud and Trapper				
Porcupine Creek				
East Fork Creek	ID17010213PN014_02 ID17010213PN014_03			
Cascade Creek	ID17010213PN012_02*			
Spring Creek	ID17010213PN021_02*			
Regal Creek	ID17010213PN013_02 (excluding Morris Creek)			
Unnamed tributaries between East Fork and Morris Creeks				

* Cascade Creek and Spring Creek are given sediment reduction allocations because of potential contributions to Lightning Creek. These assessment units are not identified as impaired by sediment on their own.

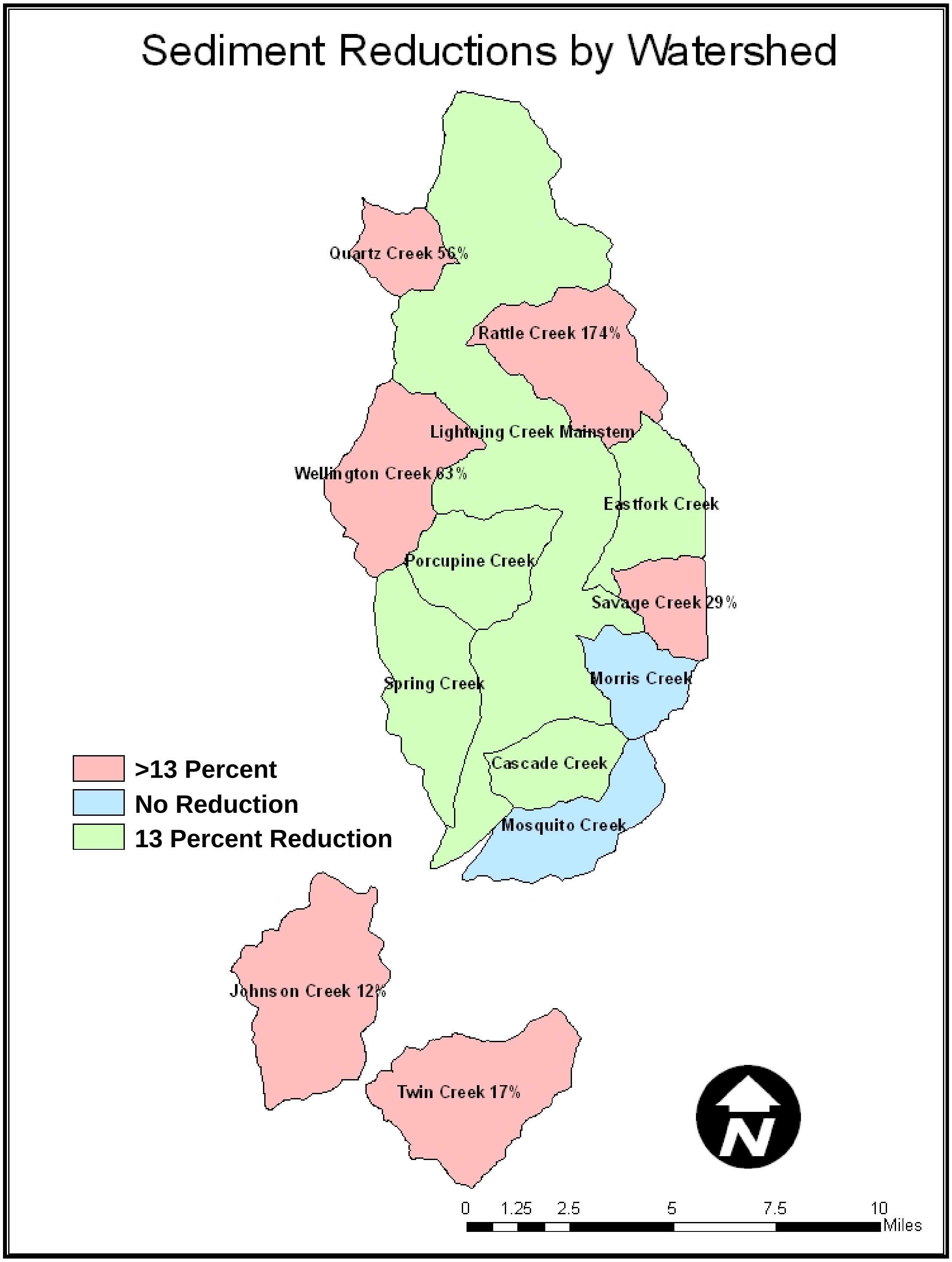


Figure 23. Sediment Reductions (%) by watershed.

Table 40. Load allocations for privately owned land within the Twin Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Agriculture	76	100%	1
Anthropogenic Slides (number of events)	2	67%	1
Forest (natural background)	411	7%	na
Forest roads	33	19%	<1
Forest roads within 200 feet of stream	11	58%	2
High canopy removal	18	17%	<1
Medium canopy removal	417	32%	5
Low canopy removal	27	14%	<1
Total	**995**	**na**	**9**

Table 41. Load allocations for USFS managed land within the Twin Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Anthropogenic Slides (number of events)	1	33%	1
Forest (natural background)	5,305	93%	na
Forest roads	138	81%	2
Forest roads within 200 feet of stream	8	42%	2
High canopy removal	88	83%	4
Medium canopy removal	873	68%	10
Low canopy removal	161	86%	1
Total	**6,572**	**na**	**20**

Table 42. Load allocations for privately owned land within the Johnson Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Forest (natural background)	303	4%	na
Forest roads	9	4%	<1
Forest roads within 200 feet of stream	5	17%	<1
High canopy removal	15	2%	<1
Total	**332**	**na**	**<1**

Table 43. Load allocations for BLM managed land within the Johnson Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Forest (natural background)	158	1%	na
Forest roads within 200 feet of stream	<1	0	0
Total	**158**	**na**	**0**

Table 44. Load allocations for USFS managed land within the Johnson Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Forest (natural background)	7,638	95%	na
Forest roads	211	96%	2
Forest roads within 200 feet of stream	24	83%	2
High canopy removal	589	98%	20
Medium canopy removal	196	100%	2
Total	**8,658**	**na**	**26**

Table 45. Load allocations for Military owned land within the Johnson Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Forest (natural background)	19	<1%	0
Total	**19**	**na**	**0**

Table 46. Load allocations for USFS managed land within the Rattle Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Anthropogenic Slides (number of events)	27	100%	108
Forest (natural background)	4,709	100%	na
Forest roads	82	100%	24
Forest roads within 200 feet of stream	20	100%	112
High canopy removal	244	100%	36
Medium canopy removal	1,015	100%	50
Low canopy removal	389	100%	7
Recent wildfire	1	100%	na
Historic wildfire	310	100%	na
Total	**6,770**	**na**	**337**

Table 47. Load allocations for USFS managed land within the Wellington Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Anthropogenic Slides (number of events)	14	100%	22
Forest (natural background)	4,356	100%	na
Forest roads	110	100%	13
Forest roads within 200 feet of stream	11	100%	36
High canopy removal	403	100%	51
Medium canopy removal	1,392	100%	58
Low canopy removal	112	100%	1
Recent wildfire	21	100%	na
Total	**6,405**	**na**	**181**

Table 48. Load allocations for USFS managed land within the Quartz Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Anthropogenic Slides (number of events)	1	100%	4
Forest (natural background)	1,726	100%	na
Forest roads	66	100%	2
Forest roads within 200 feet of stream	5	100%	2
High canopy removal	265	100%	29
Medium canopy removal	320	100%	10
Total	**2,383**	**na**	**47**

Table 49. Load allocations for (USFS) managed land within the Lightning Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Agriculture	38	9%	<1
Anthropogenic Slides (number of events)	97	98%	164
Natural slides (number of events)*	24	100%	na
Forest (natural background)*	34,339	85%	na
Forest roads	512	64%	4
Forest roads within 200 feet of stream	64	64%	7
High canopy removal	1,406	100%	47
Medium canopy removal	4,925	100%	56
Low canopy removal	481	100%	3
Recent wildfire*	943	100%	na
Historic wildfire*	3	100%	na
Sidewalls	2	<1%	na
Total	**42,718**	**na**	**281**

* Acres not contributing to load allocations.

Table 50. Load allocations for BLM managed land within the Lightning Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Forest (natural background)*	80	<1%	na
Forest roads	2	<1%	<1
Total	**82**	**na**	**<1**

* Acres not contributing to load allocations.

Table 51. Load allocations for state (IDFG) managed land within the Lightning Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Forest (natural background)*	15	<1%	na
Forest roads	<1	<1%	<1
Forest roads within 200 feet of stream	2	2%	<1
Total	**17**	**na**	**<1**

* Acres not contributing to load allocations.

Table 52. Load allocations for privately owned land within the Lightning Creek watershed.

Land use type	Acres	% Land use type by owner	Reduction (tons/year)
Agriculture	411	91%	3
Anthropogenic Slides (number of events)	2	2%	4
Forest (natural background)*	4,905	14%	na
Forest roads	241	36%	2
Forest roads within 200 feet of stream	28	33%	2
Medium canopy removal	6	<1%	<1
Urban	102	100%	3
Sidewalls	288	99%	na
Total	**5,981**	**na**	**14**

* Acres not contributing to load allocations.

Margin of Safety

The margin of safety is implicit in the sediment model design. Loading capacities set at 50% above natural background in previous TMDLs have been considered sufficiently conservative. The implicit margin of safety for the sediment model is built into the coefficients used and the target selected (see Appendix H for more details).

Seasonal Variation

Sediment from nonpoint sources is loaded episodically, primarily during high discharge events. These critical events coincide with the critical conditions and occur during November through May, generally during the rising limb of the annual hydrograph. Due to the geologic, geographic and weather experienced within the Lower Clark Fork River Subbasin rain-on-snow events pose the greatest risk for sediment generation. Such events may not occur for several seasons. Within the Idaho Panhandle the return time for large events is approximately 10-15 years.

Reasonable Assurance

The large federal ownership within the Idaho portions of the Lower Clark Fork River Subbasin should insure implementation action to reduce sediment. Sediment loaded from private land can be addressed by incentives provided to private land owners by the Bonner Soil and Water Conservation District or grant programs administered by the IDEQ. The management committee formed by the Avista FERC Settlement Agreement has identified the Lightning Creek drainage as a priority bull trout restoration area, and significant management funds are available for restoration projects.

Background

The background sediment loads for Rattle, Wellington, Quartz, Twin, Savage, Johnson Creek and Lightning Creek are listed in Table 53 below. Natural background sediment yield was calculate by multiplying the watershed acreage by the forest coefficient developed for a belt super group geologic setting and adding the material contributed to surface waters from naturally occurring slide. The background is treated as part of the load capacity and is allocated as part of the load capacity. Any unknown unallocated point sources would be included in the background portion of the load allocation.

Table 53. Background sediment loads.

Stream	Natural background (tons/year)
Rattle Creek	194
Wellington Creek	147
Quartz Creek	54
Savage Creek	225
Twin Creek	174
Johnson Creek	212
Mainstem Lightning Creek and Sidewalls	2,459

Reserve

No part of the load allocation is held for additional load. All additional activities should decrease sediment yield to the TMDL watersheds.

5.5 C Implementation Strategies Sediment

DEQ and designated lead management agencies responsible for TMDL implementation will make every effort to address past, present, and future pollution problems in an attempt to link them to watershed characteristics and management practices designed to improve water quality and restore the beneficial uses of the water body. Any and all solutions to help restore beneficial uses of a stream will be considered as part of a TMDL implementation plan in an effort to make the process as effective and cost efficient as possible. Using additional information collected during the implementation phase of the TMDL, DEQ and the designated management agencies will continue to evaluate sources of impairment and develop management actions appropriate to address these issues.

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

Time Frame

Sediment TMDL goals should be attained following three high flow events after implementation plan actions are in place. Based on the average recurrence of high flow events, this should take about 30 years. This time is needed for the stream to recover from elevated sediment levels and to respond to sediment load reductions. Although 30 years is the suggested time allotment for recovery interval, depending on implementation actions, precipitation, natural process and a multitude of other factors, water quality improvement may not be seen for 30-50 years or more.

Approach

TMDLs will be implemented through continuation of ongoing pollution control activities in the Subbasin. The designated Watershed Advisory Group, Designated Management Agencies and other appropriate public processes, are expected to:

- Develop best management practices (BMP's) to achieve load allocations.
- Give reasonable assurance that management measures will meet load allocations through both quantitative analyses of management measures.
- Adhere to measurable milestones for progress.
- Develop a timeline for implementation, with reference to costs and funding.
- Develop a monitoring plan to determine if BMPs are being implemented, if individual BMPs are effective, if load allocations and waste load allocations are being met and whether or not water quality standards are being met.

The designated management agencies will recommend specific control actions and will then submit the implementation plan to DEQ. DEQ will act as a repository for approved implementation plans and conduct five year reviews of progress toward TMDL goals.

Responsible Parties

In addition to the designated management agencies, the public, through the WAG and other equivalent process or organizations, will be provided with opportunities to be involved in developing the implementation plan to maximum extent practical.

Monitoring Strategy

Monitoring will be conducted using the DEQ approved monitoring procedure at the time of sampling.

5.1D In-stream Water Quality Targets Total Dissolved Gas (TDG)

Design Conditions

The critical time period is the time when exceedences of water quality standards are most likely to occur. For TDG, this is during runoff flows, which generally occur between May and July in the Lower Clark Fork River. Excess TDG is a concern anytime the flows exceed the capacity of hydroelectric facilities and spill occurs. For below Cabinet Gorge Dam in Idaho, this is when flows exceed the powerhouse capacity at about 38,000 cfs.

Target Selection

Idaho has a numeric water quality standard for TDG. TDG levels must not exceed 110% saturation (IDAPA 58.01.02.250.01.b.). IDAPA 58.01.02.300 also states that:

> The Director has the following authority:
>
> a. To specify the applicability of the gas supersaturation standard with respect to excess stream flow conditions; and
>
> b. To direct that all known and reasonable measures be taken to assure protection of the fishery resource; and

c. To require that operational procedures or project modifications proposed for compliance for dissolved gas criterion do not contribute to increased mortalities to juvenile migrants or impose serious delays to adult migrant fishes.

The target for this TMDL is 110% saturation or less. The water quality standard is based upon literature values that suggest that levels above 110% saturation create the potential for adverse impacts to fish populations, through displacement in the form of gas bubble disease. The TDG water quality standard is designed to protect aquatic life. A summary discussion of literature regarding TDG levels and related gas bubble disease in fish is in Section 4 of this document.

Monitoring Points

There are established continuous monitoring areas in the Cabinet Gorge forebay and below Cabinet Gorge dam, near the Cabinet Gorge fish hatchery. These locations will continue to be used as the monitoring areas for the TMDL.

5.2 D Load Capacity TDG

The daily load capacity for the Lower Clark Fork River is set at the water quality standard of 110% saturation.

5.3 D Estimates of Existing Pollutant Loads TDG

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads.

In conjunction with the relicensing of Avista's Clark Fork and Noxon Rapids hydroelectric projects, and subsequent Settlement Agreement (1999) for operation of the projects and FERC license renewal (2001), monitoring of TDG levels during the spill season has occurred since 1995. A summary of these data is shown in Table 54 and annual TDG levels above and below Cabinet Gorge dam are presented in Appendix I.

While produced by known sources, TDG is considered a nonpoint source pollutant. There are no point sources in the basin, therefore there are no wasteload allocations.

Nonpoint Source Existing Load

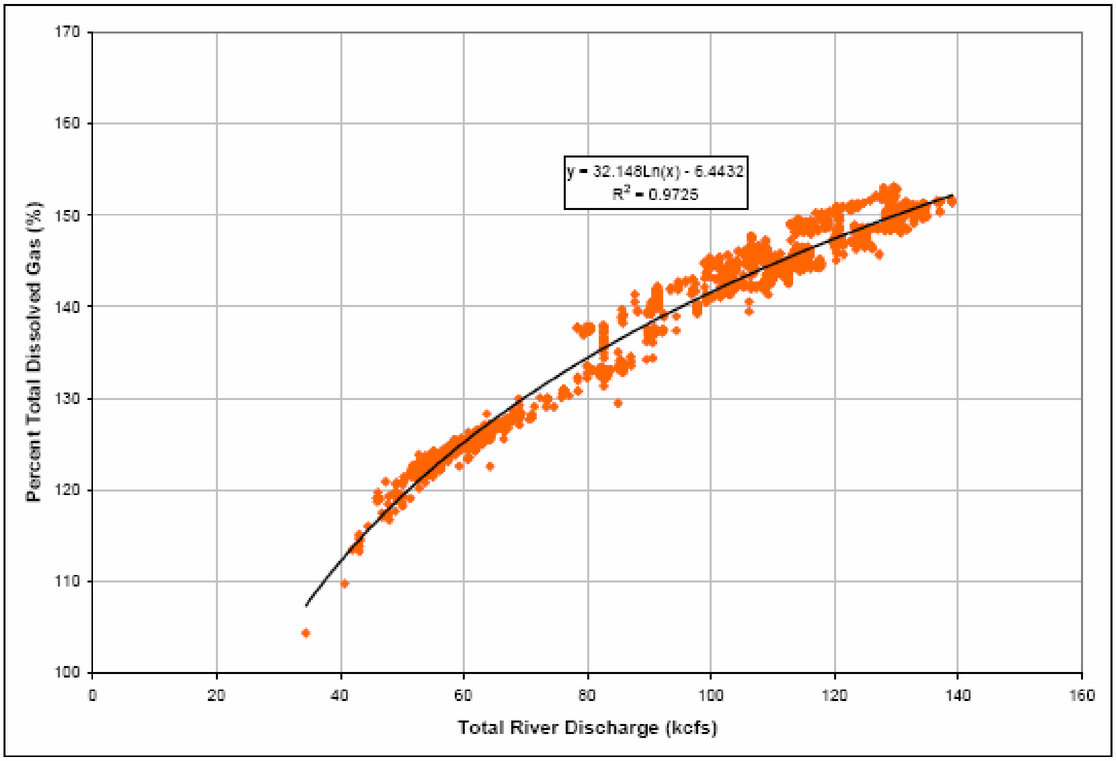
The data are extensive, and there is little uncertainty associated with the production of Total Dissolved Gas at hydroelectric facilities during periods of spill. Measurement error of the current instrumentation at designated monitoring points is +/- 2%.

Background levels of TDG are not known. Therefore, the allocation at the Idaho/Montana border is considered to be an aggregate of natural background and all other nonpoint source loads of TDG. Existing data indicate that the Montana sources of TDG are occurring above Noxon Rapids Hydroelectric project, as modifications required by the Settlement Agreement and subsequent Gas Supersaturation Control Program (2004) show no net increase in TDG even during times of spill at Noxon Rapids. Table 54 summarizes existing TDG loads.

TDG levels are directly correlated with spill volume, and river flow. (See Figure 24 excerpted from the Gas Supersaturation Control Program). Under current operations, spill at Cabinet Gorge dam is involuntary, that is, it only occurs when river flows exceed powerhouse capacity. For example, when spill volume at Cabinet Gorge dam reaches 10,000 cfs, an increase of 10% TDG is seen, and with spill at 30,000 cfs (river flow 63,000 cfs), an increase of 20% is seen. (Incoming TDG levels at this flow ranged from 105 – 115%). Once river flow reaches 100,000 cfs, levels below Cabinet Gorge tend to be reach 140%, with forebay levels typically exceeding the 110% standard as well.

Table 54. Summary of Existing TDG loads above and below Cabinet Gorge dam.

Load Type	Location	Range of Existing Load	Estimation Method
Nonpoint and natural background	Aggregate of nonpoint source loads in Montana and background at Cabinet Gorge forebay	99-126%	Actual Measurement in Cabinet Gorge forebay 1996-2003
Nonpoint and background	Below Cabinet Gorge Dam	101-158%	Actual Measurement below Cabinet Gorge dam 1996-2003



Note: Total gas level vs. river discharge assumes powerhouse is operating at maximum capacity for the indicated total river discharge, in addition to the required discharge through the spillway.

Figure 24. Measured Downstream TDG levels from Cabinet Gorge using “Best Gate” data points. (Reproduced from Avista 2004b).

5.4 D Load Allocation TDG

The load allocations are determined by the following. The MOS is implicit.

Clark Fork River - Idaho/Montana border to Cabinet Gorge Dam (17010213PN005_08)

LC = LA $_{\text{Idaho/Montana border}}$ = 110% saturation

The load allocation is an aggregate of Montana sources of TDG and the natural background amounts.

During high flows, the reduction required at the Idaho/Montana border is about 6% (e.g., 2002) to meet the target of 110% saturation at the Cabinet Gorge forebay monitoring area. During low and average flow years (e.g., 2000 and 2003) reductions are unlikely to be required above Cabinet Gorge dam as the standard is being met. After 1999, spillgate operations at Noxon Rapids dam were changed to limit TDG production at that project. Since 1999, loads in the Cabinet Gorge forebay exceed the 110% standard only during higher flow years.

Clark Fork River – Cabinet Gorge Dam to Lake Pend Oreille (17010213PN003_08 and PN001_08)

$LC = LA_{\text{Below Cabinet Gorge Dam}}$ = 110% saturation

If forebay levels of TDG are above the 110% water quality standard, the load allocation below Cabinet Gorge Dam is equal to TDG levels in the forebay (i.e., no net increase).

Because the Cabinet Gorge dam has an allocation of zero when incoming levels exceed 110%, Avista is required to maintain no net increase in TDG levels between monitoring areas in the Cabinet Gorge forebay and below the dam to be in compliance with water quality standards.

Margin of Safety

Due to the conservative nature of the criterion itself, and site specific information that indicates 110% is protective of beneficial uses, the margin of safety will be considered implicit. Accuracy of measurement is very high, with only a 2% instrument error.

Seasonal Variation

The target will not vary seasonally, however, periods of exceedance have only been observed at times of spill, which correlate with spring peak flows. It is possible that due to extenuating circumstances (such as emergency maintenance), spill may occur at other times of the year, therefore the 110% TMDL target above and below Cabinet Gorge dam will apply year-round.

Reasonable Assurance

Background

Background levels are considered in the aggregate allocation at the Montana/Idaho border.

Reserve

There is no reserve amount allocated, as no additional sources of TDG are anticipated or feasible due to the consistent exceedances during peak flows.

5.5 D Implementation Strategies TDG

In the case of TDG, DEQ is the designated lead management agency responsible for TMDL implementation and will make every effort to address past, present, and future pollution problems in an attempt to link them to watershed characteristics and management practices designed to improve water quality and restore the beneficial uses of the water body. DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

Time Frame

It is under Montana DEQ's jurisdiction to evaluate the feasibility and timeframe for additional reductions in TDG to meet the 110% TDG allocation above Cabinet Gorge dam at the Idaho/Montana border.

The Final Gas Supersaturation Control Program (Avista 2004b) outlines commitments and steps to substantially reduce TDG production from Cabinet Gorge dam and offset the impacts through mitigation efforts. The GSCP also outlines operations at Noxon Rapids dam and at Cabinet Gorge dam that have lowered TDG levels since 1999. Because of the complexity of potential operational changes needed to reduce TDG below Cabinet Gorge Dam, a timeframe of ten years is expected to reduce impacts of TDG to levels that are not impacting beneficial uses. Due to recent engineering concerns, the GSCP approved in 2004 will be reviewed in 2007 for feasibility. If revised, the approach must comply with state water quality standards and meet the intent of the TMDL. Similar to Montana DEQ's responsibility to ensure meeting Idaho water quality standards at the border, so must Idaho DEQ allocate TDG reductions to meet Washington and Kalispel Tribal TDG standards downstream in the Pend Oreille River. If appropriate, IDEQ may withdraw and/or modify the current TMDL in response to a revised GSCP.

Approach

Above Cabinet Gorge dam, it is the responsibility of the state of Montana to address TDG sources in order to reduce saturation levels at the Montana/Idaho border. There are exceedances of Montana's TDG standard of 110% upstream of the border, and Montana DEQ will examine potential and known sources of TDG in an effort to reduce overall TDG levels in the entire Lower Clark Fork River. It is Montana DEQ's jurisdiction to allocate reductions in order to meet Idaho's Water Quality Standard at the border.

Below Cabinet Gorge Dam, no net increase in TDG production up to the 7Q10 flow was expected if the GSCP was fully implemented as written. Recent developments in the engineering design of the preferred option outlined in the GSCP have indicated that this level of TDG reduction may not be achievable by the bypass tunnel design (Avista 2007a, 2007b). The GSCP (2004) includes provisions to evaluate the effectiveness of the proposed bypass tunnel, and then decide whether to proceed or investigate other alternatives for action. Actual methods of TDG abatement may change as approved by IDEQ ad other regulatory agencies in a revised GSCP. IDEQ will continue to work with Avista and the Settlement committee to insure that the TDG impacts are reduced, offset or otherwise mitigated through revisions to the GSCP.

Responsible Parties

Avista Utilities is responsible for implementing the GSCP as a condition of its FERC license to operate. In addition to regulatory agencies, there is a multi-stakeholder group established to monitor progress toward achieving the goals of the settlement, which include reducing TDG impacts through mitigation projects and actual reduction of TDG production from the Cabinet Gorge dam.

Monitoring Strategy

Monitoring by Avista Utilities using DEQ approved methodology occurs above and below Cabinet Gorge dam and will continue throughout the life of the FERC license.

5.6 Construction Storm Water and TMDL Waste Load Allocations

Construction Storm Water

The Clean Water Act requires operators of construction sites to obtain permit coverage to discharge storm water to a water body or to a municipal storm sewer. In Idaho, EPA has issued a general permit for storm water discharges from construction sites. In the past storm water was treated as a nonpoint source of pollutants. However, because storm water can be managed on site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires a National Pollution Discharge Elimination System (NPDES) Permit.

The Construction General Permit (CGP)

If a construction project disturbs more than one acre of land (or is part of larger common development that will disturb more than one acre), the operator is required to apply for permit coverage from EPA after developing a site-specific Storm Water Pollution Prevention Plan.

Storm Water Pollution Prevention Plan (SWPPP)

In order to obtain coverage under the Construction General Permit operators must develop a site-specific Storm Water Pollution Prevention Plan. The operator must document the erosion, sediment, and pollution controls they intend to use, inspect the controls periodically and maintain appropriate best management practices (BMPs) through the life of the project.

Construction Storm Water Requirements

When a stream is identified as impaired and has a TMDL developed, DEQ will incorporate a gross waste load allocation (WLA) for anticipated construction storm water activities. Since there are no known construction outfalls, the construction WLA for sediment and other pollutants in Lower Clark Fork River is zero.

Typically there are specific requirements you must follow to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for post-construction storm water management. Sediment is usually the main pollutant of concern in storm water from construction sites. The application of specific best management practices from *Idaho's Catalog of Storm Water Best Management Practices for Idaho Cities and Counties* is one source of information to meet the standards and requirements of the General Construction Permit. Local ordinances may have more stringent and site specific standards that are applicable. Permit applicants should contact the Coeur d'Alene Regional Office of DEQ for recommendations of construction BMPs that will be in compliance with the applicable TMDLs.

5.7 Application of Existing Nutrient Agreements and Lake Pend Oreille Nearshore TMDL

While not identified as impaired by nutrients at this time, nonpoint source activities that could contribute nutrients to the mainstem Clark Fork River Assessment Units are subject to an existing MOA between the states of Montana and Idaho as well as the approved Lake Pend Oreille Nearshore TMDL (DEQ 2002). The Clark Fork River and other tributaries to the lake are considered to have the largest impact on open water quality nutrients, while land activities have a more direct influence on nearshore water quality.

Idaho-Montana Nutrient Border Agreement

In 2002, the states of Idaho and Montana established the *Montana and Idaho Border Nutrient Load Memorandum of Agreement* to establish a loading agreement to protect and maintain water quality in Lake Pend Oreille. The in-lake concentration target for Lake Pend Oreille is 7.3 ug/l. Nutrient targets for the Clark Fork River are outlined in section VII of the agreement as follows:

> The total nutrient loading target for Pend Oreille Lake is 328,651 kilograms per year of total phosphorus. The nutrient loading target is further allocated to the Clark Fork River and local sources in Idaho. The nutrient loading target for the Clark Fork River at the Montana/Idaho border is 259,500 kilograms per year of total phosphorus and the nutrient loading target for local sources in Idaho is 69,151 kilograms per year of total phosphorus. Additionally, a target is set to maintain a ratio greater than 15:1 of total nitrogen to total phosphorus.
>
> These targets are designed to maintain water quality in the open water of the lake (water where the maximum depth is greater than 2.5 times water transparency as measured by secchi depth) from the mouth of the Clark Fork River to the Long Bridge (Highway 95).

Pend Oreille Lake Nearshore TMDL

A TMDL for Total Phosphorus (TP) in the nearshore area of Lake Pend Oreille sets a target of 9 µg/l TP throughout the nearshore area, with an instantaneous sample threshold of 12 µg/l. The Nearshore TMDL was written to reduce nearshore eutrophication and to prevent nuisance algae growth. The nearshore drainage area is generally defined as the land area draining directly into Lake Pend Oreille, which constitutes about one mile from the shoreline surrounding the lake (see TetraTech 2002 for map). Since the TMDL applies June-September when the lake is at full pool, the delta portion of Johnson Creek (AU 170213PN001_03) and other AUs may overlap with the area covered by the Nearshore TMDL nutrient loading requirements.

5.8 Conclusions

TMDLs were written for three metals on the mainstem Lower Clark Fork River. TMDLs for Cadmium, Copper and Zinc were developed and target loads set according to Idaho Water Quality standards, with the entire load allocated at the Idaho/Montana border. Continued monitoring will help to assess whether allocations are currently being met.

Temperature TMDLs were written for the entire subbasin, with the exception of the mainstem Clark Fork River. Using the Potential Natural Vegetation Model, virtually every water body in the subbasin has excess solar loads. TMDLs were developed for all water bodies designated as impaired by DEQ, and advisory TMDLs are included for those water bodies not currently listed as impaired by temperature pollution.

Sediment TMDLs were developed for the Lightning Creek drainage, and for Johnson and Twin Creeks. The sediment TMDL model set a sediment load capacity target of 54% above natural background conditions. All of the Lightning Creek drainage, as well as Twin and Johnson Creeks required TMDLs to reach this target. The sediment load target was developed by classifying land use types and determining associated acreage from GIS analysis, and multiplying the designated acreage by a sediment yield coefficient specific to that land use type. Similar DEQ modeling attempts in the past have generated a similar sediment yield target, and have been found to be protective of beneficial uses while allowing for an acceptable margin of safety.

All sediment inputs within the Idaho portions of the Lower Clark Fork River Subbasin are allocated to nonpoint sources. No point sources of sediment are expected to exist within the subbasin. Sediment load allocations were allocated to land managers and owners based on the amount of land managed or owned and modeled land use types within the watershed.

A total dissolved gas TMDL was developed with allocations at the Idaho/Montana border and below Cabinet Gorge dam. During spring peak flows, Idaho's water quality standard can be exceeded by a significant amount, impairing aquatic life beneficial uses. On-going efforts to reduce TDG at Cabinet Gorge dam are a part of the Project's FERC license.

Table 55. Summary of assessment outcomes.

Stream	Assessment Unit	Pollutant	TMDL(s) Completed	Recommended Changes to Integrated Report	Justification
Clark Fork River	ID 170213PN005_08 ID 170213PN003_08 ID 170213PN001_08	TDG	Yes	Move to section 4a	TMDL Completed
		Metals	Yes	Identify Metals as Cadmium, Copper and Zinc; Move to section 4a	TMDL Completed
		Toxics	No	Remove pollutant from integrated report	Listing inconsistent with historical record. Metals TMDL Completed.
		Unknown	No	Remove pollutant from integrated report	All known pollutants for these assessment units are identified
		Temperature	No	None	Adequate information to complete a TMDL is not available at this time
Cascade Creek	ID170213PN012_02	Temperature	Yes	Move to section 4a	TMDL Completed

Stream	Assessment Unit	Pollutant	TMDL(s) Completed	Recommended Changes to Integrated Report	Justification
Dry Creek	ID17010213PN004_02a	Temperature	Yes	Move to section 4a	TMDL Completed
Mosquito Creek	170213PN009_02	Temperature	Yes	Move to section 4a	TMDL Completed
Lightning Creek	ID17010213PN010_04 ID17010213PN011_02 ID17010213PN011_04 ID17010213PN013_02 ID17010213PN013_04 ID17010213PN016_02 ID17010213PN016_03 ID17010213PN017_02 ID17010213PN017_03 ID17010213PN019_02 ID17010213PN019_03	Sediment	Yes	Remove unknown pollutant and move to section 4a	Unknown pollutant identified as sediment and TMDL completed
		Temperature	Yes	Move to section 4a	TMDL completed
East Fork Creek	ID17010213PN014_02 ID17010213PN014_03	Sediment	Yes	Move to section 4a	Assessment units included in sediment TMDL and load reduction allocation for Lightning Creek
		Temperature	Yes	Move to section 4a	TMDL completed
Rattle Creek	ID17010213PN018_02	Sediment	Yes	Add to pollutant to integrated report	Current load above subbasin target; TMDL completed
		Temperature	Yes	Move to section 4a	TMDL completed
Savage Creek	17010213PN015_02	Sediment	Yes	Add pollutant to integrated report	Current load above subbasin target; TMDL completed
		Temperature	Yes	Move to section 4a	TMDL completed

Stream	Assessment Unit	Pollutant	TMDL(s) Completed	Recommended Changes to Integrated Report	Justification
Wellington Creek	ID17010213PN020_02	Sediment	Yes	Add pollutant to integrated report	Previously identified as sediment impaired in 1998, error in 2002 list did not reflect sediment impairment; Current load above subbasin target; TMDL completed
		Temperature	Yes	Move to section 4a	TMDL completed
Johnson Creek	ID17010213PN002_02 ID17010213PN002_03	Sediment	Yes	Move to section 4a	TMDL completed
		Temperature	Yes	Move to section 4a	TMDL completed
Twin Creek	ID17010213PN004_02 ID17010213PN004_03	Sediment	Yes	Add pollutant to integrated report	Current load above subbasin target; TMDL completed
		Temperature	Yes	Move to section 4a	TMDL completed

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GIS Coverages

GIS coverages from DEQ's GIS library current at the time of TMDL development were used. Data files are on file with the Coeur d'Alene regional office of DEQ.

Glossary

305(b)

Refers to section 305 subsection "b" of the Clean Water Act. The term "305(b)" generally describes a report of each state's water quality and is the principle means by which the U.S. Environmental Protection Agency, Congress, and the public evaluate whether U.S. waters meet water quality standards, the progress made in maintaining and restoring water quality, and the extent of the remaining problems.

§303(d)

Refers to section 303 subsection "d" of the Clean Water Act. 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval.

Adsorption

The adhesion of one substance to the surface of another. Clays, for example, can adsorb phosphorus and organic molecules

Aeration

A process by which water becomes charged with air directly from the atmosphere. Dissolved gases, such as oxygen, are then available for reactions in water.

Aerobic

Describes life, processes, or conditions that require the presence of oxygen.

Algae

Non-vascular (without water-conducting tissue) aquatic plants that occur as single cells, colonies, or filaments.

Alluvium

Unconsolidated recent stream deposition.

Ambient

General conditions in the environment (Armantrout 1998). In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations or specific disturbances such as a wastewater outfall (EPA 1996).

Anaerobic

Describes the processes that occur in the absence of molecular oxygen and describes the condition of water that is devoid of molecular oxygen.

Anoxia

The condition of oxygen absence or deficiency.

Anthropogenic

Relating to, or resulting from, the influence of human beings on nature.

Anti-Degradation

Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.61).

Aquatic

Occurring, growing, or living in water.

Aquifer

An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding of water to wells or springs.

Assemblage (aquatic)

An association of interacting populations of organisms in a given water body; for example, a fish assemblage or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996).

Assessment Database (ADB)

The ADB is a relational database application designed for the U.S. Environmental Protection Agency for tracking water quality assessment data, such as use attainment and causes and sources of impairment. States need to track this information and many other types of assessment data for thousands of water bodies and integrate it into meaningful reports. The ADB is designed to make this process accurate, straightforward, and user-friendly for participating states, territories, tribes, and basin commissions.

Assessment Unit (AU)

A segment of a water body that is treated as a homogenous unit, meaning that any designated uses, the rating of these uses, and any associated causes and sources must be applied to the entirety of the unit.

Assimilative Capacity

The ability to process or dissipate pollutants without ill effect to beneficial uses.

Batholith

A large body of intrusive igneous rock that has more than 40 square miles of surface exposure and no known floor. A batholith usually consists of coarse-grained rocks such as granite.

Bedload

Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.

Beneficial Use

Any of the various uses of water, including, but not limited to, aquatic life, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards.

Beneficial Use Reconnaissance Program (BURP)

A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address lakes, reservoirs, and wadeable streams and rivers

Benthic

Pertaining to or living on or in the bottom sediments of a water body

Benthic Organic Matter.

The organic matter on the bottom of a water body.

Best Management Practices (BMPs)

Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.

Best Professional Judgment

A conclusion and/or interpretation derived by a trained and/or technically competent individual by applying interpretation and synthesizing information.

Biochemical Oxygen Demand (BOD)

The amount of dissolved oxygen used by organisms during the decomposition (respiration) of organic matter, expressed as mass of oxygen per volume of water, over some specified period of time.

Biological Integrity

1) The condition of an aquatic community inhabiting unimpaired water bodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).

Biomass

The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often expressed as grams per square meter.

Biota

The animal and plant life of a given region.

Biotic

A term applied to the living components of an area.

Clark Fork Settlement Agreement

The Federal Energy Regulatory Commission (FERC) requires that hydroelectric operations receive federal licenses to operate. A negotiated Settlement Agreement was signed by the State of Idaho and other stakeholders to dictate conditions of management of Noxon Rapids and Cabinet Gorge dams under the FERC license. This Agreement also serves as the conditions for Idaho's 401 certification of the Cabinet Gorge dam.

Clean Water Act (CWA)

The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.

Coliform Bacteria

A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria, *E. Coli*, and Pathogens).

Colluvium

Community	A group of interacting organisms living together in a given place.
Criteria	In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. The U.S. Environmental Protection Agency develops criteria guidance; states establish criteria.
Cubic Feet per Second	A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.
Cultural Eutrophication	The process of eutrophication that has been accelerated by human-caused influences. Usually seen as an increase in nutrient loading (also see Eutrophication).
Decomposition	The breakdown of organic molecules (e.g., sugar) to inorganic molecules (e.g., carbon dioxide and water) through biological and nonbiological processes.
Depth Fines	Percent by weight of particles of small size within a vertical core of volume of a streambed or lake bottom sediment. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 6.5 millimeters depending on the observer and methodology used. The depth sampled varies but is typically about one foot (30 centimeters).
Designated Uses	Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.
Discharge	The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).

Dissolved Oxygen (DO)
The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.

Disturbance
Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment.

E. coli
Short for *Escherichia coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans, but their presence in water is often indicative of fecal contamination. *E. coli* are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.

Ecology
The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature.

Ecological Indicator
A characteristic of an ecosystem that is related to, or derived from, a measure of a biotic or abiotic variable that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability. Ecological indicators are often used within the multimetric index framework.

Ecological Integrity
The condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes (EPA 1996).

Ecosystem
The interacting system of a biological community and its non-living (abiotic) environmental surroundings.

Effluent
A discharge of untreated, partially treated, or treated wastewater into a receiving water body.

Endangered Species
Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act.

Environment

The complete range of external conditions, physical and biological, that affect a particular organism or community.

Ephemeral Stream

A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table (American Geological Institute 1962).

Erosion

The wearing away of areas of the earth's surface by water, wind, ice, and other forces.

Eutrophic

From Greek for "well nourished," this describes a highly productive body of water in which nutrients do not limit algal growth. It is typified by high algal densities and low clarity.

Eutrophication

1) Natural process of maturing (aging) in a body of water. 2) The natural and human-influenced process of enrichment with nutrients, especially nitrogen and phosphorus, leading to an increased production of organic matter.

Exceedance

A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.

Existing Beneficial Use or Existing Use

A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02).

Fauna

Animal life, especially the animals characteristic of a region, period, or special environment.

Fecal Coliform Bacteria

Bacteria found in the intestinal tracts of all warm-blooded animals or mammals. Their presence in water is an indicator of pollution and possible contamination by pathogens (also see Coliform Bacteria, *E. coli*, and Pathogens).

Flow

See *Discharge*.

Fluvial

In fisheries, this describes fish whose life history takes place entirely in streams but migrate to smaller streams for spawning.

Fully Supporting

In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting beneficial uses as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).

Geographical Information Systems (GIS)

A georeferenced database.

Geometric Mean

A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.

Gradient

The slope of the land, water, or streambed surface.

Ground Water

Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and usually emerges again as stream flow.

Habitat

The living place of an organism or community.

Headwater

The origin or beginning of a stream.

Hydrologic Basin

The area of land drained by a river system, a reach of a river and its tributaries in that reach, a closed basin, or a group of streams forming a drainage area (also see Watershed).

Hydrologic Cycle

The cycling of water from the atmosphere to the earth (precipitation) and back to the atmosphere (evaporation and plant transpiration). Atmospheric moisture, clouds, rainfall, runoff, surface water, ground water, and water infiltrated in soils are all part of the hydrologic cycle.

Hydrologic Unit

One of a nested series of numbered and named watersheds arising from a national standardization of watershed delineation. The initial 1974 effort (USGS 1987) described four levels (region, subregion, accounting unit, cataloging unit) of watersheds throughout the United States. The fourth level is uniquely identified by an eight-digit code built of two-digit fields for each level in the classification. Originally termed a cataloging unit, fourth field hydrologic units have been more commonly called subbasins. Fifth and sixth field hydrologic units have since been delineated for much of the country and are known as watershed and subwatersheds, respectively.

Hydrologic Unit Code (HUC)

The number assigned to a hydrologic unit. Often used to refer to fourth field hydrologic units.

Hydrology

The science dealing with the properties, distribution, and circulation of water.

Impervious

Describes a surface, such as pavement, that water cannot penetrate.

Inorganic

Materials not derived from biological sources.

Instantaneous

A condition or measurement at a moment (instant) in time.

Intergravel Dissolved Oxygen

The concentration of dissolved oxygen within spawning gravel. Consideration for determining spawning gravel includes species, water depth, velocity, and substrate.

Intermittent Stream

1) A stream that flows only part of the year, such as when the ground water table is high or when the stream receives water from springs or from surface sources such as melting snow in mountainous areas. The stream ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. 2) A stream that has a period of zero flow for at least one week during most years.

Interstate Waters

Waters that flow across or form part of state or international boundaries, including boundaries with Native American nations.

Key Watershed

A watershed that has been designated in Idaho Governor Batt's *State of Idaho Bull Trout Conservation Plan* (1996) as critical to the long-term persistence of regionally important trout populations.

Land Application
A process or activity involving application of wastewater, surface water, or semi-liquid material to the land surface for the purpose of treatment, pollutant removal, or ground water recharge.

Limiting Factor
A chemical or physical condition that determines the growth potential of an organism. This can result in a complete inhibition of growth, but typically results in less than maximum growth rates.

Limnology
The scientific study of fresh water, especially the history, geology, biology, physics, and chemistry of lakes.

Load Allocation (LA)
A portion of a water body's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).

Load(ing)
The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration.

Load(ing) Capacity (LC)
A determination of how much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, and a margin of safety, it becomes a total maximum daily load.

Lotic
An aquatic system with flowing water such as a brook, stream, or river where the net flow of water is from the headwaters to the mouth.

Luxury Consumption
A phenomenon in which sufficient nutrients are available in either the sediments or the water column of a water body, such that aquatic plants take up and store an abundance in excess of the plants' current needs.

Macroinvertebrate
An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500µm mesh (U.S. #30) screen.

Macrophytes
Rooted and floating vascular aquatic plants, commonly referred to as water weeds. These plants usually flower and bear seeds.

Some forms, such as duckweed and coontail (*Ceratophyllum sp.*), are free-floating forms not rooted in sediment.

Margin of Safety (MOS)

An implicit or explicit portion of a water body's loading capacity set aside to allow the uncertainly about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.

Mass Wasting

A general term for the down slope movement of soil and rock material under the direct influence of gravity.

Mean

Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.

Median

The middle number in a sequence of numbers. If there are an even number of numbers, the median is the average of the two middle numbers. For example, 4 is the median of 1, 2, 4, 14, 16; 6 is the median of 1, 2, 5, 7, 9, 11.

Metric

1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement.

Milligrams per Liter (mg/L)

A unit of measure for concentration. In water, it is essentially equivalent to parts per million (ppm).

Monitoring

A periodic or continuous measurement of the properties or conditions of some medium of interest, such as monitoring a water body.

Mouth

The location where flowing water enters into a larger water body.

National Pollution Discharge Elimination System (NPDES)

A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit.

Natural Condition	The condition that exists with little or no anthropogenic influence.
Nitrogen	An element essential to plant growth, and thus is considered a nutrient.
Nonpoint Source	A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.
Not Assessed (NA)	A concept and an assessment category describing water bodies that have been studied, but are missing critical information needed to complete an assessment.
Not Fully Supporting	Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).
Nuisance	Anything that is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state.
Nutrient	Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.
Nutrient Cycling	The flow of nutrients from one component of an ecosystem to another, as when macrophytes die and release nutrients that become available to algae (organic to inorganic phase and return).
Oligotrophic	The Greek term for “poorly nourished.” This describes a body of water in which productivity is low and nutrients are limiting

to algal growth, as typified by low algal density and high clarity.

Organic Matter
Compounds manufactured by plants and animals that contain principally carbon.

Orthophosphate
A form of soluble inorganic phosphorus most readily used for algal growth.

Oxygen-Demanding Materials
Those materials, mainly organic matter, in a water body that consume oxygen during decomposition.

Parameter
A variable, measurable property whose value is a determinant of the characteristics of a system, such as temperature, dissolved oxygen, and fish populations are parameters of a stream or lake.

Pathogens
A small subset of microorganisms (e.g., certain bacteria, viruses, and protozoa) that can cause sickness or death. Direct measurement of pathogen levels in surface water is difficult. Consequently, indicator bacteria that are often associated with pathogens are assessed. *E. coli*, a type of fecal coliform bacteria, are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.

Perennial Stream
A stream that flows year-around in most years.

Periphyton
Attached microflora (algae and diatoms) growing on the bottom of a water body or on submerged substrates, including larger plants.

Pesticide
Substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.

pH
The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.

Phased TMDL

A total maximum daily load (TMDL) that identifies interim load allocations and details further monitoring to gauge the success of management actions in achieving load reduction goals and the effect of actual load reductions on the water quality of a water body. Under a phased TMDL, a refinement of load allocations, wasteload allocations, and the margin of safety is planned at the outset.

Phosphorus

An element essential to plant growth, often in limited supply, and thus considered a nutrient.

Plankton

Microscopic algae (phytoplankton) and animals (zooplankton) that float freely in open water of lakes and oceans.

Point Source

A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable "point" of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.

Pollutant

Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

Pollution

A very broad concept that encompasses human-caused changes in the environment which alter the functioning of natural processes and produce undesirable environmental and health effects. This includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.

Population

A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.

Primary Productivity

The rate at which algae and macrophytes fix carbon dioxide using light energy. Commonly measured as milligrams of carbon per square meter per hour.

Protocol

A series of formal steps for conducting a test or survey.

Qualitative

Descriptive of kind, type, or direction.

Quantitative
Descriptive of size, magnitude, or degree.

Reach
A stream section with fairly homogenous physical characteristics.

Reconnaissance
An exploratory or preliminary survey of an area.

Reference
A physical or chemical quantity whose value is known and thus is used to calibrate or standardize instruments.

Reference Condition
1) A condition that fully supports applicable beneficial uses with little affect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).

Reference Site
A specific locality on a water body that is minimally impaired and is representative of reference conditions for similar water bodies.

Representative Sample
A portion of material or water that is as similar in content and consistency as possible to that in the larger body of material or water being sampled.

Respiration
A process by which organic matter is oxidized by organisms, including plants, animals, and bacteria. The process converts organic matter to energy, carbon dioxide, water, and lesser constituents.

Riffle
A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.

Riparian
Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.

Runoff

The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.

Sediments

Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.

Settleable Solids

The volume of material that settles out of one liter of water in one hour.

Species

1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.

Stream

A natural water course containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.

Stream Order

Hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher order streams result from the joining of two streams of the same order.

Storm Water Runoff

Rainfall that quickly runs off the land after a storm. In developed watersheds the water flows off roofs and pavement into storm drains that may feed quickly and directly into the stream. The water often carries pollutants picked up from these surfaces.

Stressors

Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.

Subbasin

A large watershed of several hundred thousand acres. This is the name commonly given to 4^{th} field hydrologic units (also see Hydrologic Unit).

Subbasin Assessment (SBA)

A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.

Subwatershed

A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions. Also proposed for adoption as the formal name for 6^{th} field hydrologic units.

Surface Fines

Sediments of small size deposited on the surface of a streambed or lake bottom. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 605 millimeters depending on the observer and methodology used. Results are typically expressed as a percentage of observation points with fine sediment.

Surface Runoff

Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow.

Surface Water

All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water.

Suspended Sediments

Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.

Taxon

Any formal taxonomic unit or category of organisms (e.g., species, genus, family, order). The plural of taxon is taxa (Armantrout 1998).

Total Maximum Daily Load (TMDL)

A TMDL is a water body's load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Total Dissolved Solids

Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

Total Suspended Solids (TSS)

The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Franson et al. 1998) call for using a filter of 2.0 microns or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

Toxic Pollutants

Materials that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely.

Tributary

A stream feeding into a larger stream or lake.

Turbidity

A measure of the extent to which light passing through water is scattered by fine suspended materials. The effect of turbidity depends on the size of the particles (the finer the particles, the greater the effect per unit weight) and the color of the particles.

Wasteload Allocation (WLA)

The portion of receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. Wasteload allocations specify how much pollutant each point source may release to a water body.

Water Body

A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.

Water Column

Water between the interface with the air at the surface and the interface with the sediment layer at the bottom. The idea derives from a vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water.

Water Pollution

Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state, which will or is likely to create a nuisance or to render such waters harmful, detrimental, or injurious to public health, safety, or welfare; to fish and wildlife; or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses.

Water Quality

A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.

Water Quality Criteria

Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.

Water Quality Limited

A label that describes water bodies for which one or more water quality criterion is not met or beneficial uses are not fully supported.

Water Quality Management Plan

A state or area-wide waste treatment management plan developed and updated in accordance with the provisions of the Clean Water Act.

Water Quality Modeling

The prediction of the response of some characteristics of lake or stream water based on mathematical relations of input variables such as climate, stream flow, and inflow water quality.

Water Quality Standards

State-adopted and U.S. Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Watershed

1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller "subwatersheds." 2) The whole geographic region which contributes water to a point of interest in a water body.

Wetland

An area that is at least some of the time saturated by surface or ground water so as to support with vegetation adapted to saturated soil conditions. Examples include swamps, bogs, fens, and marshes.

Appendix A. Water Body Summary Information Tables

Table A-1. Unassessed Assessment Units in the Lower Clark Fork Subbasin.

Unassessed Assessment Units	
Assessment Unit	**Description**
17010213PN001_02*	Derr Creek
17010213PN001_03	Johnson Creek – third order portion in the delta area of the Lower Clark Fork River
17010213PN008_02*	Idaho portion of Gold Creek, tributary to the Clark Fork River
17010213PN007_02*	Idaho portions of West Fork Blue Creek
17010213PN006_02*	Idaho portions of West Fork Elk Creek
17010213PN003_02*	Unnamed tributaries to the Clark Fork River

* Potential Natural Vegetation analyses for all water bodies in the Lower Clark Fork drainage were completed. Some water bodies that have not been assessed for beneficial use support status and that do not have temperature logger information were included. Figures in the temperature TMDL document have included the marked unassessed units in the shade analysis for informational purposes only.

Table A-2. Summary table for Lower Clark Fork River Assessment Units.

<table>
<tr><th colspan="2">Lower Clark Fork River in Idaho
AU 17010213PN03_08, 17010213PN 001_08, 17010213PN005_08</th></tr>
<tr><td rowspan="3">Description</td><td>17010213PN005_08: Clark Fork River forebay portion from the Idaho/Montana Border to Cabinet Gorge Dam</td></tr>
<tr><td>17010213PN003_08: Clark Fork River from Cabinet Gorge Dam to Mosquito Creek</td></tr>
<tr><td>17010213PN001_08: Clark Fork River delta portion, Mosquito Creek to Lake Pend Oreille</td></tr>
<tr><td rowspan="4">Listing Basis</td><td>Total Dissolved Gas: Added in 1998 for exceedances of water quality standard</td></tr>
<tr><td>Metals/Toxics: The entire Clark Fork River was added to the 1994 303(d) list and carried over to the 1996 list for metals pollution based on public comment. The listing is retained on the 1998 and 2002 list because of exceedances of Copper, Cadmium and Zinc in the analysis period of 1998-2003.</td></tr>
<tr><td>Temperature: 2002 addition to the 303(d) list due to measured exceedances of Idaho temperature standards.</td></tr>
<tr><td>Flow and Habitat alteration: carryover from 1998 list</td></tr>
<tr><td rowspan="3">Available Data</td><td>Federal Energy Regulatory Commission license application and settlement record regarding the Avista Clark Fork Hydropower projects includes extensive baseline monitoring data on fisheries and water quality in the Lower Clakr Fork River. Data from this process show both the TDG and temperature exceedances</td></tr>
<tr><td>USGS gaging stations below Cabinet Gorge dam
– Continuous flow measurements
– Nutrient and metals monitoring</td></tr>
<tr><td>Tri-State Water Quality Council monthly data
– 1984-1996: nutrient levels
– 1998- present: metals and nutrient samples below Cabinet Gorge dam</td></tr>
<tr><td>Land Use & Ownership</td><td>Private, agriculture/livestock grazing, recreational areas, rural residential, hydropower operation</td></tr>
<tr><td rowspan="2">Pollutant Sources</td><td>Two point source permits on the river: Cabinet Gorge dam and Cabinet Gorge hatchery (both have NPDES permits for nutrients and TSS). Permits are not for TMDL pollutants.</td></tr>
<tr><td>Metals: There are no known sources of metals pollution in Idaho. Metals contamination is attributed to transport from several possible sources in Montana, including four superfund sites upstream and possible accumulation in sediments.</td></tr>
</table>

Lower Clark Fork River in Idaho (continued) AU 17010213PN03_08, 17010213PN 001_08, 17010213PN005_08			
TMDL Summaries	**Pollutant**	**Load Capacity**	**% Reduction**
	Total Dissolved Gas	110% saturation	0-50% below Cabinet Gorge Dam
			0-18% at the Montana/Idaho border
	Cadmium, Copper and Zinc	Flow based standard – see pages 69-79	Flow based – see page 71-72 for examples
	Temperature	No TMDL was developed at this time. Further information about natural conditions and coordination with the State of Montana is necessary.	

Table A-3. Summary table for Twin and Delyle Creek Assessment Units.

Twin and Delyle Creek (AU 17010213PN 004_02a, AU 17010213PN 004_03)			
Description	Twin Creek, Delyle Creek and unnamed tributaries to Twin Creek		
Listing Basis	*Temperature*: EPA Addition to 1998 303(d) list		
	Sediment: Recommended in this SBA/TMDL for addition of sediment as a pollutant due to modeled inputs.		
Available Data	BURP 2001 site at top of assessment unit reach Macro – 3; Fish - 2; Habitat – 3		
	2001 site at top of lower assessment unit reach (Twin Creek) Macro – 3; Fish -2; Habitat – 3		
	BURP 1995 site at lower end of assessment unit Macro 1; Fish – 2; Habitat - 1		
	Idaho Fish and Game Temperature Logger – temperature exceedance		
Land Use & Ownership	Private agricultural and livestock grazing. Forestry. Conservation easement and wetlands preservation on lower portion of Twin Creek.		
Pollutant Sources	Channel modification (note restoration project to re-meander Twin Creek completed in 2001 with on-going plantings and maintenance); agriculture/livestock grazing; roads; timber harvest activities; bedload movement deposit in 1997		
TMDL Summaries	**Pollutant/Existing Load**	**Load Capacity**	**% Reduction to Meet Target**
	Temperature Existing Load = 243,227 kwh/day	118,882 kwh/day	Percent Temp Reduction/Shade Increase: 51% (See Figure 21 for site specific allocations)
	Sediment TMDL Existing Load = 297 tons/year	268 tons/year	17 % (29 tons/year)

Table A-4. Summary table for Dry Creek Assessment Unit.

Dry Creek (AU 17010213PN004_02a)			
Description	Dry Creek		
Listing Basis	*Temperature*: EPA Addition to 1998 303(d) list		
Available Data	2002 site on mainstem Dry Creek was dry when visited.		
	No temperature data are available.		
	WAG members and BURP data report that it is dry except during spring run-off.		
Land Use & Ownership	Primarily Forestry and Forest Service management; lower reaches private, rural residential.		
Pollutant Sources	Roads, bedload, reduced riparian shade.		
TMDL Summaries	**Pollutant/Existing Load**	**Load Capacity**	**% Reduction to Meet Target**
	Temperature Existing Load = 80,226 kwh/day	41,396 kwh/day	Percent Temp Reduction/Shade Increase: 48 % (See Figure 21.)

Table A-5. Summary table for Johnson and West Johnson Creek Assessment Units.

<table>
<tr><th colspan="4">Johnson Creek
AU 17010213PN 002_02 (upper) and AU17010213PN 002_03 (lower)</th></tr>
<tr><td>Description</td><td colspan="3">West Fork Johnson Creek, tributaries and mainstem Johnson Creek to the delta</td></tr>
<tr><td rowspan="3">Pollutant & Listing Basis</td><td colspan="3">Sediment: Source to mouth of Johnson Creek listed in 1994 and 1998 for sediment.</td></tr>
<tr><td colspan="3">Temperature: 1998 EPA addition for temperature.</td></tr>
<tr><td colspan="3">Flow and habitat alteration: 1994 and 1998 list</td></tr>
<tr><td rowspan="4">Available Data</td><td colspan="3">1995 BURP site on lower reach
Below Threshold Macroinvertebrate score (0)
Good Fish Score (3)
Mid-range habitat (2)</td></tr>
<tr><td colspan="3">2001 BURP on lower reach
Mid-range Macroinvertebrate (2)
Mid-range Fish (2)
High habitat (3)</td></tr>
<tr><td colspan="3">1995 BURP site on upper reach. (Dry in 2002 dry when visited.)
Below threshold Macroinvertebrate (0)
n/a Fish
Mid-range habitat (2)</td></tr>
<tr><td colspan="3">DEQ Temperature logger information shows exceedances of Salmonid Spawning Criteria</td></tr>
<tr><td>Land Use & Ownership</td><td colspan="3">Forest Service, private timber on lower end. Forestry on the majority of land in watershed.</td></tr>
<tr><td>Pollutant Sources</td><td colspan="3">Roads (and road failure), bedload movement, timber harvest</td></tr>
<tr><td rowspan="4">TMDL Summaries</td><td>Pollutant/Existing Load</td><td>Load Capacity</td><td>% Reduction to Meet Target</td></tr>
<tr><td>Sediment
Existing Load = 352 tons/year</td><td>326 tons/year</td><td>12 %
(26 tons/year)</td></tr>
<tr><td>Temperature
Johnson Creek Existing Load = 109,742 kwh/day</td><td>76,595</td><td>Percent Temp Reduction/Shade Increase: 30 %
See Figure 18.</td></tr>
<tr><td>Temperature
West Johnson Creek Existing Load= 50,130 kwh/day</td><td>13,559</td><td>Percent Temp Reduction: 73%
See Figure 18.</td></tr>
</table>

Table A-6. Summary table for the Cascade Creek Assessment Unit.

<table>
<tr><th colspan="4">Cascade Creek
(AU 17010213PN012_02)</th></tr>
<tr><td>Description</td><td colspan="3">Mainstem of Cascade Creek to Lightning Creek, including first and second order portions</td></tr>
<tr><td>Listing Basis</td><td colspan="3">Temperature: EPA Addition to 1998 303(d) list</td></tr>
<tr><td rowspan="3">Available Data</td><td colspan="3">2002 BURP site about 820 ft (250 m) upstream from Road 419 crossing
• Low Macroinvertebrate Score (1)
• Low Fish Score (1)
• Mid-range Habitat Score (2)</td></tr>
<tr><td colspan="3">Stressor Identification Report identified sediment as a possible additional pollutant (Clyne 2006).</td></tr>
<tr><td colspan="3">Cumulative Watershed Effects Analysis Report.</td></tr>
<tr><td>Land Use & Ownership</td><td colspan="3">Forest Service (Headwaters), Private forest. Forestry practiced on 92% of acreage in watershed (CWE), small acreage ranches, noxious weed issues, some rural residential</td></tr>
<tr><td rowspan="2">Pollutant Sources</td><td colspan="3">Roads, timber harvest, bank erosion</td></tr>
<tr><td colspan="3">WAG members noted that there is private timber harvest in the drainage. This information was not captured in the sediment TMDL assessment. Recommend revisiting land use activity in 5 year review. It is hoped that the sediment reduction allocation in place to reduce inputs to Lightning Creek will also improve beneficial use support in Cascade Creek itself.</td></tr>
<tr><td rowspan="3">TMDL Summaries</td><td>Pollutant/Existing Load</td><td>Load Capacity</td><td>% Reduction</td></tr>
<tr><td>Sediment
Allocation to reduce input to Lightning Creek drainage</td><td></td><td>13% reduction recommended</td></tr>
<tr><td>Temperature
Existing Load = 56,322 kwh/day</td><td>18,341 kwh/day</td><td>Percent Temp Reduction/Shade Increase: 67%
See Figure 15.</td></tr>
</table>

Table A-7. Summary table for Upper Lightning Creek Assessment Units.

Upper Lightning Creek AU 17010213PN 19_02, 17010213PN 19_03	
Description	19_02: Lightning Creek and first and second order tributaries from headwaters to Rattle Creek.
	19_03: Third order portion of Lightning Creek from headwaters to Rattle Creek.
Listing Basis	*Sediment*: carry over from 1996 list *Unknown*: 2002 addition due to field studies and observation of extreme bank destabilization and bedload movement, replaced 1996 sediment listing. Current SBA indicates that sediment is impairing Lightning Creek, replace unknown pollutant with sediment.
	Flow and Habitat alteration: carry over from 1996
	Temperature: EPA Addition to 1998 303(d) list
Available Data	1999 BURP Site: Highest in watershed. Located on Lightning Creek just above Gem Creek • Low Macroinvertebrate (1) • Mid-range Fish Score (2) • High habitat score (3)
	Cumulative Watershed Effects Analysis for Upper Lightning Creek
	Fish: bull trout below Char Falls (natural barrier). Declining trends based on Fish and Game surveys.
	1998 BURP Site: • Mid-Range Macroinvertebrate (2) • High Habitat score (3) • No fish data
	Lightning Creek Watershed Assessment (PWA 2004): Extensive land management history, road survey and summary of landslide data. Above Rattle and below Darling lake considered relatively unimpacted, representative of historic conditions.
Land Use & Ownership	Majority of the watershed is Forest Service management.
Pollutant Sources	Sediment: Impacts generally below the mouth of Gem Creek. Forest roads, mass wasting, streambank erosion. Extensive historic timber harvest.
	Temperature: Canopy removal (fire and historic timber harvest – 10-30 years ago)

Upper Lightning Creek (continued) AU 17010213PN 19_02, 17010213PN 19_03			
TMDL Summaries	**Pollutant/Existing Load**	**Load Capacity**	**% Reduction Required to Meet Target**
	Sediment Entire Lightning Creek drainage Existing Load = 4,144 tons/year	3,787 tons/year	13 % (357 tons/year)
	Sediment Quartz Creek (portion of AU 19_02) Existing Load = 122 tons/year	86 tons/year	68 % (36 tons/year)
	Temperature Mainstem Lightning Creek and tributary loads shown in Tables F-1 to F-17 and Table F-27.	Varies	Percent Temp Reduction/Shade Increase: 27-73% See Figure 15.

Table A-8. Summary table for Middle Lightning Creek Assessment Units.

Middle Lightning Creek AU 17010213PN 17_02, 17010213PN 17_03, 17010213PN 16_02, 17010213PN 16_03	
Description	Mainstem Lightning Creek and all tributaries between Rattle Creek and East Fork Lightning Creek, including Porcupine Creek
Listing Basis	Temperature: EPA Addition to 1998 303(d) list
	Habitat alteration: carry over from 1996
	Temperature: 1998 EPA addition
	Sediment: 1994 addition, 1998 sediment removed (replaced with unknown biological impairment). Unknown identified as sediment due to field studies and observation of extreme bank destabilization and bedload movement.
Available Data	Porcupine Creek BURP sites – 1995 (15 m upstream of confluence with Lightning Creek): • High Macroinvertebrate score (3) • No fish data • Mid-range Habitat Score (2) – 2002 (.5 miles up Porcupine Creek Road) • Mid-range Macroinvertebrate (2) • High fish score (3) • High habitat score (3)
	Mainstem BURP Sites – 1994 (just below Wellington Creek) • High Macroinvertebrate Score (3) • No fish data • Low Habitat Score (1) – 2002 (below Wellington and above mink creek) • Macro (3); • fish (1); • habitat (2)
	Lightning Creek Watershed Assessment: extensive land management history, road survey and summary of landslide data.
	Fish and Game redd counts and fish population trend information – declining until recently, now holding steady at decreased number
Land Use & Ownership	Forest Service.
Pollutant Sources	Sediment: Forest roads, mass wasting, streambank erosion

Middle Lightning Creek (continued) AU 17010213PN 17_02, 17010213PN 17_03, 17010213PN 16_02, 17010213PN 16_03			
Pollutant Sources (continued)	Temperature: Canopy removal (fire and historic timber harvest – 10-30 years ago)		
TMDL Summaries	**Pollutant/Existing Load**	**Load Capacity**	**% Reduction Required to Meet Target**
	Sediment Entire Lightning Creek drainage Existing Load = 4,144 tons/year	3,787 tons/year	13 % (357 tons/year)
	Temperature Mainstem Lightning Creek and tributary loads shown in Tables F-1 to F-17 and Table F-27.	Varies	Percent Temp Reduction/Shade Increase: 53-58%. See Figure 15.

Table A-9. Summary table for Lower Lightning Creek Assessment Units.

<table>
<tr><th colspan="4">Lower Lightning Creek
AU 17010213PN13_02, 17010213PN13_04 , 17010213PN11_02, 17010213PN11_04, 17010213PN10_04</th></tr>
<tr><td>Description</td><td colspan="3">Fourth order mainstem and first and second order tributaries from East Fork Creek to confluence with Lower Clark Fork River</td></tr>
<tr><td rowspan="3">Listing Basis</td><td colspan="3">Sediment: 1994 addition, 1998 sediment removed (replaced with unknown biological impairment).
Unknown: 2002 addition due to field studies and observation of extreme bank destabilization and bedload movement. Impairment determined to be sediment.</td></tr>
<tr><td colspan="3">Temperature: 1998 EPA addition</td></tr>
<tr><td colspan="3">Flow and Habitat alteration: carry over from 1996</td></tr>
<tr><td rowspan="2">Available Data</td><td colspan="3">Lightning Creek Watershed Assessment: extensive land management history, road survey and summary of landslide data.</td></tr>
<tr><td colspan="3">Cumulative Watershed Effects Analysis for Lower Lightning Creek.</td></tr>
<tr><td>Land Use & Ownership</td><td colspan="3">Forest Service and private, forestry and some rural residential.</td></tr>
<tr><td rowspan="2">Pollutant Sources</td><td colspan="3">Sediment: Forest roads, mass wasting, streambank erosion. Historic Timber harvest.</td></tr>
<tr><td colspan="3">Temperature: Canopy removal (fire and historic timber harvest – 10-30 years ago)</td></tr>
<tr><td rowspan="2">TMDL Summaries</td><td>Pollutant/Existing Load</td><td>Load Capacity</td><td>% Reduction Required to Meet Target</td></tr>
<tr><td>Sediment
Entire Lightning Creek drainage Existing Load = 4,144 tons/year</td><td>3,787 tons/year</td><td>13 %
(357 tons/year)</td></tr>
<tr><td></td><td>Temperature
Mainstem Lightning Creek and tributary loads shown in Tables F-1 to F-17 and Table F-27.</td><td>Varies</td><td>Percent Temp Reduction/Shade Increase: 58-79%. See Figure 15.</td></tr>
</table>

Table A-10. Summary table for the Wellington Creek Assessment Unit.

Wellington Creek AU 17010213PN20_02	
Description	First and second order portions of Wellington Creek from the headwaters to Lightning Creek
Listing Basis	Temperature: 1998 Temperature addition by EPA (Headwaters to mouth)
	Sediment: 1994, 1998 listing carryover (Falls to Lightning Creek); error in 2002 did not identify sediment as a pollutant. SBA/TMDL recommends adding sediment as a pollutant.
Available Data	1998 Temperature logger information near mouth exceeds aquatic life standards.
	Lightning Creek Watershed assessment shows extensive roading and landslide (natural and road-related) in the watershed. PBTTAT (1998) states populations are limited by excess bedload, loss of large woody debris in the system, and altered water flows as a result of unstable channels.
	BURP 1996 (above falls) 25-30 m upstream road 1016 bridge and above the falls • Low Macroinvertebrate Score (1) • No fish data • High Habitat Score (3)
	BURP 1995 (above falls): 25-30 m upstream road 1016 bridge and above the falls • High Macroinvertebrate score (3) • No Fish data • Low Habitat Score (1)
	BURP 1997: Location below Wellington Creek Falls • High Macroinvertebrate score (3) • No fish data • High Habitat Score (3)
	Fish and Game and joint agency surveys • Bull trout, westslope cutthroat and rainbow trout below falls. • Declining bull trout redd densities from 1983-1998. • Bull trout densities declining between 1984 (snorkel survey) and 1997 (electrofishing)
Land Use & Ownership	Forest Service

Wellington Creek (continued) AU 17010213PN20_02			
Pollutant Sources	Lightning Creek assessment ranks current road conditions as relatively low risk, with a few exceptions. While there is landsliding, Cacek (1989) found that few reached the channel.		
	Four large mass failures that contribute to channel. (CWE)		
	Historic clearcuts in South Fork and mainstem Wellington Creek. More recent (1988) helicopter logging on north aspect of mainstem. Little harvest in high landslide risk areas.		
TMDL Summaries	**Pollutant/Existing Load**	**Load Capacity**	**% Reduction Required to Meet Target**
	Sediment Existing Load = 407 tons/year	226 tons/year	123% (181 tons/year)
	Temperature Existing Load = 69,515 kwh/day	39,049 kwh/day	44 % Temp Reduction/Shade Increase. See Figure 15.

Table A-11. Summary table for East Fork Creek Assessment Units.

<table>
<tr><th colspan="4">East Fork Creek
AU 17010213PN014_02, 17010213PN014_03</th></tr>
<tr><td>Description</td><td colspan="3">Portions including mainstem East Fork Creek from Idaho/Montana border to Savage Creek and from Savage Creek to Lightning Creek, also including first and second order portions of East Fork Creek.</td></tr>
<tr><td rowspan="2">Listing Basis</td><td colspan="3">Temperature: 1997 DEQ temperature data shows violations of temperature standards during critical times.</td></tr>
<tr><td colspan="3">Sediment: 1994 BURP data, 1998 303 (d) list</td></tr>
<tr><td rowspan="5">Available Data</td><td colspan="3">1994 Site; Located below confluence with Savage Creek
• Low Macroinvertebrate score (1)
• High Fish score (3)
• Low Habitat Score (1)</td></tr>
<tr><td colspan="3">1995 Site; Located above confluence with Savage Creek
• High Macroinvertebrate score (3)
• Below threshold Fish score (0)
• Low Habitat score (1)</td></tr>
<tr><td colspan="3">2002 Site; Located below the Savage Creek confluence Low Macroinvertebrate (1)
• High Fish Score (3)
• High Habitat Score (3)</td></tr>
<tr><td colspan="3">2002 Site; Located above confluence with Savage Creek
• Low Macroinvertebrate score (1)
• High Fish Score (3)
• High Habitat Score (3)</td></tr>
<tr><td colspan="3">Cumulative Watershed Effects Analysis (2003)</td></tr>
<tr><td>Land Use & Ownership</td><td colspan="3">Forest Service</td></tr>
<tr><td rowspan="2">Pollutant Sources</td><td colspan="3">Sediment: Impacts generally from forest roads, mass wasting, streambank erosion</td></tr>
<tr><td colspan="3">Temperature: Canopy removal</td></tr>
<tr><td rowspan="3">TMDL Summaries</td><td>Pollutant/Existing Load</td><td>Load Capacity</td><td>% Reduction Required to Meet Target</td></tr>
<tr><td>Sediment
Included in Entire Lightning Creek drainage Existing Load = 4,144 tons/year</td><td>3,787 tons/year</td><td>13 %
(357 tons/year)</td></tr>
<tr><td>Temperature
Existing Load = 325,702 kwh/day</td><td>127,061 kwh/day</td><td>61% Temp Reduction/Shade Increase. See Figure 15.</td></tr>
</table>

Table A-12. Summary table for the Savage Creek Assessment Unit.

<table>
<tr><th colspan="4">Savage Creek
AU 17010213PN015_02</th></tr>
<tr><td>Description</td><td colspan="3">First and second order portions of Savage Creek from Idaho/Montana border to East Fork Creek.</td></tr>
<tr><td rowspan="2">Listing Basis</td><td colspan="3">Temperature: 1998 DEQ temperature data shows violations of temperature standards during critical times.</td></tr>
<tr><td colspan="3">Sediment: Recommended in this SBA/TMDL for addition of sediment as a pollutant due to modeled inputs.</td></tr>
<tr><td rowspan="4">Available Data</td><td colspan="3">1999 Site: BURP site located 100 meters upstream from confluence with East Fork Creek
• Low Macroinvertebrate Score (1)
• No Fish data
• High Habitat Score (3)</td></tr>
<tr><td colspan="3">1998 DEQ temperature data</td></tr>
<tr><td colspan="3">2004 Lightning Creek Watershed Assessment
– Bedload deposition concerns
– Above historic logging areas and roads, considered one of the least disturbed areas in Lightning Creek drainage
– Extensive road condition surveys and sediment delivery information available</td></tr>
<tr><td colspan="3">PBTTAT – considers area highly unstable and in poor condition. Adfluvial bull trout use 2.3 km of channel for spawning.</td></tr>
<tr><td>Land Use & Ownership</td><td colspan="3">Forest Service</td></tr>
<tr><td>Pollutant Sources</td><td colspan="3">Temperature: Canopy removal (lower Savage historic timber, fire activity)
Sediment: lower area has road impacts and historic mass wasting</td></tr>
<tr><td rowspan="3">TMDL Summaries</td><td>Pollutant/Existing Load</td><td>Load Capacity</td><td>% Reduction Required to Meet Target</td></tr>
<tr><td>Sediment
Existing Load =413 tons/year</td><td>347 (tons/year)</td><td>29%
(66 tons/year)</td></tr>
<tr><td>Temperature
Included in East Fork Creek TMDL Existing Load = 325,702 kwh/day</td><td>127,061 kwh/day</td><td>61% Temp Reduction/Shade Increase. See Figure 15.</td></tr>
</table>

Table A-13. Summary table for the Rattle Creek Assessment Unit.

Rattle Creek 17010213PN018_02			
Description	First and second order portions of Rattle Creek from headwaters to Lightning Creek.		
Listing Basis	*Temperature*: 2002 addition. Failing temperature standards during critical times		
	Sediment: Recommended in this SBA/TMDL for addition of sediment as a pollutant due to modeled inputs.		
Available Data	1995 Site: BURP site located approximately 0.5 miles upstream from confluence with Lightning Creek. • Low Macroinvertebrate Score (1) • No Fish data • Low Habitat Score (1)		
	2002 Site: BURP site located approximately 0.5 miles upstream from confluence with Lightning Creek. • Low Macroinvertebrate Score (1) • High Fish Score (3) • High Habitat Score (3)		
	Cumulative Watershed Effects Analysis (2003)		
Land Use & Ownership	Forest Service		
Pollutant Sources	Temperature: Canopy removal		
	Sediment: high road density in the basin, road failure, mass wasting and past timber harvest activities		
TMDL Summaries	**Pollutant/Existing Load**	**Load Capacity**	**% Reduction Required to Meet Target**
	Sediment Existing Load = 636 tons/year	299 tons/year	174 % (337 tons/year)
	Temperature Existing Load = 150,706 kwh/day	64,630 kwh/day	57% Temp Reduction/Shade Increase. See Figure 15.

Table A-14. Summary table for the Spring Creek Assessment Unit.

Spring Creek 17010213PN021_02			
Description	Spring Creek from headwaters to Lightning Creek		
Listing Basis	Not listed		
Available Data	1995 BURP data show Full Support. Subsequent revision of the macroinvertebrate index indicates that this data would now be characterized as not fully supporting beneficial uses.		
	Current status determination needs verification due to the age of data, and the refinement of the support indices since data were collected at Spring Creek. Recent DEQ site visits indicate that there are potential water quality concerns in the watershed.		
	Cumulative Watershed Effects Analysis.		
Land Use & Ownership	Forest Service, private timberland and rural residential		
Pollutant Sources	Potential sedimentation and flow alteration from proposed private hydropower project and active rural development		
	Forest roads and stream crossings		
	Point Source pollution permit for Spring Creek (Clark Fork) Fish and Game hatchery, however, the hatchery is not currently in operation. Therefore, there are not pollution contributions at this time.		
TMDL Summaries	**Pollutant/Existing Load**	**Load Capacity**	**% Reduction Required to Meet Target**
	Sediment: Reassessment of the watershed recommended due to dated BURP data and recent development activities that may be impacting the water quality status of the Creek. Allocation for reduction of sediment contribution to Lightning Creek in Lightning Creek TMDL.		
	Advisory Temperature TMDL: Potential Natural vegetation model shows load reduction needed. Existing Load = 102,688 kwh/day	44,952 kwh/day	56% Temp Reduction/Shade Increase. See Figure 15.

Table A-15. Summary table for the Mosquito Creek Assessment Unit.

<table>
<tr><th colspan="4">Mosquito Creek
AU 17010213PN009_02</th></tr>
<tr><td>Description</td><td colspan="3">Mosquito Creek headwaters to confluence with Lower Clark Fork River</td></tr>
<tr><td>Listing Basis</td><td colspan="3">Temperature: 2002 Temperature Addition</td></tr>
<tr><td></td><td colspan="3"></td></tr>
<tr><td rowspan="2">Available Data</td><td colspan="3">1995 Site Lower Mosquito Creek
• Low Macroinvertebrate (1)
• No fish data
• Low Habitat score (1)</td></tr>
<tr><td colspan="3">2002 Site Lower Mosquito Creek, just upstream from 1995 site
• High Macroinvertebrate score (3)
• Low Fish score(1)
• Mid-range Habitat score (2)
• Sediment delisted in 2000 based on this data</td></tr>
<tr><td>Land Use & Ownership</td><td colspan="3">Mostly private forestry and rural residential</td></tr>
<tr><td>Pollutant Sources</td><td colspan="3">Potential forest road or development related impacts.</td></tr>
<tr><td rowspan="2">TMDL Summaries</td><td>Pollutant/Existing Load</td><td>Load Capacity</td><td>% Reduction Required to Meet Target</td></tr>
<tr><td>Temperature:
Existing Load = 100,771 kwh/day</td><td>46,598 kwh/day</td><td>54% Temp Reduction/Shade Increase. See Figure 18.</td></tr>
</table>

Appendix B. Select Water Column Data for USGS Stations at Cabinet Gorge and Lightning Creek

Table B-1. Water Column data for the Lower Clark Fork River at the USGS Gaging Station Below the Cabinet Gorge Dam

Date	Temperature (degrees Celcius)	Instantaneous Discharge (cubic feet per second)	Specific Conductance (microsiemens per centimeter)	pH (standard units)	Ammonia (mg/L as N)	Ammonia + Organic Nitrogen (mg/L as N)	Nitrate + Nitrite (mg/L as N)	Phosphorus (mg/L)	Ortho-phosphate (mg/L as P)
WQS									
4/14/98	7.5	27,500	188	7.5	0.06	0.12	0.06	0.01	0.01
5/27/98	12	45,400	140	7.6	≤.02	3.3	0.06	≤.01	≤.01
6/24/98	14.9	52,000	163	7.9	0.12	≤.10	≤.05	≤.01	≤.01
7/16/98	19.3	33,800	172	7.7	0.04	0.15	0.05	0.02	0.02
8/4/98	22.8	33,300	183	8.3	0.05	0.15	0.07	≤.01	≤.01
9/1/98	20.8	3,500	192	8.3	0.02	0.2	≤.05	0.01	≤.01
4/8/99	6.2	30,500	179	7.7	0.003	0.14	0.035	0.011	0.003
5/12/99	9.1	34,000	156	7.5	0.003	0.14	0.023	0.01	0.001
6/11/99	11.1	54,400	128	7.8	0.007	0.12	0.037	0.02	0.004
7/21/99	17.3	31,000	158	8.1	≤.002	0.16	0.006	0.007	0.001
8/23/99	19.7	36,700	180	8.2	0.004	0.15	0.01	0.021	≤.001
9/14/99	17.1	5,430	188	8.1	≤.002	0.12	0.013	0.01	≤.001
4/4/00	6	30,500	192	8.2	≤.002	.06[1]	0.026	.004[1]	0.003
5/9/00	10.2	34,800	147	7.9	0.005	0.14	0.032	.004[1]	≤.001
5/23/00	12.5	35,100	151	8					
5/24/00	12	35,100	151	7.9					
5/24/00	12.5	47,000	151	8					
5/24/00	13	54,600	150	8					
5/25/00	12	35,000	148	7.9					
6/19/00	14.6	48,000	142	7.5	0.002	0.1	0.014	0.01	≤.001
7/7/00	17.5	31,100	162	8	0.002	0.11	0.01	.007[1]	0.002
8/7/00	22.2	21,300	173	8.1					
8/31/00	17.8	5,750	183	8					
9/5/00	17.9	8,230	184	8	0.006	.09[1]	0.03	0.008	0.002
10/25/00	10.8	20,700	196	8.2					

Date	Temperature (degrees Celcius)	Instantaneous Discharge (cubic feet per second)	Specific Conductance (microsiemens per centimeter)	pH (standard units)	Ammonia (mg/L as N)	Ammonia + Organic Nitrogen (mg/L as N)	Nitrate + Nitrite (mg/L as N)	Phosphorus (mg/L)	Ortho-phosphate (mg/L as P)
11/20/00	8.5	21,100	191	8.1					
12/20/00	1	22,900	198	7.8					
1/16/01	2.5	22,200	194	7.8					
3/1/01	4	18,400	196	7.7					
3/22/01	6	8,080	210	7.9					
4/5/01	5.6	8,110	211	8.6	0.01	0.1	0.043	0.005	≤.007
5/23/01	12	30,900	137	7.8	≤.002	0.11	0.026	0.018	≤.007
6/28/01	15.8	30,400	165	8.1	0.006	0.17	0.008	0.017	≤.007
7/26/01	19.8	6,330	179	8.2	0.002	0.11	0.009	0.006	≤.007
8/30/01	19.6	5,520	191	8.1	.008[1]	0.25	.014[1]	0.038	≤.007
9/25/01	17.1	5,440	201	8.2	0.008	0.14	0.021	0.017	≤.007
4/3/02	3	22,800	173	8	≤.015	.08[1]	0.041	0.005	≤.007
5/3/02	8.5	36,700	152	7.9	≤.015	0.14	0.04	0.015	≤.007
6/4/02	11.3	94,400	116	7.4	.013[1]	0.18	0.044	0.029	≤.007

[1]Estimated value

Table B-2. Water Column Data at the USGS Gaging Station on Lightning Creek.

Date	Temperature (degrees Celcius)	Instantaneous Discharge (cubic feet per second)	Specific Conductance (microsiemens per centimeter)	pH (standard units)	Ammonia (mg/L as N)	Ammonia + Organic Nitrogen (mg/L as N)	Nitrate + Nitrite (mg/L as N)	Phosphorus (mg/L)	Orthophosphate (mg/L as P)
WQS									
7/29/98	17.3		21	6.5					
7/29/98									
7/29/99	25	218		6.8	0.002	.10[1]		≤.004	
8/2/99	12.7	175	15	7					
9/2/99	10	42		7.1	≤.002	.10[1]		0.004	0.001
10/26/99	8.2	97	24	7.5	0.005	.06[1]	0.086	≤.008	≤.001
3/2/00	2.9	183	32	7.2	0.004	≤.10	0.094	≤.008	0.003
3/30/00	2.7	314	26	7.3	≤.002	≤.10	0.112	≤.008	0.003
4/12/00	4.6	1030	19	7.3	0.005	.07[1]	0.207	≤.008	≤.001
5/4/00	4.4	2120	14	6.9	≤.002	.06[1]	0.211	.004[1]	≤.001
6/5/00	6.1	1810	12	6.8	≤.002	0.19	0.107	≤.008	≤.001
6/30/00	9.3	518	15	6.7	≤.002	.07[1]	0.042	≤.008	0.001
7/27/00	13.8	69	25	7.1	0.008	0.13	0.029	≤.008	0.001
9/1/00	9.2	7.1	26	7.4	0.006	≤.10	0.025	≤.008	≤.001
11/9/00	6.1	30	27	6.9	≤.002	≤.08	0.083	≤.004	≤.007
12/14/00	4.3	6.6	26	6.6	0.024	≤.08	0.114	≤.004	≤.007
1/25/01	4.8	7.4	27	7.3	≤.002	≤.08	0.156	.002[1]	≤.007
3/15/01	4	43	31	7.3	0.003	≤.08	0.162	.003[1]	≤.007
4/11/01	3.7	139	36	7	0.002	.06[1]	0.14	.002[1]	≤.007
5/4/01	7.4	595	21	7.1	≤.002	.08[1]	0.247	≤.004	≤.007
6/14/01	7.2	821	16	7.2	0.003	.06[1]	0.072	0.004	≤.007

[1] Estimated Value

Appendix C. USGS and Tri-State Water Quality Council metals samples below Cabinet Gorge Dam

Table C-1. USGS Water Column Dissolved Metals Samples

Sample Date	Sample Time	Water Temp (C)	Air Temp (C)	Flow (cfs)	Hardness (mg/l)	Barium (ug/l)	Cadmium (ug/l)	Chromium (ug/l)	Copper (ug/l)	Iron (ug/l)	Lead (ug/l)	Manganese (ug/l)	Silver (ug/l)	Zinc (ug/l)	Selenium (ug/l)
11/13/1989	10:15	8.2	3	26600	85.9	79	< 1	1	1	16	< 1	2	2	8	< 1
3/27/1990	9:00	6	13	25200	91.3	81	< 1	< 5	< 10	9	< 10	1	< 1	9	< 1
5/30/1990	10:45	11	15	50700	74.3	73	< 1	< 1	< 3.0	72	< 1	15	< 1	20	< 1
9/26/1990	13:30	17.9	25	14100	90.8	82	< 1	< 1	1	6	< 1	< 1.0	< 1	8	< 1
11/25/1990	13:30	5.4	2	27100	89.2	82	1	2	9	7	1	1	< 1	19	< 1
3/18/1991	11:30	3.5	14	28200	88.4	80	< 1	< 1	3	60	< 1	12	< 1	7	< 1
5/13/1991	10:30	9.2	17	34200	78.4	73	2	4	3	67	1	12	< 1.0	5	< 1
9/18/1991	9:15	18.7	21	1780	89.6	77	< 1.0	< 1	3	11	< 1	1	< 1.0	13	< 1
11/12/1991	10:00	7.5	8	15300	95.4	85	< 1.0	< 1	6	12	< 1	2	< 1.0	28	< 1
3/20/1992	14:00	7.5	14	35600	92.1	79	< 1.0	< 1	3	26	2	9	< 1.0	13	< 1
5/12/1992	10:45	12.2	13.2	34400	69.7	63	< 1.0	< 1	38	25	60	3	< 1.0	12	< 1
9/8/1992	11:30	17	10.2	15000	92.9	82	< 1.0	< 1	8	12	6	2	< 1.0	27	< 1
11/16/1992	11:00	9.5	5	25600	92.5	87	< 1.0	< 1	12	61	10	7	< 1.0	26	< 1
3/9/1993	12:00	2	9	30500	96.2	87	< 1.0	< 1	1	6	< 1	2	< 1.0	6	< 1
3/14/1994	10:40	1.8	15	23200	94.6	90	< 1.0	4.1	5	5	2	3	< 1.0	18	< 1
4/4/2000	9:35	6	10.5	30500	86.9		M		M					M	
5/9/2000	9:55	10.2	16.5	34800	69.5		M		M					3.6	
5/23/2000	10:20	12.5	20	35100	70.0		M		M					2.5	
5/24/2000	9:25	12	18	35100	73.4		M		M					3.7	
5/24/2000	10:45	12.5	20.5	47000	73.1		M		M					2.4	
5/24/2000	12:00	13	26	54600	71.8		M		M					2.4	
5/25/2000	9:55	12	13	35000	71.7		M		M					4	
6/19/2000	12:30	14.6	21	48000	64.4		M		M					4.6	
7/7/2000	9:45	17.5	18	31100	76.5		M		M					1	
8/7/2000	15:00	22.2	29	21300	81.8		M		M					M	
8/31/2000	9:45	17.8	21	5750	87.2		M		M					M	
9/5/2000	11:15	17.9	13	8230	92.7		M		M					M	
10/25/2000	8:10	10.8	3	20700	95.7		M		0.6					M	

Sample Date	Sample Time	Water Temp (C)	Air Temp (C)	Flow (cfs)	Hardness (mg/l)	Barium (ug/l)	Cadmium (ug/l)	Chromium (ug/l)	Copper (ug/l)	Iron (ug/l)	Lead (ug/l)	Manganese (ug/l)	Silver (ug/l)	Zinc (ug/l)	Selenium (ug/l)
11/20/2000	10:25	8.5	1	21100	91.5		M		0.7					M	
12/20/2000	9:50	1	-5	22900	93.9		M		0.6					3.1	
1/16/2001	10:15	2.5	-1	22200	97.5		M		0.6					1.3	
3/1/2001	10:15	4	2.5	18400	94.3		< .04		0.8					1.1	
3/22/2001	11:45	6	6	8080	97.1		< .04		0.7					< 1.0	
9/25/2001	10:00	17.1	22	5440	96.0	17.1									
9/4/2003	10:40	20.7	18	5390	92.6	20.7									
9/20/2004	11:50	16	14	29000	88.5	16									

Table C-2. Tri-State Water Quality Council Copper, Zinc and Cadmium water column samples 2001-2003.

Sample ID	Date	Time	Flow (cfs)	Dissolved Copper (ug/l)	Dissolved Zinc (ug/l)	Dissolved Cadmium (mg/l)
Idaho Water Quality Standard						
C0104-0953	4/4/01	3:50 PM	6980	0.5 (U)		
C0104-1184	4/24/01	3:00 PM	7660			0.5 (U)
C0105-1579	5/23/01	2:30 PM	27100	0.5 (U)	23.30	0.5 (U)
C0106-1744	6/5/01	3:00 PM	28600	0.5 (U)	0.25 (U)	
C0106-1782	6/7/01	1:20 PM	25500	0.5 (U)	10.50	0.5 (U)
C0106-1827	6/11/01	12:45 PM	25700	0.5 (U)	12.30	0.5 (U)
C0106-1883	6/14/01	1:15 PM	26700	0.5 (U)	0.25 (U)	0.5 (U)
C0106-2006	6/20/01	12:00 PM	25000	0.5 (U)	0.25 (U)	0.5 (U)
C0107-2446	7/22/01	2:20 PM	9710	0.5 (U)	0.25 (U)	0.5 (U)
C0108-2981	8/22/01	9:45 AM	6750	0.5 (U)	0.25 (U)	0.5 (U)
C0109-3636	9/26/01	5:20 PM	5430	0.5 (U)	0.25 (U)	0.5 (U)
C0109-3637	9/26/01	5:20 PM	5430	0.5 (U)	0.25 (U)	0.5 (U)
C0110-3973	10/25/01	2:40 PM	6650	0.5 (U)	22.30	0.5 (U)
C0111-4238	11/20/01	3:45 PM	7000	0.5 (U)	6.40	0.5 (U)
C0112-4548	12/20/01	9:30 AM	12500	0.5 (U)	0.25 (U)	0.5 (U)
C0201-0434	1/30/02	1:15 PM	12300	0.5 (U)	0.60 (U)	0.5 (U)
C0203-0771	3/6/02	3:30 PM	13100	0.5 (U)	0.25 (U)	0.5 (U)
C0204-1010	4/3/02	1:45 PM	15200	0.5 (U)	0.25 (U)	0.5 (U)
C0205-1441	5/1/02	1:25 PM	27700	2.0	13.20	0.5 (U)
C0205-1442	5/1/02	1:25 PM	27700	2.0	13.20	0.5 (U)
C0205-1822	5/30/02	1:45 PM	67700	0.5 (U)	0.25 (U)	0.5 (U)
C0205-1823	5/30/02	1:45 PM	67700	0.5 (U)	0.25 (U)	0.5 (U)
C0206-2128	5/28/02	12:40 PM	55400	0.5 (U)	0.25 (U)	0.5 (U)

Sample ID	Date	Time	Flow (cfs)	Dissolved Copper (ug/l)	Dissolved Zinc (ug/l)	Dissolved Cadmium (mg/l)
C0206-2129	6/4/02	11:40 AM	94200	0.5 (U)	0.25 (U)	0.5 (U)
C0206-2130	6/10/02	12:40 PM	83200	0.5 (U)	0.25 (U)	0.5 (U)
C0206-2131	6/6/02	11:30 AM	91400	3.0	0.90	0.5 (U)
C0206-2132	6/13/02	10:30 AM	75100	2.0	0.90	0.5 (U)
C0206-2133	6/17/02	10:50 AM	79500	2.0	0.90	0.5 (U)
C0206-2141	6/19/02	2:00 PM	77700	0.5 (U)	0.25 (U)	0.5 (U)
C0207-2810	7/24/02	1:50 PM	24100	0.5 (U)	0.25 (U)	0.5 (U)
C0208-3215	8/21/02	2:00 PM	12900	0.5 (U)	0.25 (U)	0.5 (U)
C0209-3887	9/25/02	1:10 PM	9630	1.0	3.10	0.5 (U)
C0305-1416	05/14/03	11:40 AM		0.5 (U)	0.25 (U)	0.5 (U)
C0306-1931	05/21/03	11:40 AM		1	2.2	0.5 (U)
C0306-1932	05/27/03	10:30 AM		2	1.2	0.5 (U)
C0306-1933	05/30/03	11:55 AM		1	0.6	0.5 (U)
C0306-1934	06/04/03	12:30 PM		2	2.0	0.5 (U)
C0306-1935	06/09/03	1:20 PM		3	3.3	0.5 (U)
C0306-1936	06/13/03	10:50 AM		1	0.9	0.5 (U)
C0306-1940	06/18/03	1:50 PM		2	0.9	0.5 (U)
C0307-2402	07/16/03	2:20 PM		1	1.4	1
C0308-2957	08/10/03	3:00 PM		0.5 (U)	0.25 (U)	0.5 (U)
C0309-4054	09/21/03	2:30 PM		0.5 (U)	0.25 (U)	0.5 (U)
C0310-4440	10/15/03	1:10 PM		0.5 (U)	80.8	0.5 (U)
C0311-4722	11/13/03	2:00 PM		0.5 (U)	2.3	0.5 (U)
C0312-5101	12/18/03	1:50 PM		0.5 (U)	0.25 (U)	0.5 (U)

Appendix D. 2006 Idaho Water Quality Standards for Cadmium and Sample Calculations for Metals Standards

2006 Idaho Water Quality Standards for Cadmium

Idaho Code (IAC 2006) contains an updated Cadmium Standard that is not yet approved by EPA. The 2006 proposed standard is shown in Table D-1. The Load Capacity for chronic exposure, using the 2006 standard is show in Table D-2.

Table D-1. Proposed (IAC 2006) and EPA Approved (IAC 2005) Idaho Water Quality Standards for Cadmium.

	Hardness (mg/l)	CCC (ug/l)	CMC (ug/l)
Dissolved Cadmium (IAC 2006)	64	0.53	0.89
Dissolved Cadmium (IAC 2005)	64	0.74	1.30

Table D-2. Cadmium Load Capacity for the Lower Clark Fork River using Idaho Water Quality Criterion adopted April 2006 by the State of Idaho.

Cadmium Target Load (2006 Revised Standards)			
	Flow (cfs)	Cadmium CCC (ug/L)	Load Capacity (lb/day)
7Q10	6054	0.44	14
10th percentile*	8400	0.44	20
50th percentile*	16900	0.44	40
90th percentile*	44600	0.44	106

Table D-3. Cadmium Load Reduction for the Lower Clark Fork River using Idaho Water Quality Criterion adopted April 2006 by the State of Idaho.

Load Type	Discharge (cfs)*	Pounds per day
Measured exceeding load	18200	98
Load Capacity	18200	43
Load Reduction	18200	55
Percent Reduction		**44%**

* measured at USGS gaging station 12391950.

Sample Calculations

The toxicity of cadmium, zinc and copper are hardness dependent. Idaho Code identifies the formula by which criterion are to be calculated. These formulas and example calculations to illustrate the derivation of Water Quality Standards and Load Capacities reported in the cadmium, copper, and zinc TMDLs are included here for reference. See Idaho Code (IDAPA 58.01.02) for more detail on these formulas.

Hardness Dependent Criteria Formulas

Acute and Chronic Conversation factors and other variables are reported in IDAPA 58.01.02.

The criteria are calculated by using the following formula.

CMC=WER exp{mA[ln(hardness)]+bA} X Acute Conversion Factor.

CCC=WER exp{mc[ln(hardness)]+bc} X Chronic Conversion Factor.

For TMDLs in the Lower Clark Fork River the Water Effect Ratio (WER) was assigned a value of 1.0, because site-specific data that show toxicity effects to differ from the laboratory results upon which the criteria are based are not available.

Load Calculations

Load capacity was determined by using the actual flow at time of sampling and the criterion established in Idaho water quality standards (at a hardness value of 64 mg/l), with units converted to pounds per day as shown below.

LC (lbs/day) = Flow (ft^3/s) X 86400 s/day X Metal standard (ug/L) X (1 L/0.0353146 ft^3) X (1 lb/4.535924*10^8 ug)

For example, at the 10^{th} percentile flow (8400 cfs), the allowable load for Cadmium (IAC 2005) is calculated as follows.

(8,400 ft^3/s) X (86,400 s/day) X (0.74 ug/l) X (1 L/0.0353146 ft^3) X (1 lb/4.535924*10^8 ug)

= 33.5 lbs/day

Appendix E. State and Site-Specific Standards and Temperature Criteria

Water Quality Standards Applicable to Salmonid Spawning Temperature

Water quality standards for temperature are specific numeric values not to be exceeded during the salmonid spawning and egg incubation period, which varies with species. For spring spawning salmonids, the default spawning and incubation period recognized by DEQ is generally from March 15th to July 1st each year (Grafe et al. 2002). Fall spawning can occur as early as August 15th and continue with incubation on into the following spring up to June 1st. As per IDAPA 58.01.02.250.02.e.ii., the water quality criteria that need to be met during that time period are:

> 13^oC as a daily maximum water temperature,
>
> 9^oC as a daily average water temperature.

For the purposes of a temperature TMDL, the highest recorded water temperature in a recorded data set (excluding any high water temperatures that may occur on days when air temperatures exceed the 90th percentile of highest annual MWMT air temperatures) is compared to the daily maximum criterion of 13^oC. The difference between the two water temperatures represents the temperature reduction necessary to achieve compliance with temperature standards.

Natural Background Provisions

For potential natural vegetation temperature TMDLs, it is assumed that natural temperatures may exceed these criteria during these time periods. If potential natural vegetation targets are achieved yet stream temperatures are warmer than these criteria, it is assumed that the stream's temperature is natural (provided there are no point sources or human induced ground water sources of heat) and natural background provisions of Idaho water quality standards apply. As per IDAPA 58.01.02.200.09:

> *When natural background conditions exceed any applicable water quality criteria set forth in Sections 210, 250, 251, 252, or 253, the applicable water quality criteria shall not apply; instead, pollutant levels shall not exceed the natural background conditions, except that temperature levels may be increased above natural background conditions when allowed under Section 401.*

Section 401 relates to point source wastewater treatment requirements. In this case if temperature criteria for any aquatic life use is exceeded due to natural conditions, then a point source discharge cannot raise the water temperature by more than 0.3^oC (IDAPA 58.01.02.401.03.a.v.).

Appendix F. Temperature Loading Tables

This appendix includes loading tables by stream and the percent reduction in load required to meet TMDL targets. These existing shade estimates, target (or potential) shade estimates and the difference between the two, which gives the percent change required to meet TDML targets, are also presented graphically in Section 5.3B of this document.

Potential shade targets for this TMDL were based on expected vegetation. Descriptions of shade target development are contained in Section 5.3, with target tables shown below. Areas with the lower elevation forest targets applied are shaded light gray. Areas with the high elevation forest targets applied are not shaded. Where Shrub/forest and meadow targets were applied, it is noted in the right margin and fields are shaded dark gray. Field verified (and adjusted) solar pathfinder sites are identified in the right margin and in italics, as well as general location information of the segments. Segments are presented from headwaters to the mouth, with tributaries identified in the margins.

Table F-1. Effective Shade Targets for the Forested Tributaries Vegetation Type.

Effective Shade Curves	Stream Width (m)													
	2	4	5	8	10	12	14	18	19	21	24	28	40	54
Below 4000 feet Elevation (VRU 8)	95	92	89	85	81	75	72	65	63	58	56	49	40	31
Above 4000 feet elevation (VRU 10)	90	89	80	73	68	62	54	45	46	42	39	35	36	20

Table. F-2. Effective Shade Targets for the Forest/Shrub Mix Vegetation Type.

Effective Shade Curves	Stream Width (m)			
	7	8	11	40
Target Class	**70-79**	**70-79**	**60-69**	**20-29**

Table F -1. Gordon Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (m)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
530	0.7	1.65	0.9	0.55	-1.10	1	1	530	875	530	292	-583	
450	0.4	3.3	0.9	0.55	-2.75	3	3	1,350	4,455	1,350	743	-3,713	
1730	0.8	1.1	0.89	0.605	-0.495	4	4	6,920	7,612	6,920	4,187	-3,425	
155	0.7	1.65	0.9	0.55	-1.1	1	1	155	256	155	85	-171	Tributary
200	0.8	1.1	0.9	0.55	-0.55	3	3	600	660	600	330	-330	Tributary
							Total	**9,555**	**13,857**	**9,555**	**5,636**	**-8,221**	
												Gordon Creek	**59% Reduction**

Table F-2. Gem Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
135	0.7	1.65	0.9	0.55	-1.10	1	1	135	223	135	74	-149	
550	0.8	1.1	0.9	0.55	-0.55	1	1	550	605	550	303	-303	
1630	0.7	1.65	0.9	0.55	-1.1	3	3	4,890	8,069	4,890	2,690	-5,379	
							Total	**5,575**	**8,896**	**5,575**	**3,066**	**-5,830**	
												Gem Creek	**66% Reduction**

Table F-3. Lunch Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (m)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
440	0.7	1.65	0.9	0.55	-1.10	1	1	440	726	440	242	-484	
470	0.6	2.2	0.9	0.55	-1.65	1	1	470	1,034	470	259	-776	
486	0.7	1.65	0.9	0.55	-1.1	1	1	486	802	486	267	-535	
182	0.6	2.2	0.9	0.55	-1.65	3	3	546	1,201	546	300	-901	
295	0.7	1.65	0.9	0.55	-1.1	3	3	885	1,460	885	487	-974	
350	0.5	2.75	0.9	0.55	-2.2	3	3	1,050	2,888	1,050	578	-2,310	
395	0.6	2.2	0.9	0.55	-1.65	1	1	395	869	395	217	-652	tributary
480	0.7	1.65	0.9	0.55	-1.1	1	1	480	792	480	264	-528	tributary
							Total	**4,752**	**9,772**	**4,752**	**2,614**	**-7,158**	
												Lunch Creek	**73% Reduction**

Table F-4. Moose Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (m)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
2300	0.8	1.1	0.9	0.55	-0.55	1	1	2,300	2,530	2,300	1,265	-1,265	
1240	0.6	2.2	0.89	0.605	-1.595	4	4	4,960	10,912	4,960	3,001	-7,911	
170	0.4	3.3	0.89	0.605	-2.695	4	4	680	2,244	680	411	-1,833	
150	0.7	1.65	0.89	0.605	-1.045	4	4	600	990	600	363	-627	
865	0.8	1.1	0.8	1.1	0	5	5	4,325	4,758	4,325	4,758	0	
125	0.7	1.65	0.76	1.32	-0.33	7	7	875	1,444	875	1,155	-289	
35	0.6	2.2	0.76	1.32	-0.88	7	7	245	539	245	323	-216	
							Total	**13,985**	**23,416**	**13,985**	**11,276**	**-12,140**	
												Moose Creek	**52% Reduction**

Table F-5. Quartz Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)
310	0.8	1.1	0.9	0.55	-0.55	1	1	310	341	310	171	-171
178	0.9	0.55	0.9	0.55	0	1	1	178	98	178	98	0
405	0.8	1.1	0.9	0.55	-0.55	1	1	405	446	405	223	-223
55	0.6	2.2	0.9	0.55	-1.65	3	3	165	363	165	91	-272
270	0.7	1.65	0.9	0.55	-1.1	3	3	810	1,337	810	446	-891
590	0.9	0.55	0.9	0.55	0	3	3	1,770	974	1,770	974	0
1950	0.9	0.55	0.9	0.55	0	3	3	5,850	3,218	5,850	3,218	0
1380	0.7	1.65	0.8	1.1	-0.55	5	5	6,900	11,385	6,900	7,590	-3,795
300	0.8	1.1	0.8	1.1	0	5	5	1,500	1,650	1,500	1,650	0
							Total	**17,888**	**19,810**	**17,888**	**14,458**	**-5,352**

Quartz Creek 27% Reduction

Table F-6. Deer Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (m)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)
450	0.7	1.65	0.9	0.55	-1.10	1	1	450	743	450	248	-495
610	0.8	1.1	0.9	0.55	-0.55	3	3	1,830	2,013	1,830	1,007	-1,007
1440	0.9	0.55	0.9	0.55	0	3	3	4,320	2,376	4,320	2,376	0
330	0.7	1.65	0.89	0.605	-1.045	4	4	1,320	2,178	1,320	799	-1,379
380	0.8	1.1	0.89	0.605	-0.495	4	4	1,520	1,672	1,520	920	-752
							Total	**9,440**	**8,982**	**9,440**	**5,348**	**-3,633**

Deer Creek 40% Reduction

Table F-7. Fall, Sheep and Bear Creeks Existing and Target (Potential) Summer Temperature Loads.

Segment Length (m)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
1825	0.7	1.65	0.9	0.55	-1.10	3	3	5,475	9,034	5,475	3,011	-6,023	Fall
410	0.9	0.55	0.9	0.55	0	4	4	1,640	902	1,640	902	0	
310	0.8	1.1	0.9	0.55	-0.55	1	1	310	341	310	171	-171	Sheep
1000	0.9	0.55	0.9	0.55	0	3	3	3,000	1,650	3,000	1,650	0	
620	0.8	1.1	0.89	0.605	-0.495	4	4	2,480	2,728	2,480	1,500	-1,228	
340	0.9	0.55	0.9	0.55	0	4	4	1,360	748	1,360	748	0	
1250	0.7	1.65	0.9	0.55	-1.1	3	3	3,750	6,188	3,750	2,063	-4,125	Bear
420	0.9	0.55	0.9	0.55	0	4	4	1,680	924	1,680	924	0	
520	0.7	1.65	0.89	0.605	-1.045	4	4	2,080	3,432	2,080	1,258	-2,174	
							Total	**21,775**	**25,946**	**21,775**	**12,227**	**-13,719**	
											Fall, Sheep & Bear Creeks		**53% Reduction**

Table F-8. Rattle Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (m)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
1665	***0.7***	***1.65***	***0.9***	***0.55***	***-1.10***	***4***	***1***	***6,660***	***10,989***	***1,665***	***916***	***-10,073***	***pathfinder = 71.3%***
510	0.8	1.1	0.9	0.55	-0.55	4	3	2,040	2,244	1,530	842	-1,403	tributary
1370	0.8	1.1	0.9	0.55	-0.55	1	1	1,370	1,507	1,370	754	-754	tributary
70	0.8	1.1	0.9	0.55	-0.55	3	3	210	231	210	116	-116	tributary
330	0.9	0.55	0.9	0.55	0	3	3	990	545	990	545	0	tributary
390	0.8	1.1	0.9	0.55	-0.55	3	3	1,170	1,287	1,170	644	-644	tributary
820	0.7	1.65	0.89	0.605	-1.045	4	4	3,280	5,412	3,280	1,984	-3,428	tributary
440	0.8	1.1	0.89	0.605	-0.495	4	4	1,760	1,936	1,760	1,065	-871	tributary
410	0.7	1.65	0.89	0.605	-1.045	4	4	1,640	2,706	1,640	992	-1,714	tributary

Segment Length (m)	Existing Shade (fraction)	Existing Summer Load ($kWh/m^2/day$)	Potential Shade (fraction)	Potential Summer Load ($kWh/m^2/day$)	Potential Load minus Existing load ($kWh/m^2/day$)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
90	0.6	2.2	0.89	0.605	-1.595	4	4	360	792	360	218	-574	tributary
160	0.8	1.1	0.9	0.55	-0.55	1	1	160	176	160	88	-88	tributary
990	0.7	1.65	0.9	0.55	-1.1	3	3	2,970	4,901	2,970	1,634	-3,267	tributary
380	0.8	1.1	0.9	0.55	-0.55	3	3	1,140	1,254	1,140	627	-627	tributary
725	0.7	1.65	0.9	0.55	-1.1	1	1	725	1,196	725	399	-798	tributary
420	0.8	1.1	0.9	0.55	-0.55	3	3	1,260	1,386	1,260	693	-693	tributary
270	0.7	1.65	0.9	0.55	-1.1	3	3	810	1,337	810	446	-891	tributary
890	0.8	1.1	0.9	0.55	-0.55	1	1	890	979	890	490	-490	tributary
440	0.7	1.65	0.9	0.55	-1.1	3	3	1,320	2,178	1,320	726	-1,452	tributary
185	0.8	1.1	0.9	0.55	-0.55	1	1	185	204	185	102	-102	tributary
460	0.6	2.2	0.9	0.55	-1.65	3	3	1,380	3,036	1,380	759	-2,277	tributary
100	0.7	1.65	0.9	0.55	-1.1	3	3	300	495	300	165	-330	tributary
260	0.7	1.65	0.9	0.55	-1.1	1	1	260	429	260	143	-286	tributary
450	0.8	1.1	0.9	0.55	-0.55	1	1	450	495	450	248	-248	tributary
840	0.7	1.65	0.9	0.55	-1.1	3	3	2,520	4,158	2,520	1,386	-2,772	tributary
960	0.6	2.2	0.9	0.55	-1.65	3	3	2,880	6,336	2,880	1,584	-4,752	tributary
150	0.5	2.75	0.89	0.605	-2.145	4	4	600	1,650	600	363	-1,287	tributary
580	0.8	1.1	0.89	0.605	-0.495	4	4	2,320	2,552	2,320	1,404	-1,148	tributary
630	***0.6***	***2.2***	***0.9***	***0.55***	***-1.65***	***3***	***1***	***1,890***	***4,158***	***630***	***347***	***-3,812***	***pathfinder = 68.4%***
2770	0.7	1.65	0.9	0.55	-1.1	3	3	8,310	13,712	8,310	4,571	-9,141	
300	0.8	1.1	0.89	0.605	-0.495	5	4	1,500	1,650	1,200	726	-924	
1275	0.7	1.65	0.8	1.1	-0.55	7	5	8,925	14,726	6,375	7,013	-7,714	
960	0.8	1.1	0.8	1.1	0	9	7	8,640	9,504	6,720	7,392	-2,112	
1430	***0.6***	***2.2***	***0.73***	***1.485***	***-0.715***	***11***	***8***	***15,730***	***34,606***	***11,440***	***16,988***	***-17,618***	***pathfinder = 67.9%***
490	0.8	1.1	0.8	1.1	0	13	9	6,370	7,007	4,410	4,851	-2,156	
230	0.7	1.65	0.7	1.65	0	13	9	2,990	4,934	2,070	3,416	-1,518	
							Total	**94,005**	**150,706**	**75,300**	**64,630**	**-86,076**	

Rattle Creek Drainage **57% Reduction**

Table F-9. Wellington Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (m)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential minus Existing Load (kWh/day)	
1200	0.9	0.55	0.9	0.55	0.00	1	1	1,200	660	1,200	660	0	SF
480	0.8	1.1	0.9	0.55	-0.55	3	3	1,440	1,584	1,440	792	-792	SF
400	0.7	1.65	0.9	0.55	-1.1	3	3	1,200	1,980	1,200	660	-1,320	SF
1040	0.6	2.2	0.89	0.605	-1.595	4	4	4,160	9,152	4,160	2,517	-6,635	SF
210	0.9	0.55	0.9	0.55	0	5	5	1,050	578	1,050	578	0	SF
210	0.6	2.2	0.9	0.55	-1.65	1	1	210	462	210	116	-347	tributary
580	0.7	1.65	0.9	0.55	-1.1	1	1	580	957	580	319	-638	tributary
1300	0.7	1.65	0.9	0.55	-1.1	3	3	3,900	6,435	3,900	2,145	-4,290	tributary
800	0.8	1.1	0.89	0.605	-0.495	4	4	3,200	3,520	3,200	1,936	-1,584	tributary
600	0.9	0.55	0.9	0.55	0	4	4	2,400	1,320	2,400	1,320	0	tributary
620	0.6	2.2	0.9	0.55	-1.65	1	1	620	1,364	620	341	-1,023	
630	0.7	1.65	0.95	0.275	-1.375	1	1	630	1,040	630	173	-866	
1570	0.8	1.1	0.93	0.385	-0.715	3	3	4,710	5,181	4,710	1,813	-3,368	
470	0.9	0.55	0.92	0.44	-0.11	4	4	1,880	1,034	1,880	827	-207	
240	0.8	1.1	0.92	0.44	-0.66	4	4	960	1,056	960	422	-634	
300	0.9	0.55	0.92	0.44	-0.11	4	4	1,200	660	1,200	528	-132	
100	0.7	1.65	0.92	0.44	-1.21	4	4	400	660	400	176	-484	
890	0.9	0.55	0.9	0.55	0	7	7	6,230	3,427	6,230	3,427	0	
90	0.8	1.1	0.87	0.715	-0.385	7	7	630	693	630	450	-243	
160	0.9	0.55	0.9	0.55	0	7	7	1,120	616	1,120	616	0	
150	0.8	1.1	0.87	0.715	-0.385	7	7	1,050	1,155	1,050	751	-404	
120	0.7	1.65	0.85	0.825	-0.825	9	8	1,080	1,782	960	792	-990	
550	0.9	0.55	0.9	0.55	0	9	8	4,950	2,723	4,400	2,420	-303	
1550	0.8	1.1	0.83	0.935	-0.165	11	9	17,050	18,755	13,950	13,043	-5,712	
450	***0.9***	***0.55***	***0.9***	***0.55***	***0***	***11***	***9***	***4,950***	***2,723***	***4,050***	***2,228***	***-495***	***pathfinder = 90.9% @ 8.5m w***
							Total	**66,800**	**69,515**	**62,130**	**39,049**	**-30,465**	

Wellington Creek Drainage **44% Reduction**

Table F-10. Tributaries Mud Creek through Trapper Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential minus Existing (kWh/day)	
395	0.6	2.2	0.9	0.55	-1.65	1	1	395	869	395	217	-652	Mud
245	0.8	1.1	0.9	0.55	-0.55	1	1	245	270	245	135	-135	Mud
1000	0.7	1.65	0.9	0.55	-1.1	3	3	3,000	4,950	3,000	1,650	-3,300	Mud
143	0.6	2.2	0.9	0.55	-1.65	3	3	429	944	429	236	-708	Mud
690	0.7	1.65	0.89	0.605	-1.045	4	4	2,760	4,554	2,760	1,670	-2,884	Mud
138	0.2	4.4	0.89	0.605	-3.795	4	4	552	2,429	552	334	-2,095	Mud
540	0.8	1.1	0.9	0.55	-0.55	1	1	540	594	540	297	-297	Steep
390	0.7	1.65	0.9	0.55	-1.1	1	1	390	644	390	215	-429	Steep
430	0.8	1.1	0.9	0.55	-0.55	3	3	1,290	1,419	1,290	710	-710	Steep
770	0.9	0.55	0.9	0.55	0	3	3	2,310	1,271	2,310	1,271	0	Steep
425	0.8	1.1	0.9	0.55	-0.55	1	1	425	468	425	234	-234	Steep/unnamed
750	0.7	1.65	0.9	0.55	-1.1	1	1	750	1,238	750	413	-825	Steep/unnamed
550	0.8	1.1	0.9	0.55	-0.55	3	3	1,650	1,815	1,650	908	-908	Steep/unnamed
293	0.9	0.55	0.9	0.55	0	3	3	879	483	879	483	0	Steep/unnamed
245	0.6	2.2	0.9	0.55	-1.65	1	1	245	539	245	135	-404	unnamed
665	0.7	1.65	0.9	0.55	-1.1	1	1	665	1,097	665	366	-732	unnamed
510	0.6	2.2	0.9	0.55	-1.65	3	3	1,530	3,366	1,530	842	-2,525	unnamed
273	0.9	0.55	0.9	0.55	0	3	3	819	450	819	450	0	unnamed
260	0.7	1.65	0.9	0.55	-1.1	3	3	780	1,287	780	429	-858	unnamed
760	0.7	1.65	0.9	0.55	-1.1	1	1	760	1,254	760	418	-836	Silvertip
885	0.8	1.1	0.9	0.55	-0.55	1	1	885	974	885	487	-487	Silvertip
495	0.9	0.55	0.9	0.55	0	4	4	1,980	1,089	1,980	1,089	0	Silvertip
485	0.7	1.65	0.89	0.605	-1.045	4	4	1,940	3,201	1,940	1,174	-2,027	Silvertip
490	0.5	2.75	0.9	0.55	-2.2	1	1	490	1,348	490	270	-1,078	Trapper
1110	0.7	1.65	0.9	0.55	-1.1	3	3	3,330	5,495	3,330	1,832	-3,663	Trapper
1000	0.8	1.1	0.89	0.605	-0.495	4	4	4,000	4,400	4,000	2,420	-1,980	Trapper
180	0.3	3.85	0.89	0.605	-3.245	4	4	720	2,772	720	436	-2,336	Trapper
							Total	**33,759**	**49,217**	**33,759**	**19,116**	**-30,101**	

Tributaries, Mud Creek thru Trapper Creek **61% Reduction**

Table F-11. Porcupine Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
480	0.7	1.65	0.9	0.55	-1.10	1	1	480	792	480	264	-528	tributary
620	0.8	1.1	0.9	0.55	-0.55	1	1	620	682	620	341	-341	tributary
355	0.7	1.65	0.9	0.55	-1.1	3	3	1,065	1,757	1,065	586	-1,172	tributary
150	0.9	0.55	0.9	0.55	0	3	3	450	248	450	248	0	tributary
2310	0.7	1.65	0.9	0.55	-1.1	3	3	6,930	11,435	6,930	3,812	-7,623	SF
485	0.9	0.55	0.9	0.55	0	4	4	1,940	1,067	1,940	1,067	0	SF
245	0.7	1.65	0.95	0.275	-1.375	1	1	245	404	245	67	-337	
700	0.8	1.1	0.93	0.385	-0.715	3	3	2,100	2,310	2,100	808	-1,502	
550	0.9	0.55	0.93	0.385	-0.165	5	3	2,750	1,513	1,650	635	-877	
220	0.7	1.65	0.92	0.44	-1.21	7	4	1,540	2,541	880	387	-2,154	
190	0.8	1.1	0.92	0.44	-0.66	7	4	1,330	1,463	760	334	-1,129	
2190	0.9	0.55	0.9	0.55	0	9	7	19,710	10,841	15,330	8,432	-2,409	
660	***0.5***	***2.75***	***0.85***	***0.825***	***-1.925***	***11***	***8***	***7,260***	***19,965***	***5,280***	***4,356***	***-15,609***	***pathfinder = 56.9%***
670	0.9	0.55	0.9	0.55	0	11	8	7,370	4,054	5,360	2,948	-1,106	
320	0.8	1.1	0.85	0.825	-0.275	11	8	3,520	3,872	2,560	2,112	-1,760	
							Total	**57,310**	**62,942**	**45,650**	**26,397**	**-36,545**	

Porcupine Creek **58% Reduction**

Table F-12. East Fork Creek and tributaries, including Savage Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
640	0.6	2.2	0.92	0.44	-1.76	4	4	2,560	5,632	2,560	1,126	-4,506	tributary
1090	0.7	1.65	0.92	0.44	-1.21	4	4	4,360	7,194	4,360	1,918	-5,276	tributary
520	0.9	0.55	0.9	0.55	0	5	5	2,600	1,430	2,600	1,430	0	tributary
540	0.8	1.1	0.89	0.605	-0.495	5	5	2,700	2,970	2,700	1,634	-1,337	tributary
860	0.9	0.55	0.9	0.55	0	5	5	4,300	2,365	4,300	2,365	0	tributary
445	0.7	1.65	0.93	0.385	-1.265	3	3	1,335	2,203	1,335	514	-1,689	Savage
1480	0.9	0.55	0.92	0.44	-0.11	8	4	11,840	6,512	5,920	2,605	-3,907	Savage
3440	***0.9***	***0.55***	***0.9***	***0.55***	***0***	***13***	***7***	***44,720***	***24,596***	***24,080***	***13,244***	***-11,352***	***pathfinder = 91.9%***
300	0.9	0.55	0.9	0.55	0	10	9	3,000	1,650	2,700	1,485	-165	
480	0.8	1.1	0.83	0.935	-0.165	10	9	4,800	5,280	4,320	4,039	-1,241	
160	0.5	2.75	0.83	0.935	-1.815	12	9	1,920	5,280	1,440	1,346	-3,934	
1390	0.8	1.1	0.8	1.1	0	14	11	19,460	21,406	15,290	16,819	-4,587	
2460	***0.7***	***1.65***	***0.75***	***1.375***	***-0.275***	***16***	***12***	***39,360***	***64,944***	***29,520***	***40,590***	***-24,354***	***pathfinder = 70.7%***
1760	***0.1***	***4.95***	***0.72***	***1.54***	***-3.41***	***20***	***14***	***35,200***	***174,240***	***24,640***	***37,946***	***-136,294***	***pathfinder = 15.2%***
							Total	**178,155**	**325,702**	**125,765**	**127,061**	**-198,640**	
												East Fork Creek Drainage	**61% Reduction**

Table F-13. Tributaries between East Fork and Morris Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
970	0.7	1.65	0.95	0.275	-1.38	1	1	970	1,601	970	267	-1,334	#1
480	0.6	2.2	0.93	0.385	-1.815	3	3	1,440	3,168	1,440	554	-2,614	
390	0.7	1.65	0.93	0.385	-1.265	3	3	1,170	1,931	1,170	450	-1,480	
2190	0.7	1.65	0.93	0.385	-1.265	3	3	6,570	10,841	6,570	2,529	-8,311	#2
1470	0.7	1.65	0.93	0.385	-1.265	3	3	4,410	7,277	4,410	1,698	-5,579	#3
380	0.5	2.75	0.92	0.44	-2.31	4	4	1,520	4,180	1,520	669	-3,511	
							Total	**16,080**	**28,996**	**16,080**	**6,168**	**-22,828**	

3 Unnamed between EF and Morris 79 % Reduction

Table F-14. Morris Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
240	0.6	2.2	0.9	0.55	-1.65	1	1	240	528	240	132	-396	tributary
965	0.8	1.1	0.9	0.55	-0.55	3	3	2,895	3,185	2,895	1,592	-1,592	tributary
60	0.9	0.55	0.9	0.55	0	3	3	180	99	180	99	0	tributary
860	0.9	0.55	0.95	0.275	-0.275	1	1	860	473	860	237	-237	
790	0.8	1.1	0.93	0.385	-0.715	3	3	2,370	2,607	2,370	912	-1,695	
395	0.9	0.55	0.93	0.385	-0.165	4	3	1,580	869	1,185	456	-413	
160	0.8	1.1	0.92	0.44	-0.66	6	4	960	1,056	640	282	-774	
170	0.9	0.55	0.92	0.44	-0.11	6	4	1,020	561	680	299	-262	
200	0.8	1.1	0.89	0.605	-0.495	8	5	1,600	1,760	1,000	605	-1,155	
210	0.9	0.55	0.9	0.55	0	8	5	1,680	924	1,050	578	-347	
2250	***0.7***	***1.65***	***0.87***	***0.715***	***-0.935***	***10***	***7***	***22,500***	***37,125***	***15,750***	***11,261***	***-25,864***	***pathfinder = 78.5%***
							Total	**35,885**	**49,187**	**26,850**	**16,453**	**-32,734**	

Morris Creek 67% Reduction

Table F-15. Regal Creek and unnamed tributary between Morris Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
420	0.8	1.1	0.95	0.275	-0.82	1	1	420	462	420	116	-347	
340	0.9	0.55	0.95	0.275	-0.275	1	1	340	187	340	94	-93	
495	0.8	1.1	0.93	0.385	-0.715	3	3	1,485	1,634	1,485	572	-1,062	
610	0.9	0.55	0.93	0.385	-0.165	3	3	1,830	1,007	1,830	705	-302	
780	0.6	2.2	0.95	0.275	-1.925	1	1	780	1,716	780	215	-1,502	unnamed
1120	0.8	1.1	0.93	0.385	-0.715	3	3	3,360	3,696	3,360	1,294	-2,402	
810	0.9	0.55	0.92	0.44	-0.11	4	4	3,240	1,782	3,240	1,426	-356	
							Total	**11,455**	**10,483**	**11,455**	**4,419**	**-6,064**	
											Regal Creek & unnamed between Morris		**58% Reduction**

Table F-16. Cascade Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
1111	0.9	0.55	0.93	0.385	-0.17	3	3	3,333	1,833	3,333	1,283	-550	tributary
360	0.8	1.1	0.95	0.275	-0.825	1	1	360	396	360	99	-297	Webb
980	0.9	0.55	0.95	0.275	-0.275	1	1	980	539	980	270	-270	Webb
250	0.7	1.65	0.93	0.385	-1.265	3	3	750	1,238	750	289	-949	Webb
540	0.8	1.1	0.93	0.385	-0.715	3	3	1,620	1,782	1,620	624	-1,158	Webb
200	0.9	0.55	0.93	0.385	-0.165	3	3	600	330	600	231	-99	Webb
210	0.7	1.65	0.93	0.385	-1.265	3	3	630	1,040	630	243	-797	Webb
220	0.8	1.1	0.93	0.385	-0.715	3	3	660	726	660	254	-472	Webb
440	0.5	2.75	0.92	0.44	-2.31	4	4	1,760	4,840	1,760	774	-4,066	Webb
410	0.7	1.65	0.92	0.44	-1.21	4	4	1,640	2,706	1,640	722	-1,984	Webb
240	0.8	1.1	0.92	0.44	-0.66	4	4	960	1,056	960	422	-634	Webb
260	0.5	2.75	0.92	0.44	-2.31	4	4	1,040	2,860	1,040	458	-2,402	Webb
80	0.7	1.65	0.92	0.44	-1.21	4	4	320	528	320	141	-387	Webb
435	0.7	1.65	0.95	0.275	-1.375	1	1	435	718	435	120	-598	
370	0.8	1.1	0.95	0.275	-0.825	1	1	370	407	370	102	-305	
1370	0.9	0.55	0.93	0.385	-0.165	3	3	4,110	2,261	4,110	1,582	-678	
220	0.7	1.65	0.93	0.385	-1.265	3	3	660	1,089	660	254	-835	
1575	***0.9***	***0.55***	***0.92***	***0.44***	***-0.11***	***4***	***4***	***6,300***	***3,465***	***6,300***	***2,772***	***-693***	***pathfinder = 90.8% @ 3.5m bfw***
180	0.5	2.75	0.92	0.44	-2.31	4	4	720	1,980	720	317	-1,663	
285	0.7	1.65	0.92	0.44	-1.21	4	4	1,140	1,881	1,140	502	-1,379	
230	0.3	3.85	0.89	0.605	-3.245	5	5	1,150	4,428	1,150	696	-3,732	
1020	0.9	0.55	0.9	0.55	0	5	5	5,100	2,805	5,100	2,805	0	
225	0.5	2.75	0.89	0.605	-2.145	5	5	1,125	3,094	1,125	681	-2,413	
240	0.7	1.65	0.87	0.715	-0.935	7	7	1,680	2,772	1,680	1,201	-1,571	
300	0	5.5	0.87	0.715	-4.785	7	7	2,100	11,550	2,100	1,502	-10,049	
							Total	**39,543**	**56,322**	**39,543**	**18,341**	**-37,981**	**67% Reduction**

Cascade Creek Drainage

Table F-17. Spring Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
665	0.7	1.65	0.95	0.275	-1.38	1	1	665	1,097	665	183	-914	tributary
320	0.8	1.1	0.95	0.275	-0.825	1	1	320	352	320	88	-264	tributary
340	0.7	1.65	0.93	0.385	-1.265	3	3	1,020	1,683	1,020	393	-1,290	tributary
780	0.9	0.55	0.93	0.385	-0.165	3	3	2,340	1,287	2,340	901	-386	tributary
300	0.8	1.1	0.95	0.275	-0.825	1	1	300	330	300	83	-248	tributary
380	0.7	1.65	0.95	0.275	-1.375	1	1	380	627	380	105	-523	tributary
350	0.8	1.1	0.93	0.385	-0.715	3	3	1,050	1,155	1,050	404	-751	tributary
450	0.9	0.55	0.93	0.385	-0.165	3	3	1,350	743	1,350	520	-223	tributary
180	0.8	1.1	0.93	0.385	-0.715	3	3	540	594	540	208	-386	tributary
1770	0.9	0.55	0.92	0.44	-0.11	4	4	7,080	3,894	7,080	3,115	-779	tributary
360	0.7	1.65	0.95	0.275	-1.375	1	1	360	594	360	99	-495	
440	0.8	1.1	0.95	0.275	-0.825	1	1	440	484	440	121	-363	
480	0.7	1.65	0.93	0.385	-1.265	3	3	1,440	2,376	1,440	554	-1,822	
340	0.8	1.1	0.93	0.385	-0.715	3	3	1,020	1,122	1,020	393	-729	
1450	0.9	0.55	0.93	0.385	-0.165	3	3	4,350	2,393	4,350	1,675	-718	
190	0.7	1.65	0.92	0.44	-1.21	4	4	760	1,254	760	334	-920	
910	0.9	0.55	0.92	0.44	-0.11	4	4	3,640	2,002	3,640	1,602	-400	
510	0.7	1.65	0.89	0.605	-1.045	5	5	2,550	4,208	2,550	1,543	-2,665	
760	0.5	2.75	0.89	0.605	-2.145	5	5	3,800	10,450	3,800	2,299	-8,151	
1330	0.9	0.55	0.9	0.55	0	7	7	9,310	5,121	9,310	5,121	0	
50	0.3	3.85	0.87	0.715	-3.135	7	7	350	1,348	350	250	-1,097	
700	0.9	0.55	0.9	0.55	0	7	7	4,900	2,695	4,900	2,695	0	
40	0.7	1.65	0.87	0.715	-0.935	7	7	280	462	280	200	-262	
290	0.3	3.85	0.87	0.715	-3.135	7	7	2,030	7,816	2,030	1,451	-6,364	
220	0.9	0.55	0.9	0.55	0	7	7	1,540	847	1,540	847	0	
440	0.4	3.3	0.85	0.825	-2.475	8	8	3,520	11,616	3,520	2,904	-8,712	
350	0.9	0.55	0.9	0.55	0	8	8	2,800	1,540	2,800	1,540	0	
150	0.7	1.65	0.85	0.825	-0.825	8	8	1,200	1,980	1,200	990	-990	

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)
340	0.6	2.2	0.85	0.825	-1.375	8	8	2,720	5,984	2,720	2,244	-3,740
215	0.9	0.55	0.9	0.55	0	8	8	1,720	946	1,720	946	0
160	0.7	1.65	0.83	0.935	-0.715	9	9	1,440	2,376	1,440	1,346	-1,030
220	0.3	3.85	0.83	0.935	-2.915	9	9	1,980	7,623	1,980	1,851	-5,772
235	0.8	1.1	0.83	0.935	-0.165	9	9	2,115	2,327	2,115	1,978	-349
900	0.9	0.55	0.9	0.55	0	9	9	8,100	4,455	8,100	4,455	0
180	0	5.5	0.83	0.935	-4.565	9	9	1,620	8,910	1,620	1,515	-7,395
							Total	**79,030**	**102,688**	**79,030**	**44,952**	**-57,736**

Spring Creek Drainage **56% Reduction**

Table F-18. Mosquito Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential minus Existing Load (kWh/day)	
1070	0.9	0.55	0.95	0.275	-0.28	1	1	1,070	589	1,070	294	-294	tributary
220	0.2	4.4	0.95	0.275	-4.125	1	1	220	968	220	61	-908	tributary
360	0.7	1.65	0.93	0.385	-1.265	3	3	1,080	1,782	1,080	416	-1,366	tributary
1190	0.9	0.55	0.93	0.385	-0.165	3	3	3,570	1,964	3,570	1,374	-589	tributary
185	0.8	1.1	0.92	0.44	-0.66	4	4	740	814	740	326	-488	tributary
1260	0.9	0.55	0.92	0.44	-0.11	4	4	5,040	2,772	5,040	2,218	-554	tributary
490	0.7	1.65	0.95	0.275	-1.375	1	1	490	809	490	135	-674	
3185	0.9	0.55	0.93	0.385	-0.165	3	3	9,555	5,255	9,555	3,679	-1,577	
560	0.8	1.1	0.92	0.44	-0.66	4	4	2,240	2,464	2,240	986	-1,478	
775	0.9	0.55	0.9	0.55	0	5	5	3,875	2,131	3,875	2,131	0	
800	0.8	1.1	0.89	0.605	-0.495	5	5	4,000	4,400	4,000	2,420	-1,980	
1140	0.9	0.55	0.9	0.55	0	5	5	5,700	3,135	5,700	3,135	0	
245	0.8	1.1	0.87	0.715	-0.385	7	7	1,715	1,887	1,715	1,226	-660	
780	0.9	0.55	0.9	0.55	0	7	7	5,460	3,003	5,460	3,003	0	
250	0.7	1.65	0.7	1.65	0	7	7	1,750	2,888	1,750	2,888	0	forest/shrub
260	0.2	4.4	0.7	1.65	-2.75	8	8	2,080	9,152	2,080	3,432	-5,720	forest/shrub
280	0.5	2.75	0.7	1.65	-1.1	8	8	2,240	6,160	2,240	3,696	-2,464	forest/shrub
1150	0	5.5	0.7	1.65	-3.85	8	8	9,200	50,600	9,200	15,180	-35,420	forest/shrub
							Total	**60,025**	**100,771**	**60,025**	**46,598**	**-54,173**	

Mosquito Creek Drainage 54% Reduction

Table F-19. Gold Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
1040	0.9	0.55	0.95	0.275	-0.28	1	1	1,040	572	1,040	286	-286	tributary
1415	0.8	1.1	0.93	0.385	-0.715	3	3	4,245	4,670	4,245	1,634	-3,035	tributary
190	0.9	0.55	0.95	0.275	-0.275	1	1	190	105	190	52	-52	
660	0.7	1.65	0.95	0.275	-1.375	1	1	660	1,089	660	182	-908	
230	0.9	0.55	0.93	0.385	-0.165	3	3	690	380	690	266	-114	
630	0.8	1.1	0.93	0.385	-0.715	3	3	1,890	2,079	1,890	728	-1,351	
250	0.5	2.75	0.93	0.385	-2.365	3	3	750	2,063	750	289	-1,774	
1590	0.8	1.1	0.92	0.44	-0.66	4	4	6,360	6,996	6,360	2,798	-4,198	
170	0.6	2.2	0.92	0.44	-1.76	4	4	680	1,496	680	299	-1,197	
110	0.3	3.85	0.7	1.65	-2.2	4	4	440	1,694	440	726	-968	meadow
220	0.2	4.4	0.7	1.65	-2.75	5	5	1,100	4,840	1,100	1,815	-3,025	meadow
735	0.3	3.85	0.7	1.65	-2.2	5	5	3,675	14,149	3,675	6,064	-8,085	meadow
740	0.7	1.65	0.89	0.605	-1.045	5	5	3,700	6,105	3,700	2,239	-3,867	
300	0.6	2.2	0.87	0.715	-1.485	7	7	2,100	4,620	2,100	1,502	-3,119	
380	0.5	2.75	0.87	0.715	-2.035	7	7	2,660	7,315	2,660	1,902	-5,413	
70	0.1	4.95	0.87	0.715	-4.235	7	7	490	2,426	490	350	-2,075	
235	0.5	2.75	0.87	0.715	-2.035	7	7	1,645	4,524	1,645	1,176	-3,348	
250	0.3	3.85	0.87	0.715	-3.135	7	7	1,750	6,738	1,750	1,251	-5,486	
255	0.1	4.95	0.87	0.715	-4.235	7	7	1,785	8,836	1,785	1,276	-7,559	
90	0.2	4.4	0.87	0.715	-3.685	7	7	630	2,772	630	450	-2,322	MT
420	0.5	2.75	0.85	0.825	-1.925	8	8	3,360	9,240	3,360	2,772	-6,468	MT
125	0.1	4.95	0.85	0.825	-4.125	8	8	1,000	4,950	1,000	825	-4,125	MT
480	0.8	1.1	0.85	0.825	-0.275	8	8	3,840	4,224	3,840	3,168	-1,056	MT
160	0.6	2.2	0.85	0.825	-1.375	8	8	1,280	2,816	1,280	1,056	-1,760	MT
310	0.7	1.65	0.85	0.825	-0.825	8	8	2,480	4,092	2,480	2,046	-2,046	MT
240	0.9	0.55	0.9	0.55	0	8	8	1,920	1,056	1,920	1,056	0	MT
							Total	**50,360**	**109,843**	**50,360**	**36,208**	**-73,635**	
												Gold Creek	**67% Reduction**

Table F-20. Idaho portions of West Fork Gold Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
1590	0.5	2.75	0.95	0.275	-2.48	1	1	1,590	4,373	1,590	437	-3,935	tributary
300	0.4	3.3	0.93	0.385	-2.915	3	3	900	2,970	900	347	-2,624	tributary
380	0.3	3.85	0.93	0.385	-3.465	3	3	1,140	4,389	1,140	439	-3,950	tributary
3700	0.9	0.55	0.9	0.55	0	9	9	33,300	18,315	33,300	18,315	0	
420	0.5	2.75	0.78	1.21	-1.54	11	11	4,620	12,705	4,620	5,590	-7,115	
690	0.3	3.85	0.78	1.21	-2.64	11	11	7,590	29,222	7,590	9,184	-20,038	
							Total	**49,140**	**71,973**	**49,140**	**34,312**	**-37,661**	

WF Blue Creek in Idaho 52% Reduction

Table F-21. Johnson Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
1250	0.9	0.55	0.95	0.275	-0.28	1	1	1,250	688	1,250	344	-344	tributary 1
370	0.8	1.1	0.93	0.385	-0.715	3	3	1,110	1,221	1,110	427	-794	tributary 1
50	0.9	0.55	0.93	0.385	-0.165	3	3	150	83	150	58	-25	tributary 1
240	0.8	1.1	0.95	0.275	-0.825	1	1	240	264	240	66	-198	tributary 2
190	0.9	0.55	0.95	0.275	-0.275	1	1	190	105	190	52	-52	tributary 2
960	0.8	1.1	0.95	0.275	-0.825	1	1	960	1,056	960	264	-792	tributary 2
490	0.9	0.55	0.93	0.385	-0.165	3	3	1,470	809	1,470	566	-243	tributary 2
700	0.8	1.1	0.93	0.385	-0.715	3	3	2,100	2,310	2,100	808	-1,502	tributary 2
390	0.8	1.1	0.93	0.385	-0.715	3	3	1,170	1,287	1,170	450	-837	tributary 2
260	0.9	0.55	0.92	0.44	-0.11	4	4	1,040	572	1,040	458	-114	tributary 2
800	0.8	1.1	0.92	0.44	-0.66	4	4	3,200	3,520	3,200	1,408	-2,112	tributary 2
640	0.9	0.55	0.95	0.275	-0.275	1	1	640	352	640	176	-176	tributary 3
1470	0.8	1.1	0.93	0.385	-0.715	3	3	4,410	4,851	4,410	1,698	-3,153	tributary 3

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
1120	0.9	0.55	0.95	0.275	-0.275	1	1	1,120	616	1,120	308	-308	tributary 4
160	0.7	1.65	0.93	0.385	-1.265	3	3	480	792	480	185	-607	tributary 4
250	0.8	1.1	0.93	0.385	-0.715	3	3	750	825	750	289	-536	tributary 4
130	0.7	1.65	0.93	0.385	-1.265	3	3	390	644	390	150	-493	tributary 4
380	0.8	1.1	0.93	0.385	-0.715	3	3	1,140	1,254	1,140	439	-815	tributary 4
930	0.9	0.55	0.95	0.275	-0.275	1	1	930	512	930	256	-256	tributary 5
530	0.8	1.1	0.93	0.385	-0.715	3	3	1,590	1,749	1,590	612	-1,137	tributary 5
170	0.6	2.2	0.93	0.385	-1.815	3	3	510	1,122	510	196	-926	tributary 5
170	0.9	0.55	0.93	0.385	-0.165	3	3	510	281	510	196	-84	tributary 5
210	0.8	1.1	0.93	0.385	-0.715	3	3	630	693	630	243	-450	tributary 5
980	0.9	0.55	0.95	0.275	-0.275	1	1	980	539	980	270	-270	
1000	0.8	1.1	0.93	0.385	-0.715	3	3	3,000	3,300	3,000	1,155	-2,145	
740	0.7	1.65	0.92	0.44	-1.21	4	4	2,960	4,884	2,960	1,302	-3,582	
4330	***0.8***	***1.1***	***0.83***	***0.935***	***-0.165***	***9***	***9***	***38,970***	***42,867***	***38,970***	***36,437***	***-6,430***	***pathfinder = 87.6%***
400	0.7	1.65	0.78	1.21	-0.44	11	11	4,400	7,260	4,400	5,324	-1,936	
1570	0.8	1.1	0.8	1.1	0	11	11	17,270	18,997	17,270	18,997	0	
260	0.6	2.2	0.78	1.21	-0.99	11	11	2,860	6,292	2,860	3,461	-2,831	
							Total	**96,420**	**109,742**	**96,420**	**76,595**	**-33,147**	
											Johnson Creek		**30% Reduction**

Table F-22. West Johnson Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
230	0.7	1.65	0.95	0.275	-1.38	1	1	230	380	230	63	-316	tributary 1
285	0.6	2.2	0.95	0.275	-1.925	1	1	285	627	285	78	-549	tributary 1
250	0.5	2.75	0.95	0.275	-2.475	1	1	250	688	250	69	-619	tributary 1
120	0.7	1.65	0.93	0.385	-1.265	3	3	360	594	360	139	-455	tributary 1
1150	0.5	2.75	0.93	0.385	-2.365	3	3	3,450	9,488	3,450	1,328	-8,159	tributary 1
245	0.8	1.1	0.93	0.385	-0.715	3	3	735	809	735	283	-526	tributary 1
500	0.7	1.65	0.95	0.275	-1.375	1	1	500	825	500	138	-688	tributary 2
560	0.8	1.1	0.95	0.275	-0.825	1	1	560	616	560	154	-462	tributary 2
145	0.7	1.65	0.93	0.385	-1.265	3	3	435	718	435	167	-550	tributary 2
50	0.5	2.75	0.93	0.385	-2.365	3	3	150	413	150	58	-355	tributary 2
365	0.7	1.65	0.95	0.275	-1.375	1	1	365	602	365	100	-502	tributary 3
650	0.8	1.1	0.95	0.275	-0.825	1	1	650	715	650	179	-536	tributary 3
940	0.7	1.65	0.93	0.385	-1.265	3	3	2,820	4,653	2,820	1,086	-3,567	tributary 3
50	0.3	3.85	0.93	0.385	-3.465	3	3	150	578	150	58	-520	tributary 3
1400	0.8	1.1	0.95	0.275	-0.825	1	1	1,400	1,540	1,400	385	-1,155	tributary 4
325	0.7	1.65	0.93	0.385	-1.265	3	3	975	1,609	975	375	-1,233	tributary 4
230	0.9	0.55	0.93	0.385	-0.165	3	3	690	380	690	266	-114	tributary 4
290	0.7	1.65	0.95	0.275	-1.375	1	1	290	479	290	80	-399	
2300	0.8	1.1	0.93	0.385	-0.715	3	3	6,900	7,590	6,900	2,657	-4,934	
80	0.5	2.75	0.92	0.44	-2.31	4	4	320	880	320	141	-739	
370	0.8	1.1	0.92	0.44	-0.66	4	4	1,480	1,628	1,480	651	-977	
560	0.5	2.75	0.87	0.715	-2.035	7	7	3,920	10,780	3,920	2,803	-7,977	
460	0.8	1.1	0.87	0.715	-0.385	7	7	3,220	3,542	3,220	2,302	-1,240	
							Total	**30,135**	**50,130**	**30,135**	**13,559**	**-36,571**	

West Johnson Creek 73% Reduction

Table F-23. Derr Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
790	0.8	1.1	0.95	0.275	-0.82	1	1	790	869	790	217	-652	forest
930	0.9	0.55	0.93	0.385	-0.165	3	3	2,790	1,535	2,790	1,074	-460	
1160	0.8	1.1	0.92	0.44	-0.66	4	4	4,640	5,104	4,640	2,042	-3,062	
2140	0.9	0.55	0.9	0.55	0	5	5	10,700	5,885	10,700	5,885	0	
950	0.8	1.1	0.89	0.605	-0.495	5	5	4,750	5,225	4,750	2,874	-2,351	
1080	0.1	4.95	0.7	1.65	-3.3	7	7	7,560	37,422	7,560	12,474	-24,948	forest/shrub
460	0.2	4.4	0.7	1.65	-2.75	7	7	3,220	14,168	3,220	5,313	-8,855	
580	0.1	4.95	0.7	1.65	-3.3	7	7	4,060	20,097	4,060	6,699	-13,398	
60	0.2	4.4	0.7	1.65	-2.75	7	7	420	1,848	420	693	-1,155	
75	0.1	4.95	0.7	1.65	-3.3	7	7	525	2,599	525	866	-1,733	
150	0.3	3.85	0.7	1.65	-2.2	8	8	1,200	4,620	1,200	1,980	-2,640	
400	0.2	4.4	0.7	1.65	-2.75	8	8	3,200	14,080	3,200	5,280	-8,800	
565	0.1	4.95	0.7	1.65	-3.3	8	8	4,520	22,374	4,520	7,458	-14,916	
145	0.2	4.4	0.7	1.65	-2.75	8	8	1,160	5,104	1,160	1,914	-3,190	
150	0.1	4.95	0.7	1.65	-3.3	8	8	1,200	5,940	1,200	1,980	-3,960	
2130	0	5.5	0.2	4.4	-1.1	40	40	85,200	468,600	85,200	374,880	-93,720	backwater
							Total	**135,935**	**615,469**	**135,935**	**431,629**	**-183,840**	
												Derr Creek	**30% Reduction**

Table F-24. Twin Creek Existing and Target (Potential) Summer Temperature Loads.

Segmen t Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
1640	0.9	0.55	0.93	0.385	-0.17	3	3	4,920	2,706	4,920	1,894	-812	tributary 1
1000	0.8	1.1	0.95	0.275	-0.825	1	1	1,000	1,100	1,000	275	-825	Delyle Cr.
1220	0.9	0.55	0.93	0.385	-0.165	3	3	3,660	2,013	3,660	1,409	-604	Delyle Cr.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
1965	0.8	1.1	0.92	0.44	-0.66	4	4	7,860	8,646	7,860	3,458	-5,188	Delyle Cr.
800	0.7	1.65	0.92	0.44	-1.21	4	4	3,200	5,280	3,200	1,408	-3,872	Delyle Cr.
915	0.9	0.55	0.95	0.275	-0.275	1	1	915	503	915	252	-252	tributary 3
475	0.8	1.1	0.93	0.385	-0.715	3	3	1,425	1,568	1,425	549	-1,019	tributary 3
2630	0.9	0.55	0.92	0.44	-0.11	4	4	10,520	5,786	10,520	4,629	-1,157	tributary 3
490	0.6	2.2	0.92	0.44	-1.76	4	4	1,960	4,312	1,960	862	-3,450	tributary 3
695	0.9	0.55	0.95	0.275	-0.275	1	1	695	382	695	191	-191	tributary 3
290	0.7	1.65	0.95	0.275	-1.375	1	1	290	479	290	80	-399	tributary 3
620	0.9	0.55	0.93	0.385	-0.165	3	3	1,860	1,023	1,860	716	-307	tributary 3
380	0.8	1.1	0.93	0.385	-0.715	3	3	1,140	1,254	1,140	439	-815	tributary 3
230	0.8	1.1	0.95	0.275	-0.825	1	1	230	253	230	63	-190	tributary 4
420	0.9	0.55	0.95	0.275	-0.275	1	1	420	231	420	116	-116	tributary 4
360	0.8	1.1	0.95	0.275	-0.825	1	1	360	396	360	99	-297	tributary 4
270	0.9	0.55	0.93	0.385	-0.165	3	3	810	446	810	312	-134	tributary 4
250	0.7	1.65	0.93	0.385	-1.265	3	3	750	1,238	750	289	-949	tributary 4
360	0.8	1.1	0.93	0.385	-0.715	3	3	1,080	1,188	1,080	416	-772	tributary 4
500	0.5	2.75	0.95	0.275	-2.475	1	1	500	1,375	500	138	-1,238	
510	0.7	1.65	0.93	0.385	-1.265	3	3	1,530	2,525	1,530	589	-1,935	
490	0.8	1.1	0.92	0.44	-0.66	4	4	1,960	2,156	1,960	862	-1,294	
3140	0.9	0.55	0.9	0.55	0	5	5	15,700	8,635	15,700	8,635	0	
870	0.7	1.65	0.87	0.715	-0.935	7	7	6,090	10,049	6,090	4,354	-5,694	
310	0.8	1.1	0.85	0.825	-0.275	8	8	2,480	2,728	2,480	2,046	-682	
1230	0.7	1.65	0.83	0.935	-0.715	9	9	11,070	18,266	11,070	10,350	-7,915	
145	0.8	1.1	0.8	1.1	0	11	11	1,595	1,755	1,595	1,755	0	
380	0.7	1.65	0.78	1.21	-0.44	11	11	4,180	6,897	4,180	5,058	-1,839	
1050	***0.8***	***1.1***	***0.8***	***1.1***	***0***	***11***	***11***	***11,550***	***12,705***	***11,550***	***12,705***	***0***	***pathfinder = 86.9%***
2270	0	5.5	0.6	2.2	-3.3	11	11	24,970	137,335	24,970	54,934	-82,401	forest/shrub
							Total	**124,720**	**243,227**	**124,720**	**118,882**	**-124,344**	

Twin Creek Drainage **51% Reduction**

Table F-25. Dry Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
680	0.8	1.1	0.95	0.275	-0.82	1	1	680	748	680	187	-561	tributary
230	0.7	1.65	0.93	0.385	-1.265	3	3	690	1,139	690	266	-873	tributary
220	0.8	1.1	0.92	0.44	-0.66	4	4	880	968	880	387	-581	tributary
550	0.7	1.65	0.89	0.605	-1.045	5	5	2,750	4,538	2,750	1,664	-2,874	tributary
790	0.9	0.55	0.95	0.275	-0.275	1	1	790	435	790	217	-217	
4060	0.8	1.1	0.92	0.44	-0.66	4	4	16,240	17,864	16,240	7,146	-10,718	
1025	0.7	1.65	0.89	0.605	-1.045	5	5	5,125	8,456	5,125	3,101	-5,356	
1790	0.8	1.1	0.87	0.715	-0.385	7	7	12,530	13,783	12,530	8,959	-4,824	
70	0.6	2.2	0.85	0.825	-1.375	8	8	560	1,232	560	462	-770	
930	0.8	1.1	0.85	0.825	-0.275	8	8	7,440	8,184	7,440	6,138	-2,046	
700	0.7	1.65	0.85	0.825	-0.825	8	8	5,600	9,240	5,600	4,620	-4,620	
650	0.8	1.1	0.85	0.825	-0.275	8	8	5,200	5,720	5,200	4,290	-1,430	
600	0.7	1.65	0.85	0.825	-0.825	8	8	4,800	7,920	4,800	3,960	-3,960	
							Total	**63,285**	**80,226**	**63,285**	**41,396**	**-38,830**	
												Dry Creek	**48%Reduction**

Table F-26. Unnamed stream near Montana border Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
780	0.8	1.1	0.95	0.275	-0.82	1	1	780	858	780	215	-644	forest
910	0.9	0.55	0.95	0.275	-0.275	1	1	910	501	910	250	-250	
480	0.8	1.1	0.93	0.385	-0.715	3	3	1,440	1,584	1,440	554	-1,030	
275	0.6	2.2	0.93	0.385	-1.815	3	3	825	1,815	825	318	-1,497	
450	0.7	1.65	0.92	0.44	-1.21	4	4	1,800	2,970	1,800	792	-2,178	
100	0	5.5	0.92	0.44	-5.06	4	4	400	2,200	400	176	-2,024	
230	0.6	2.2	0.92	0.44	-1.76	4	4	920	2,024	920	405	-1,619	
50	0	5.5	0.89	0.605	-4.895	5	5	250	1,375	250	151	-1,224	
450	0.5	2.75	0.89	0.605	-2.145	5	5	2,250	6,188	2,250	1,361	-4,826	
260	0.1	4.95	0.7	1.65	-3.3	7	7	1,820	9,009	1,820	3,003	-6,006	forest/shrub
220	0.7	1.65	0.7	1.65	0	7	7	1,540	2,541	1,540	2,541	0	forest/shrub
80	0.6	2.2	0.7	1.65	-0.55	7	7	560	1,232	560	924	-308	forest/shrub
390	0.8	1.1	0.8	1.1	0	7	7	2,730	3,003	2,730	3,003	0	forest/shrub
300	0.7	1.65	0.7	1.65	0	7	7	2,100	3,465	2,100	3,465	0	forest/shrub
130	0.9	0.55	0.9	0.55	0	7	7	910	501	910	501	0	forest/shrub
							Total	**19,235**	**39,265**	**19,235**	**17,659**	**-21,606**	

Unnamed nearr MT border 55% Reduction

Table F-27. Lightning Creek Existing and Target (Potential) Summer Temperature Loads.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load ($kWh/m^2/day$)	Potential Shade (fraction)	Potential Summer Load ($kWh/m^2/day$)	Potential Load minus Existing load ($kWh/m^2/day$)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	
241.4	0.9	0.55	0.9	0.55	0.00	1	1	241	133	241	133	0	
241.4	0.8	1.1	0.9	0.55	-0.55	3	2	724	797	483	266	-531	
965.6	0.9	0.55	0.9	0.55	0.00	5	3	4,828	2,655	2,897	1,593	-1,062	
3057.8	***0.7***	***1.65***	***0.8***	***1.10***	***-0.55***	***8***	***5***	***24,462***	***40,362***	***15,289***	***16,818***	***-23,545***	***ab Gem***
402.3	0.7	1.65	0.7	1.65	0.00	12	11	4,828	7,966	4,426	7,302	-664	
563.3	0.6	2.2	0.62	2.09	-0.11	12	11	6,759	14,870	6,196	12,950	-1,921	
643.7	***0.7***	***1.65***	***0.7***	***1.65***	***0.00***	***14***	***11***	***9,012***	***14,870***	***7,081***	***11,684***	***-3,187***	***ab Moose***
402.3	0.6	2.2	0.6	2.20	0.00	16	14	6,437	14,162	5,633	12,392	-1,770	
724.2	0.7	1.65	0.6	2.20	0.55	16	14	11,587	19,119	10,139	22,306	3,187	
965.6	***0.8***	***1.1***	***0.8***	***1.10***	***0.00***	***16***	***14***	***15,450***	***16,995***	***13,518***	***14,870***	***-2,124***	***ab Quartz***
965.6	0.7	1.65	0.7	1.65	0.00	18	16	17,381	28,679	15,450	25,492	-3,187	
1448.4	***0.6***	***2.2***	***0.6***	***2.20***	***0.00***	***18***	***16***	***26,071***	***57,357***	***23,175***	***50,984***	***-6,373***	***ab Rattle***
5954.6	0.5	2.75	0.63	2.04	-0.72	26	19	154,819	425,752	113,137	230,234	-195,518	ab Wellington
2333.5	0.2	4.4	0.56	2.42	-1.98	35	24	81,674	359,367	56,005	135,533	-223,834	
4828.0	0.4	3.3	0.56	2.42	-0.88	50	24	241,402	796,625	115,873	280,412	-516,213	ab EF
8529.5	0.2	4.4	0.49	2.81	-1.60	68	28	580,008	2,552,033	238,827	669,909	-1,882,125	ab Cascade
5632.7	0	5.5	0.31	3.80	-1.71	100	54	563,270	3,097,987	304,166	1,154,310	-1,943,677	Cascade to mth
							Total	**1,748,955**	**7,449,730**	**932,534**	**2,647,186**	**-4,802,544**	

Solar pathfinder verification sites in order from top to bottom = 73.3%, 50.3%, 25.7%, and 7.1%

Lightning Creek **64% Reduction**

Appendix G. Lower Clark Fork River Subbasin Sediment Model Methodology

Lower Clark Fork River Subbasin Sediment Model

In the panhandle region of Idaho, sediment is the pollutant of concern in the majority of water quality limited streams. The lithology, or terrain of the region, most often governs the form the sediment takes. Two major types of terrain dominate in northern Idaho. These are the meta-sedimentary Belt Supergroup and granitics present either in the Kaniksu batholith or in smaller intrusions such as the Round Top Pluton and the Gem Stocks. In some locations Columbia River Basalt formations are important, but these tend to be to the south and west; primarily on the Coeur d'Alene Indian Reservation. Granitics mainly weather to sandy materials, but also weather to pebbles or larger-sized particles. Pebbles and larger particles with significant amounts of sand remain in the higher gradient stream bedload. The Belt terrain produces silt size particles, pebbles, and larger particles. Silt particles are transported to low gradient reaches, while the larger particles comprise the majority of the higher gradient stream bedload. Basalts erode to silt and particles similar in size to the Belt terrain. Large basalt particles are less resistant and weather to smaller particles.

A sediment model was developed specific to the Idaho portions of the Lower Clark Fork River Subbasin. The model was developed to try and quantify the state of Idaho's narrative sediment water quality standard. The model attempts to account for all land use types separately. By estimating the existing contributing sediment load by land use types implementation strategies may be developed to address these site specific issues. All attempts to model sediment were intended to provide a relative rather than an exact sediment yield.

<u>Land use types</u>

All attempts were made to use the most applicable and accurate data available to determine sediment yield coefficients. Coefficients were developed from a mixture of literature, EPA approved TMDLs, group discussion and professional experience. The processes used attempts to characterize all known sediment contributing land activities separately. Coefficients were designed to provide a relative rather than an exact estimate of sediment yield within the basin.

Forest (natural background)

Natural background sediment yield coefficient was measured in-stream on geologies on north central Idaho and covers production and delivery from forested areas. This sediment yield coefficient reflects both fine and course sediment.

Forested areas were assigned sediment yield coefficient for metasediment Belt Supergroup geologies. Forested areas included fully stocked and naturally non stocked areas. Applying the sediment yield coefficient to all forested areas provided for a conservative estimate (overestimate).

The Water and Sediment yield (WATSED) model was used to develop natural background sediment yield coefficients for forested land use type within a metamorphic Belt Supergroup geology setting for the *Priest River Subbasin Assessment and Total Maximum Daily Load* (IDEQ 2001). Similar sediment yield coefficients were used in the development of the *St. Joe River Subbasin Assessment and Total Maximum Daily Loads* (IDEQ 2003).

The sediment yield coefficient used in the Priest River TMDL (0.02 tons/acre/year) most closely represents the geologic setting in the Lower Clark Fork River Subbasin. The sediment yield value used in the St. Joe River TMDL was 0.023 tons/acre/year with an expected range of 0.019 tons/acre/year to 0.027 tons/acre/year. These two coefficients are consistent with the 0.023 tons/acre/year used in the Lower Clark Fork River Subbasin sediment model.

Forest Roads

Road erosion scores from the Cumulative Watershed Effects (CWE) program were applied to all road scores within the subbasin. Roads located within 200 feet of a stream were allocated the entire associated sediment yield amount. A 40 foot buffer was applied to all roads. A 40 foot buffer was chosen to account the entire typical road prism of an active timber road (IDEQ 2001). Road mileage of forest roads was multiplied by the 40 foot buffer in order to converted sediment yield to tons per acre.

Forest roads were modeled using data developed with CWE protocol (IDL 2000). CWE scores were used to estimate surface erosion from the road surface. Forest road sediment yield was estimated using the relationship between the CWE score and the sediment yield per mile of road (Figure G-1). The relationship was developed for roads on a Kaniksu granitic terrain in the LaClerc Creek watershed (McGreer 1998). Its application to roads on a Belt terrain conservatively estimates (overestimates) sediment yields from these systems. The watershed CWE score was used to develop sediment tons per acre, which was multiplied by the estimated road acreage.

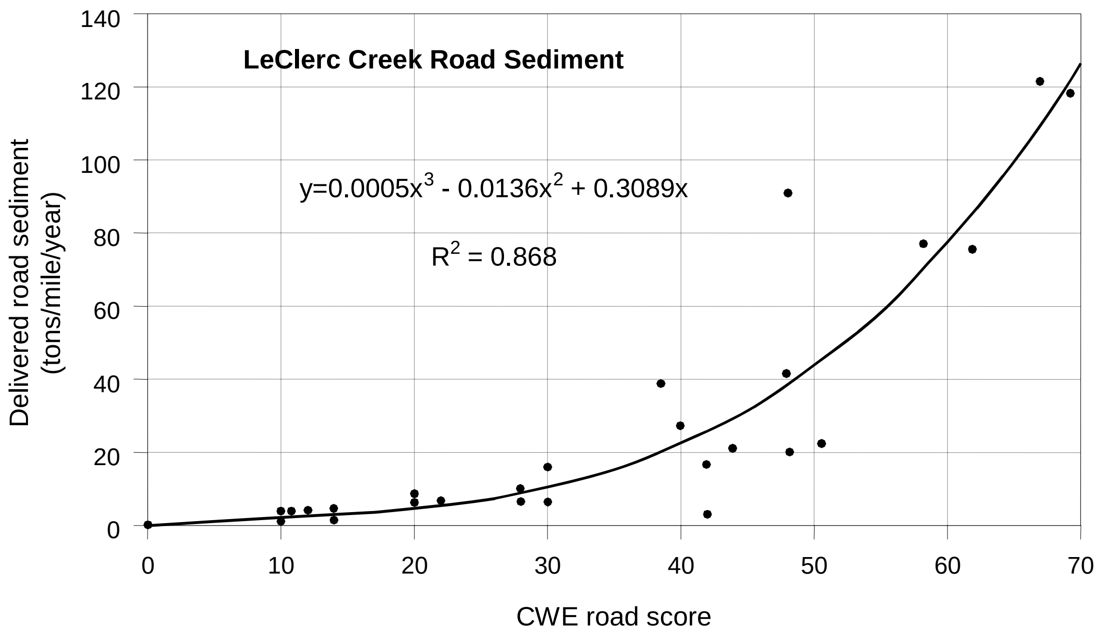

Figure G-1. Sediment export from roads based on CWE scores.

Roads within the 200 feet steam corridor were allocated 100% of the sediment yield coefficient. It was assumed that all sediment from roads within the 200 foot corridor was delivered to the stream system. This is a conservative estimate of actual delivery. Roads not within the 200 foot stream corridor were allocated 10% of the sediment yield coefficient. Roads which were not scored using the CWE process were assigned the lowest CWE scored noted within the watershed, and allocated 10% of the sediment yield coefficient. The allocation of sediment yield to forest roads outside of the 200 foot stream corridor and roads which were not originally scored is a conservative estimate of sediment yield.

Roads cause stream sedimentation by an additional mechanism. The presence of roads in the floodplain of a stream often interferes with the stream's natural tendency to seek a steady state gradient. During high discharge periods, the constrained stream often erodes at the roadbed, or, if the bed is armored, erodes at the opposite bank or its bed. The erosion resulting from a road-imposed gradient change results in stream sedimentation. The bulk of this erosion is assumed to occur during large discharge events which occur on a 10 - 15-year return period (McClelland et. al 1997).

Agriculture

Revised Universal Soil Loss Equation Version 2 (RUSLE 2) is the correct model for agricultural land within the basin as it accounts for production and delivery of fine-grained sediment. Agricultural activities modeled were relatively small in area. Agricultural areas are located within the historic floodplain of the Clark Fork River. Low land portions of Lower Lightning Creek and Twin Creek were the only watersheds modeled to reflect agricultural activities.

Sediment yields from agriculture lands that received any tillage are modeled with RUSLE 2.

Equation 1: A = (R)(K)(LS)(C)(D) tons per acre per year where:

: A is the average annual soil loss from sheet and till erosion

: R is climate erosivity

: K is the soil erodibility

: LS is the slope length and steepness

: C is the cover management

: D is the support practices

The RUSLE 2 does not take into account stream bank erosion, gully erosion, or scour erosion. The RUSLE 2 applies to cropland, pasture, hayland or other land that has some vegetation improvement by tilling or seeding. Sediment yields were developed based on the soils, the characteristics of the agriculture and the slope. The RUSLE 2 develops values that reflect the amount of sediment eroded and delivered to the active channel of the stream system annually.

Wild fire

An attempt was made to categorize wild fire into two distinct categories, Recent and Historic fire. Recent fire includes all fires that have occurred within the last sixteen years, 1990-2002. Historic fire includes fires from 1970-1989. Areas burned prior to 1970 were assigned the natural background coefficient. Assuming that accelerated rates of erosion typically do not persist for more than several years after revegetation, assigning an above background sediment yield coefficient to historic burns is a conservative estimate.

Harvested areas

Harvested areas were classified into three land use type classes, High canopy alteration, Medium canopy alteration and Low canopy alteration. Classes were determined by visual interpretation of satellite imagery, field verified GIS data outlining percent canopy removal, and harvest practice utilized (clearcut, thinning or salvage). By classifying harvested areas into different classes an attempt was made to recognize the landscapes ability to revegetate and slow or stop erosional processes.

All harvested classifications included areas of clearcutting, liberation and salvage logging. Although information regarding harvest practice activities was utilized in the classifying harvested areas, the age of the harvest was used to determine the land use type. Areas classified as having high canopy alteration occurred after 1980 and continued through present, Medium canopy alteration were those areas harvested from 1960-1979 and Low canopy alteration areas were classified as areas cut prior to and including 1959.

Similar to wild fire, assuming that accelerated rates of erosion do not persist for more than several years after revegetation, assigning any sediment yield coefficient to historic harvest areas is a conservative estimate.

Mass wasting

Mass wasting was modeled to be the largest source of sediment yield to surface waters per area. Cacek identified one hundred and fifteen slides within the Lightning Creek watershed ranging in volume from 25 cubic meters to 75,000 cubic meters (Cacek 1989). In subsequent years additional mass wasting events have been identified and volumes estimated by federal and state governmental agencies. Cacek identified 75.5% of slides as occurring in sites impacted by roads or roads and clearcuts and 19% of all slide debris delivered to third-order or greater streams.

Mass wasting events were classified into Anthropogenic or Natural. Anthropogenic slides were classified as those slides originating from timber harvest activities or associated with roads. Naturally occurring slides were those slide not located in proximity to harvest activities or roads. Naturally occurring mass wasting events were allocated to natural background conditions and do not require a load reduction. Anthropogenic slides were allocated to land owners and managers. Vegetation removal, fire, roads and rural development have all been shown to increase the likelihood of mass wasting events.

A regression analysis was applied to mass wasting events, Figure G-2. Regression analysis was applied assuming a one third loss of material per large flow event. Volumes of mass wasting events were estimated in the field and by the use of aerial photo interpretation. Cacek directly measured slide volumes for small accessible slides. Using the data from smaller slides Cacek estimated slide volumes of larger slides using aerial photos and field measurements. Along with the entire estimated volume moved during the event, the amount yielded to surface water was also estimated. Estimates were made in cubic meters. Volume estimates were then multiplied by 2.7 to convert cubic meters to tons.

Applying a regression analysis is an attempt to model the documented accounts of mass failures returning to zero sediment yield over time. This assumption may be an overestimate for some events while being an under estimate for chronic mass wasting events. Each slide was evaluated individually to determine the amount yielded to surface water after three high flow events.

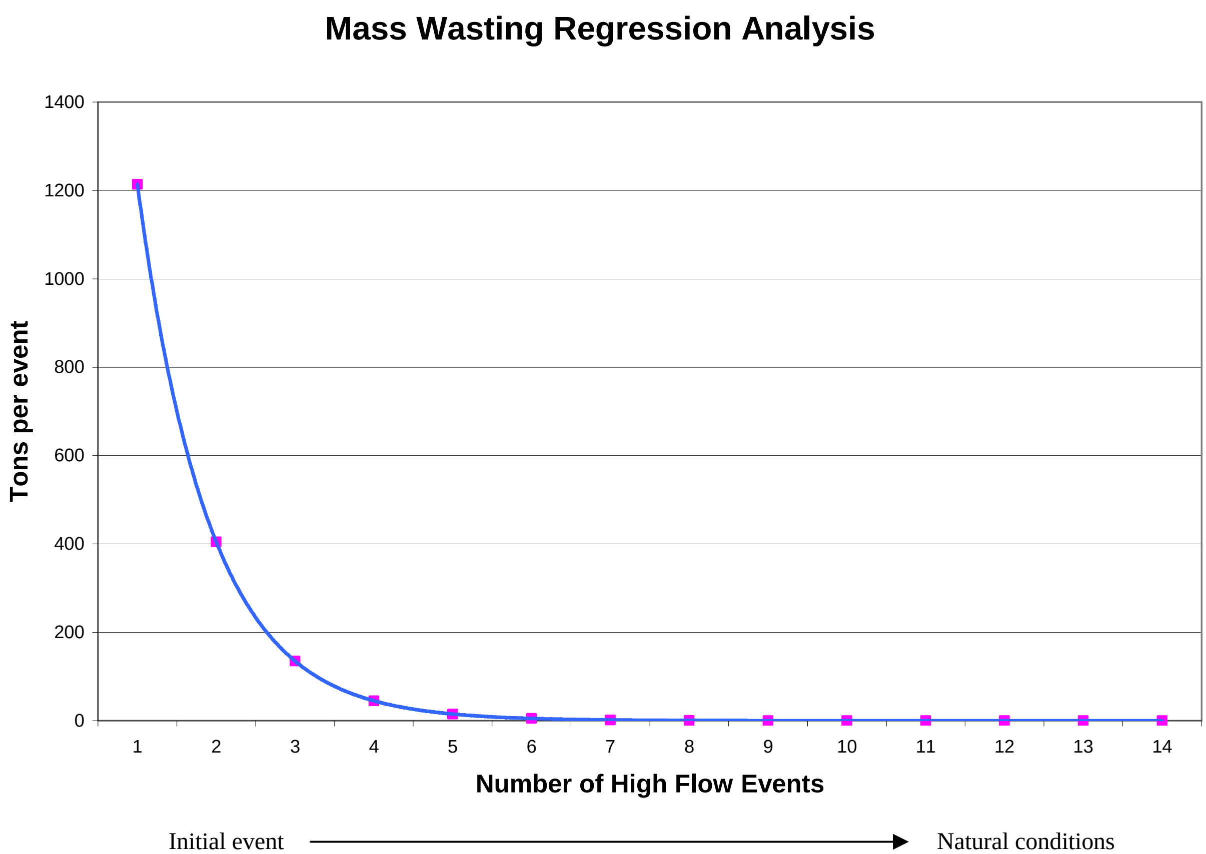

Figure G-2. Mass wasting regression analysis used in sediment model.

Sediment Coefficients

All sediment yield coefficients are expressed as tons per acre per year (t/a/y) and are applied to the acreage of each land type developed from the Geographical Information System (GIS) coverage (Table G-1). See Figure G-4 through Figure G-11 for modeled land use types per watershed in the Lower Clark Fork River Subbasin, Idaho. All land uses are displayed with estimated sediment delivery.

Land use	Coefficient (tons/acre/year)	Reference
High Canopy Alteration	0.21 t/a/y	Within ranges recorded for harvest activities.
Medium Canopy Alteration	0.07 t/a/y	Within ranges recorded for harvest activities.
Low Canopy Alteration	0.025 t/a/y	Within ranges recorded for harvest activities.
Anthropogenic slide	Volumes reported in cubic meters. Volume multiplied by 2.7 to convert to tons. Applied regression analysis to determine sediment contribution on an average annual basis.	Stream delivery volume obtained from IDL CWE reports and Cacek thesis (Cacek 1989).
Natural slide	Volumes reported in cubic meters. Volume multiplied by 2.7 to convert to tons. Applied regression analysis to determine sediment contribution on an average annual basis.	Stream delivery volume obtained from IDL CWE reports and Cacek thesis (Cacek 1989).
Forest Roads	McGreer equation used to determine sediment export from forest roads based on CWE scores, given 10% delivery.	Road scores obtained from CWE reports.
Forest Roads within 200 feet of stream	McGreer equation used to determine sediment export from forest roads based on CWE scores, given 100% delivery.	Road scores obtained from CWE reports.
Recent fire (2000-1990)	0.10 t/a/y	Values derived from WAG input and from best professional judgment.
Historic fire (1989-1970)	0.025 t/a/y	Values derived from WAG input and from best professional judgment.
Forest (Natural background)	0.023 t/a/y	Developed based on geology of the watershed and used in previously approved TMDL in northern Idaho.
Agriculture	0.055 t/a/y	Developed with RUSEL2, data supplied by IASCD
Urban	0.25 t/a/y	Developed from best professional judgment accounting for relevance with other land use types

Table G-1. Sediment yield coefficients used in Lower Clark Fork River Subbasin sediment TMDL.

Sediment yield coefficients were developed using best professional judgment, literature references and WAG input. Sediment yield was quantified to obtain a relative understanding of land use activity sediment yield to surface water.

Sediment Delivery Assumptions

- 100% delivery from forestlands with sediment yield coefficients measured in-stream on geologies of north central Idaho.
- 100% delivery from agriculture lands estimated with RUSLE 2 was applicable.

- Fine and coarse materials are delivered at the same rate from erosion resulting from road encroachment.
- 100% delivery from roads within 200 feet of stream.
- 10% delivery from all roads outside of 200 foot stream corridor.

Target Selection

Although it is well understood that streams have the ability to process sediment levels above natural background levels, it is not well understood to what level this is possible before impairment occurs. Sediment load targets have been set at various levels within northern Idaho. To determine the most appropriate target each subbasin must be evaluated on an individual basis.

Reference (conditions) streams were chosen to determine the appropriate sediment target to be used. Reference watersheds, watersheds supporting beneficial uses or those assumed to be biologically functioning, were selected using local knowledge and Watershed Advisory Group (WAG) input. The reference condition is based on a group of streams that are considered least impacted. Morris, Savage and Upper Lightning Creek above the Moose Creek confluence within Lightning Creek are considered relatively undisturbed and appropriate for reference streams (PWA 2004, WAG pers. Comm.). The neighboring watershed, Trestle Creek, the tributary with one of the highest number of bull trout redds in the Pend Oreille system, was also used as a reference stream (DuPont et al. 2004). Table G-2 provides a detailed breakdown of land use conditions in the reference watersheds. Land use activities within the watershed were mapped using a Global Information System (GIS) software package. Once the chosen land uses (Table G-1) were mapped, the area for each land use could be determined. Sediment yield coefficients were then applied to the appropriate land use and multiplied by the associated acreage. A pre-anthropogenic value was determined by multiplying the acreage of the watershed by the natural background sediment coefficient. The percentage above natural background was then derived by subtracting natural background conditions from current conditions, dividing by natural background conditions and then multiplying by 100.

Table G-2. Detailed breakdown of reference watershed modeled land use types.

	Morris Creek	**Savage Creek**	**Lightning Creek Headwaters**	**Trestle Creek**
Watershed type	Reference watershed	Reference watershed	Reference watershed	Reference watershed
Watershed size (acres)	3,016	2,485	3,884	12,606
Ecoregions	Purcell-Cabinet-Northern Bitterroot Mountains High Northern Rockies	Purcell-Cabinet-Northern Bitterroot Mountains High Northern Rockies	Purcell-Cabinet-Northern Bitterroot Mountains High Northern Rockies	Purcell-Cabinet-Northern Bitterroot Mountains High Northern Rockies
Land use Types	**% Land use (acres)**	**% Land use (acres)**	**% Land use (acres)**	**% Land use (acres)**
High Canopy Removal	0% (0)	0% (0)	2% (78)	2.7% (331)
Medium Canopy Removal	0.1% (3)	9.5% (235)	4.8% (187)	1.6% (195)
Low Canopy Removal	0% (0)	0% (0)	0% (0)	0.4% (55)
Forest (natural background)*	99.5% (3,000)	89.1% (2,215)	91.8% (3,561)	93.4% (11,571)
Agriculture	0% (0)	0% (0)	0% (0)	0% (0)
Forest Road	0.4% (12)	1.3% (32)	1.2% (47)	1.7% (211)
Forest Road with 200 feet of stream	0% (1)	0.1% (3)	0.2% (9)	0.2% (30)
Recent Fire*	0% (0)	0% (0)	0% (2)	0% (0)
Historic Fire*	0% (0)	0% (0)	0% (0)	0% (0)
	Number of Mass wasting events	**Number of mass wasting events**	**Number of mass wasting events**	**Number of mass wasting events**
Natural Slides*	0	5	0	0
Anthropogenic Slides	0	11	0	4

* Loads from naturally occurring land use types are not allocated for reductions.

The current sediment yield condition (percentage above natural background) of the reference streams were then analyzed to determine the most appropriate sediment yield target for the Lower Clark Fork River Subbasin. Once the sediment yield target was selected all other sub-watersheds within the Lower Clark Fork River Subbasin were analyzed to determine sediment yield reductions when appropriate.

The sediment yield target was derived from percentile categories of the reference condition, a process similar to the one used to determine stream macroinvertebrate index scores (see Garfe et al 2002). The seventy-fifth percentile was chosen as a sediment target from the distribution of reference conditions (Figure G-3).

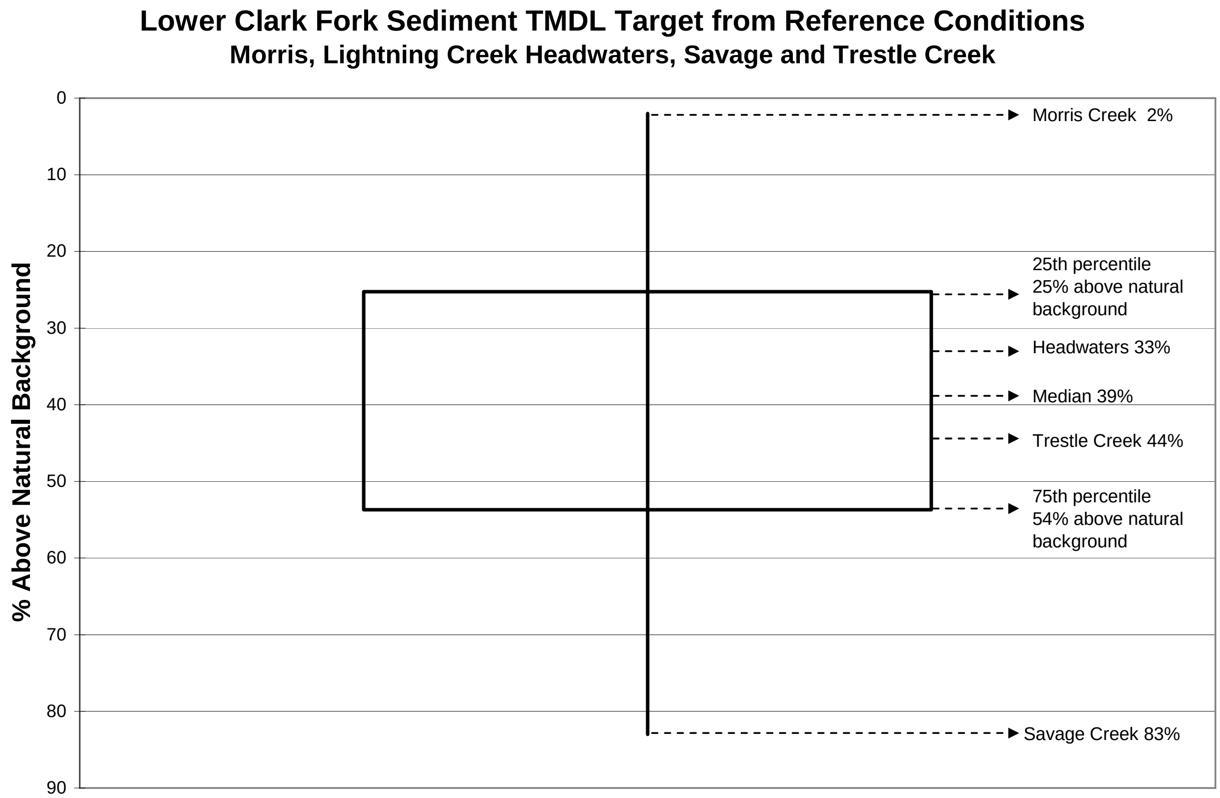

Figure G-3. Boxplot of reference watersheds percent above natural background conditions.

Allocating Loads

Sediment load allocation reductions were assigned to land owners and managers based on modeled land use types located within areas of ownership (Figure G-4). The load reduction required for each land owner/manger is based on the difference between the existing sediment contribution and the load capacity at 54% above natural background conditions. Steps were taken to allocated load reductions based on percent of modeled land type owned or managed. Sediment load contributions from forest (natural background), recent and historic fire, and naturally occurring mass wasting events were not allocated as reductions.

Steps taken to allocate sediment loads by land use types within the Lower Clark Fork River Subbasin are described below.

Step 1 Determine land use acres within the watershed and current load.

Step 2 Determine percent reductions from current conditions to achieve sediment target.

Load capacity at sediment target = (Natural background x target % above natural background) + natural background sediment load

Step 3 Determine reduction required.

Modeled existing load – Load capacity at sediment target

Step 4 Reductions from land use type other than land use types allocated to natural background conditions.

(Current load from non naturally occurring land use types/Total load from land use type other than natural background) x 100 = weighted reductions from land use types

Step 5 Reductions from land use types.

Step 4 x Step 3 = Total reductions required from land use types.

<u>Steps taken to allocate sediment reductions from land use types to land owners and land managers within the Lower Clark Fork River Subbasin.</u>

Step 6 From GIS coverage, determine land use type acreage owned or managed by owner/manager divided by the total land use type acreage within the watershed.

(Land use type acreage owned/managed by entity/total land use acreage within watershed) x 100 = Percent land owned by land use type

Step 7 Determe reductions from land use type by land owner and manager.

Step 6 x Reduction required for land use type within watershed

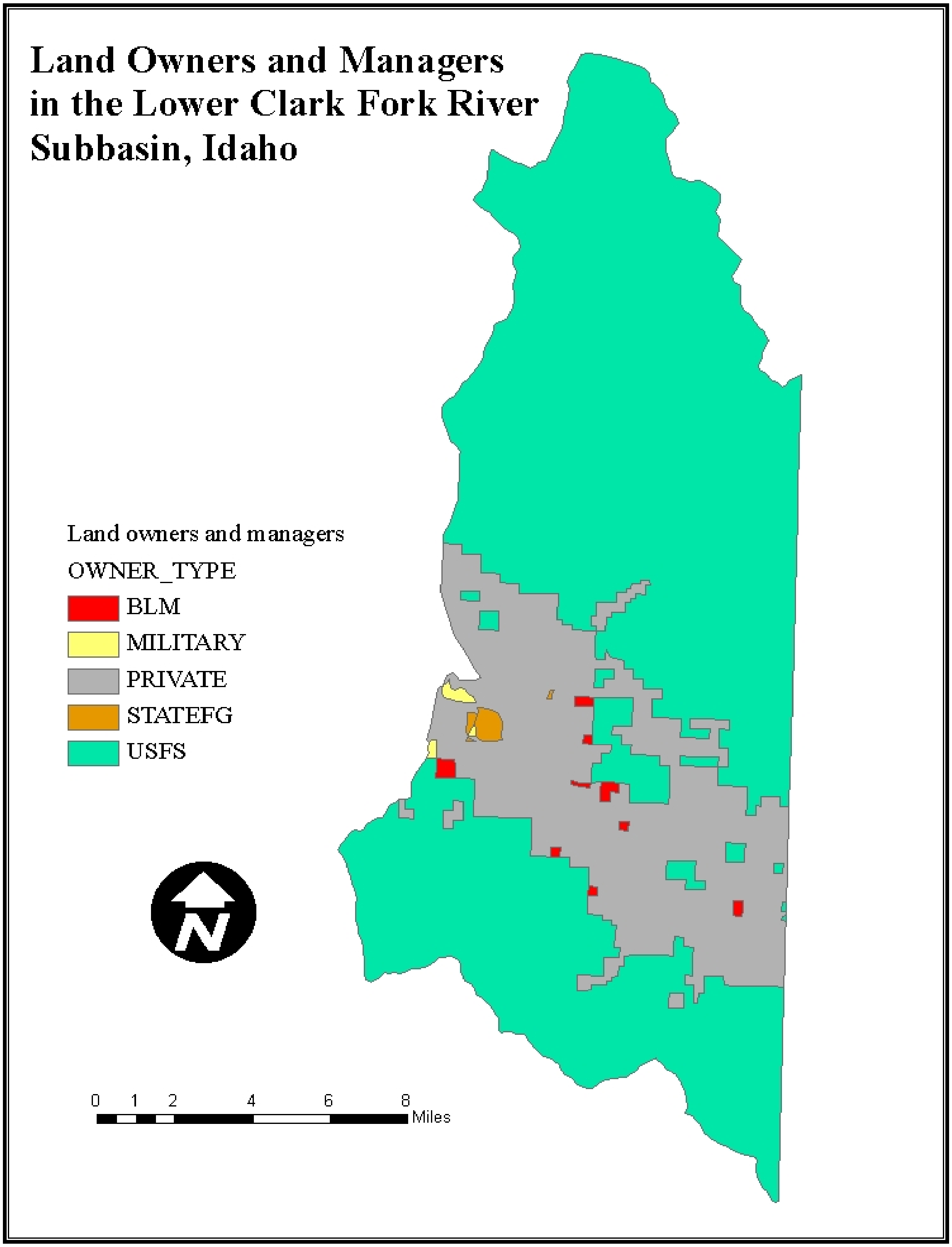

Figure G-4. Land owners and managers in the Lower Clark Fork River Subbasin, Idaho.

Assessment of Model's Margin of Safety

The margin of safety is implicit in the model design. Several conservative estimates were made in the model construction, which cause it to develop conservatively high estimates of sediment yield to surface water. Conservative estimates were made in the development of all land use type sediment yield coefficients.

The model uses RUSLE 2 to develop agricultural land use sediment delivery estimates. The output values are treated as delivery to the stream. The RUSLE 2 assumes delivery if the slope assessed is immediately up gradient from the stream system. This is not the case on the majority of the agricultural land assessed. Estimates made in the Lake Creek Sediment Study indicate that, at most, 25% of the erosion modeled was delivered as sediment to the stream (Bauer, Golden, and Pettit 1998). A similar local estimate has not been made with sediment yield coefficients, but it is likely that this estimate would be 25% as well. The agricultural land use model component is 75% conservative.

The forest roads within the 200 foot stream corridor component of the model assumes 100% delivery of fine sediment from the 200 feet on either side of a stream crossing and road encroachment of 200 feet upon the stream channel. It is more likely that some fine sediment remains in ditches. A reasonable level of delivery is 80%. The model is likely 20% conservative in this component. On Belt terrain, use of the McGreer model is conservative. Since the sediment yield coefficients measured in-stream for Kaniksu granites are 167% of the coefficient for Belt terrain, this factor is estimated to be 67% conservative.

Model Verification

Attempts to verify similar modeling approaches used in the Idaho portions of the Lower Clark Fork River Subbasin sediment TMDL have been conducted within the northern Idaho region. Verification of the model can be developed by comparing measured sediment loads with those predicted by the model. For example, the United States Geological Survey measured sediment load at the Enaville Station on the Coeur d'Alene River during water year 1999. Based on these measured estimates, the sediment load per square mile of the basin above this point was calculated to be 28 tons (URS Greiner 2001). The middle value of the Belt geology sediment yield coefficient range is 14.7 tons per square mile. The model predicted a sediment yield of 33.6 tons/year for the entire subbasin. The agreement between the measured estimates and the modeled estimates is good.

References

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McClelland, D.E., R.B. Foltz, W.D. Wilson, T.W. Cundy, R. Heinemann, J.A. Saurbier, and R.L. Schuster. 1997. Assessment of the 1995 and 1996 Floods and Landslides on the Clearwater National Forest, Part I: Landslide Assessment. A Report to the Regional Forester, Northern Region, U.S. Forest Service. 52 p.

URS Greiner. 2001. Final remedial investigation report Coeur d'Alene River basin remedial investigation/feasibility study. Estimated United Costs, CSM 5, Spokane River. URS Corp: Seattle, WA. 1(3): 7-69.

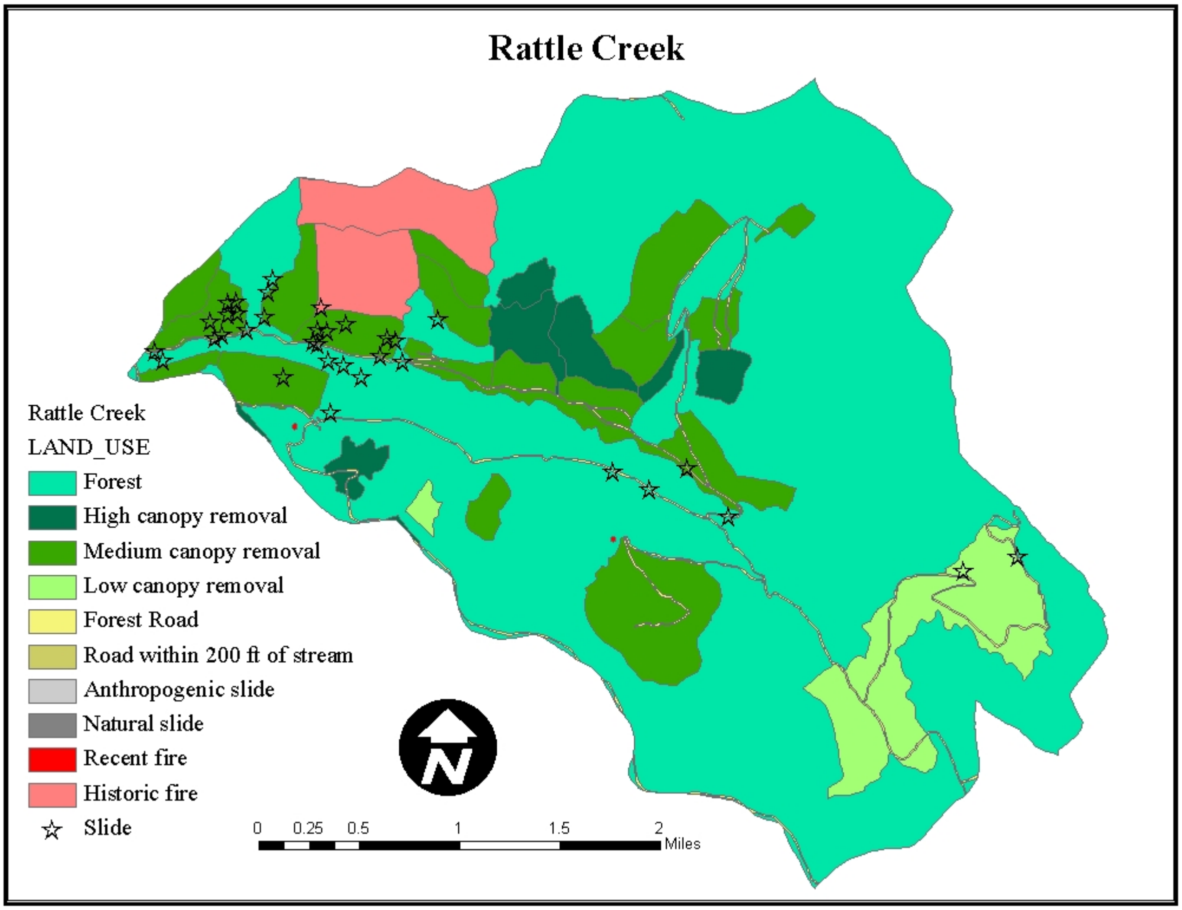

Figure G-5. Modeled land use types in the Rattle Creek watershed.

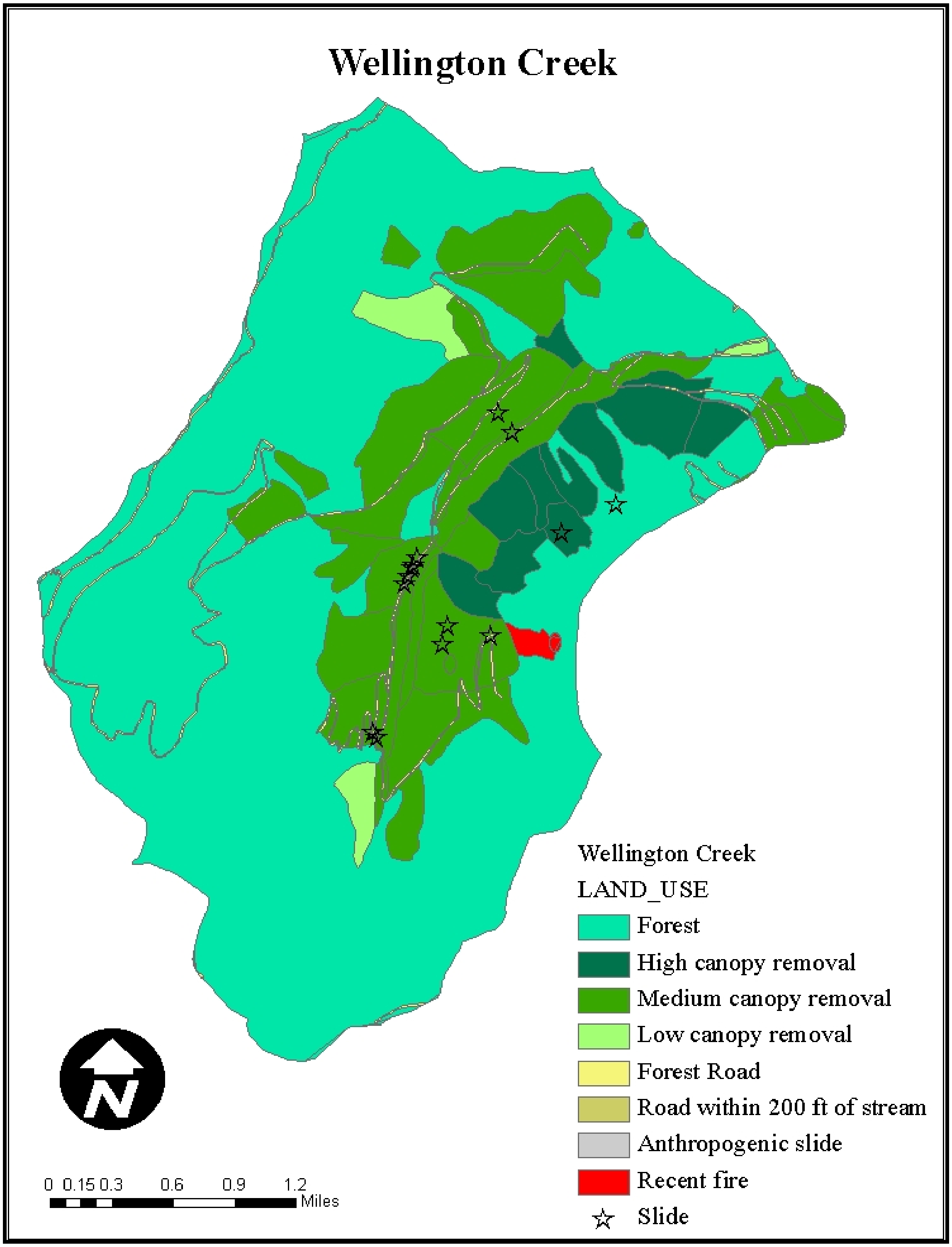

Figure G-6. Modeled land use types in the Wellington Creek watershed.

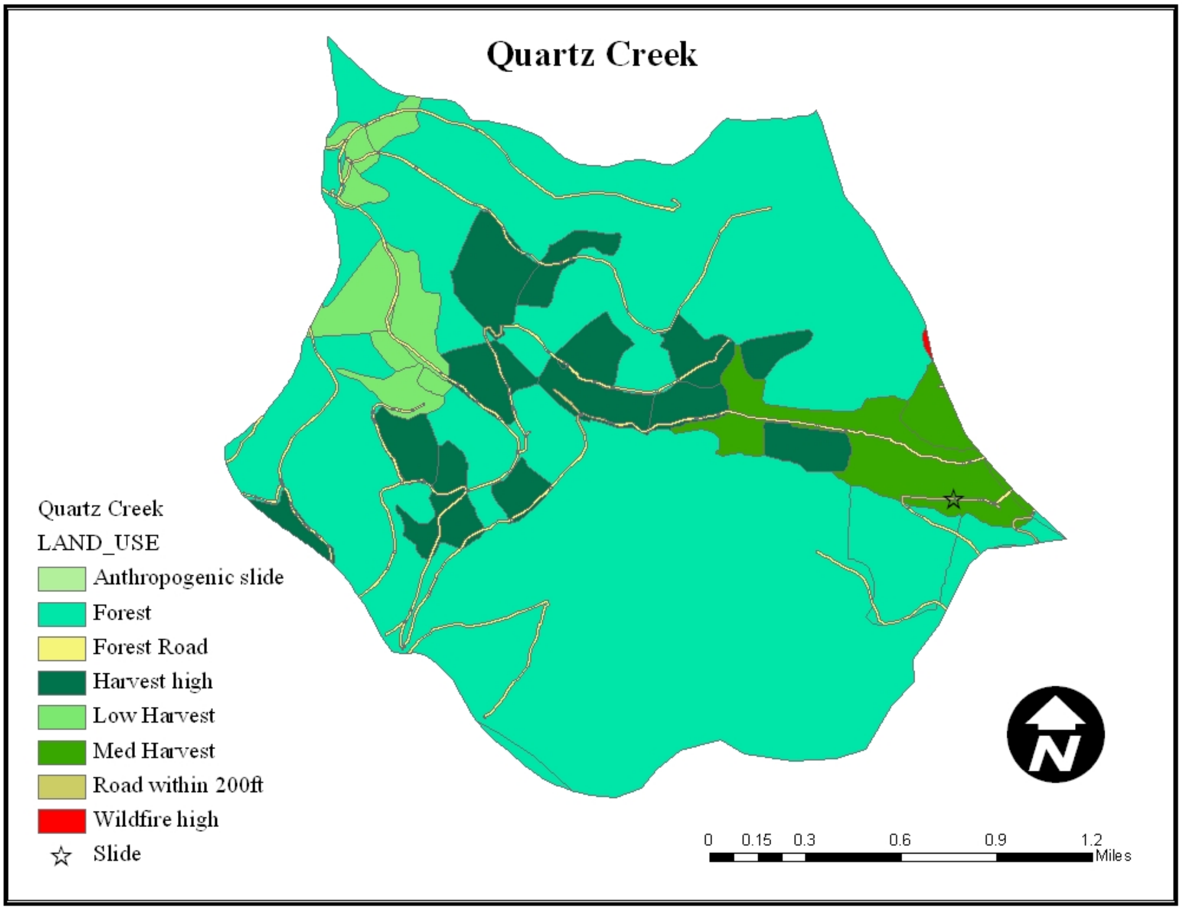

Figure G-7. Modeled land use types in the Quartz Creek watershed.

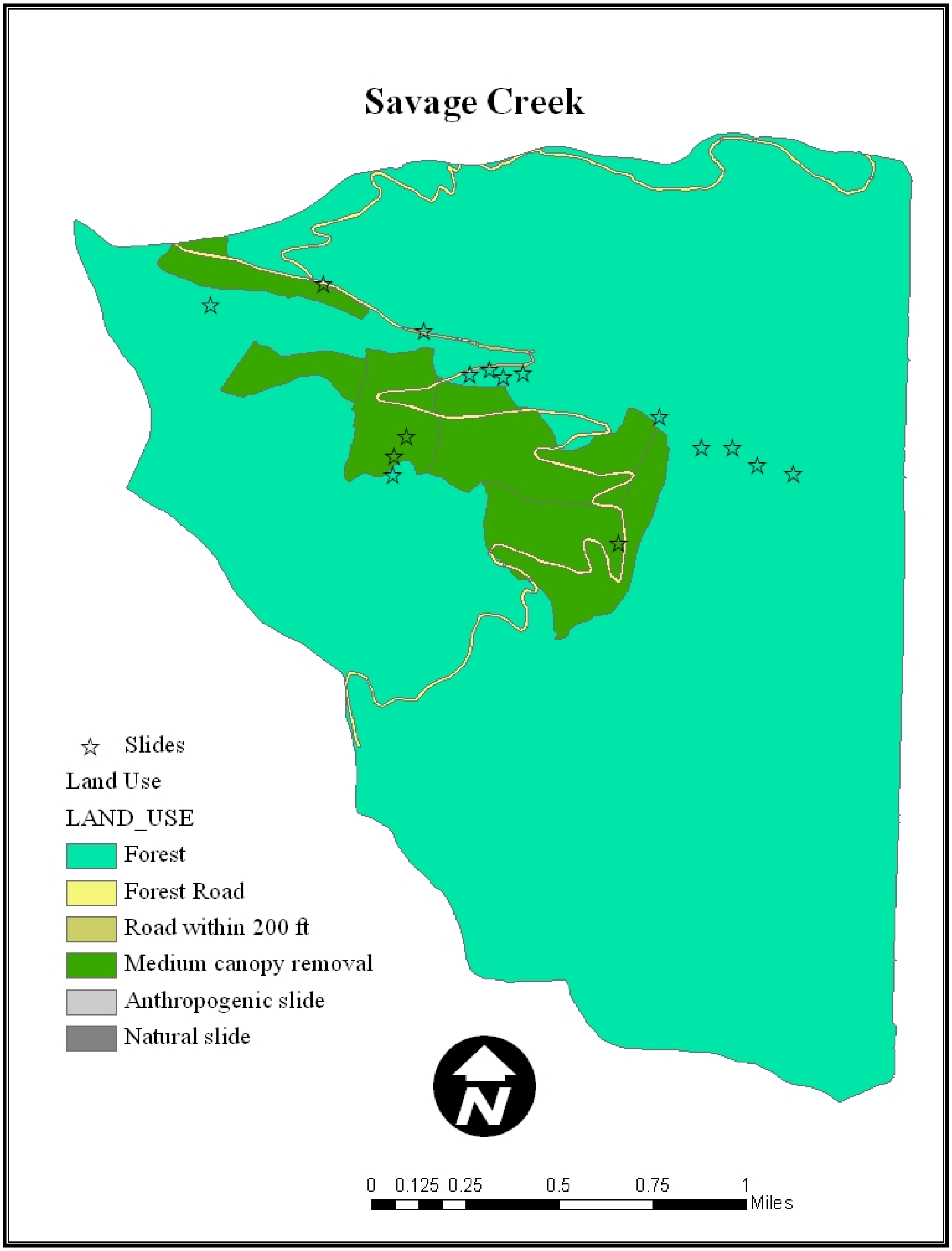

Figure G-8. Modeled land use types in the Savage Creek watershed.

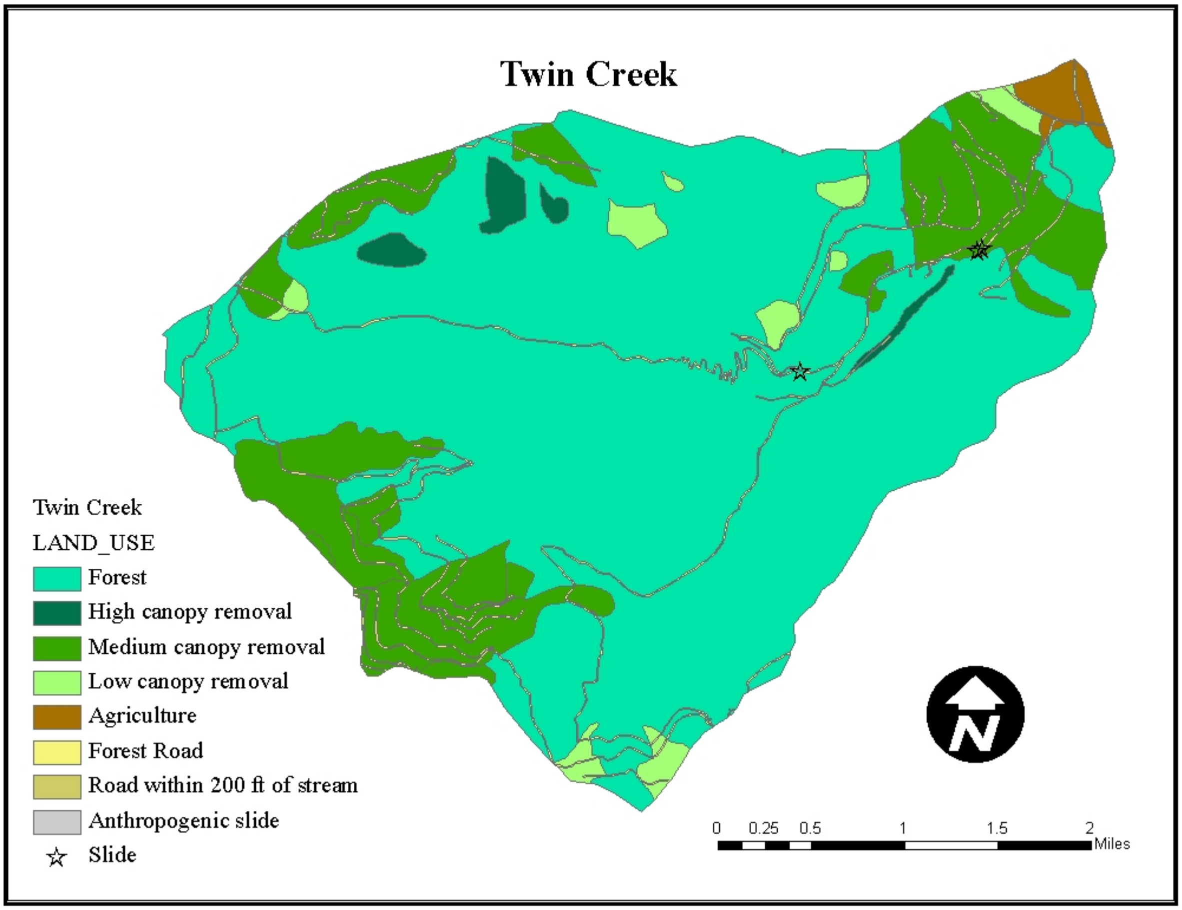

Figure G-9. Modeled land use types in the Twin Creek watershed.

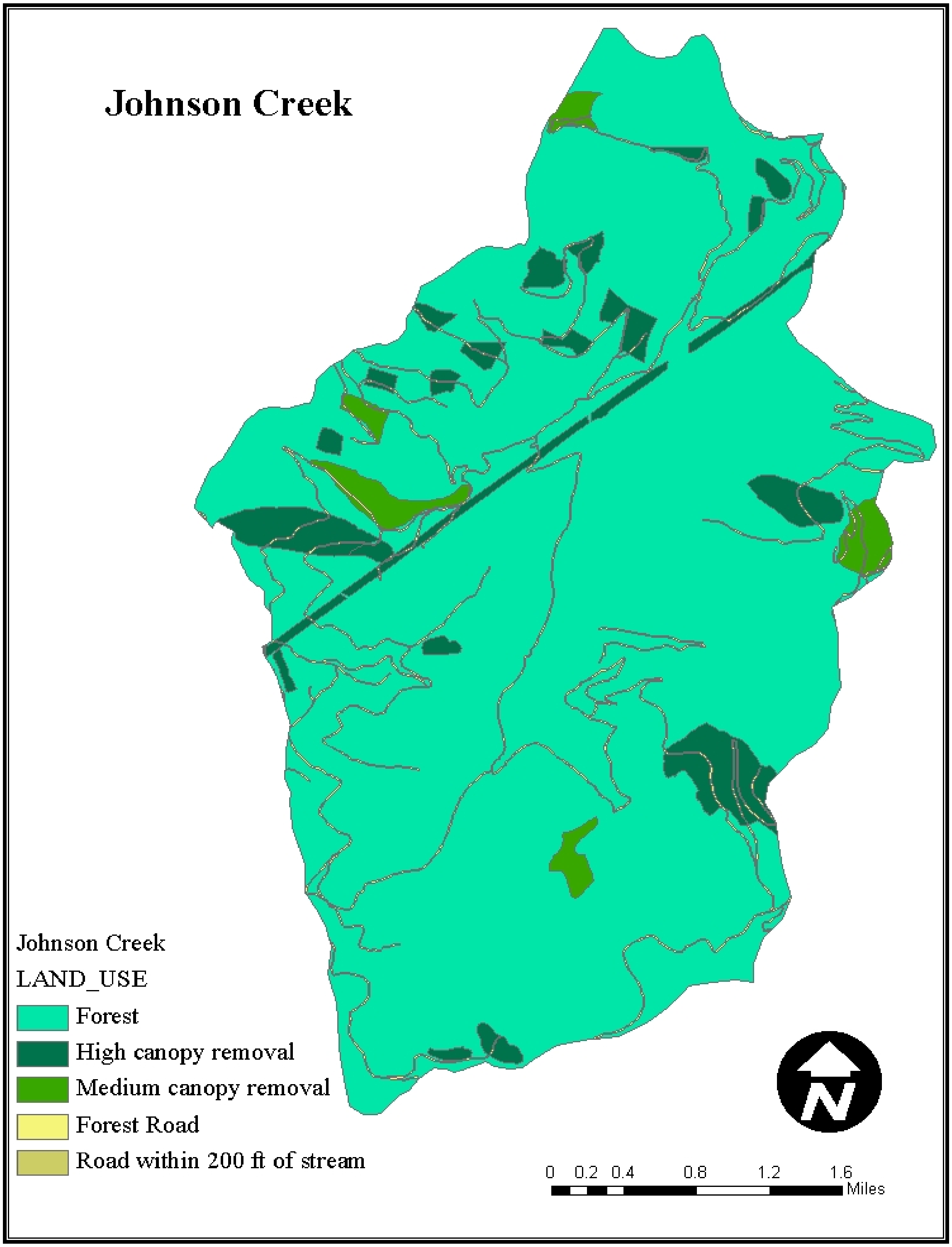

Figure G-10. Modeled land use types in the Johnson Creek watershed.

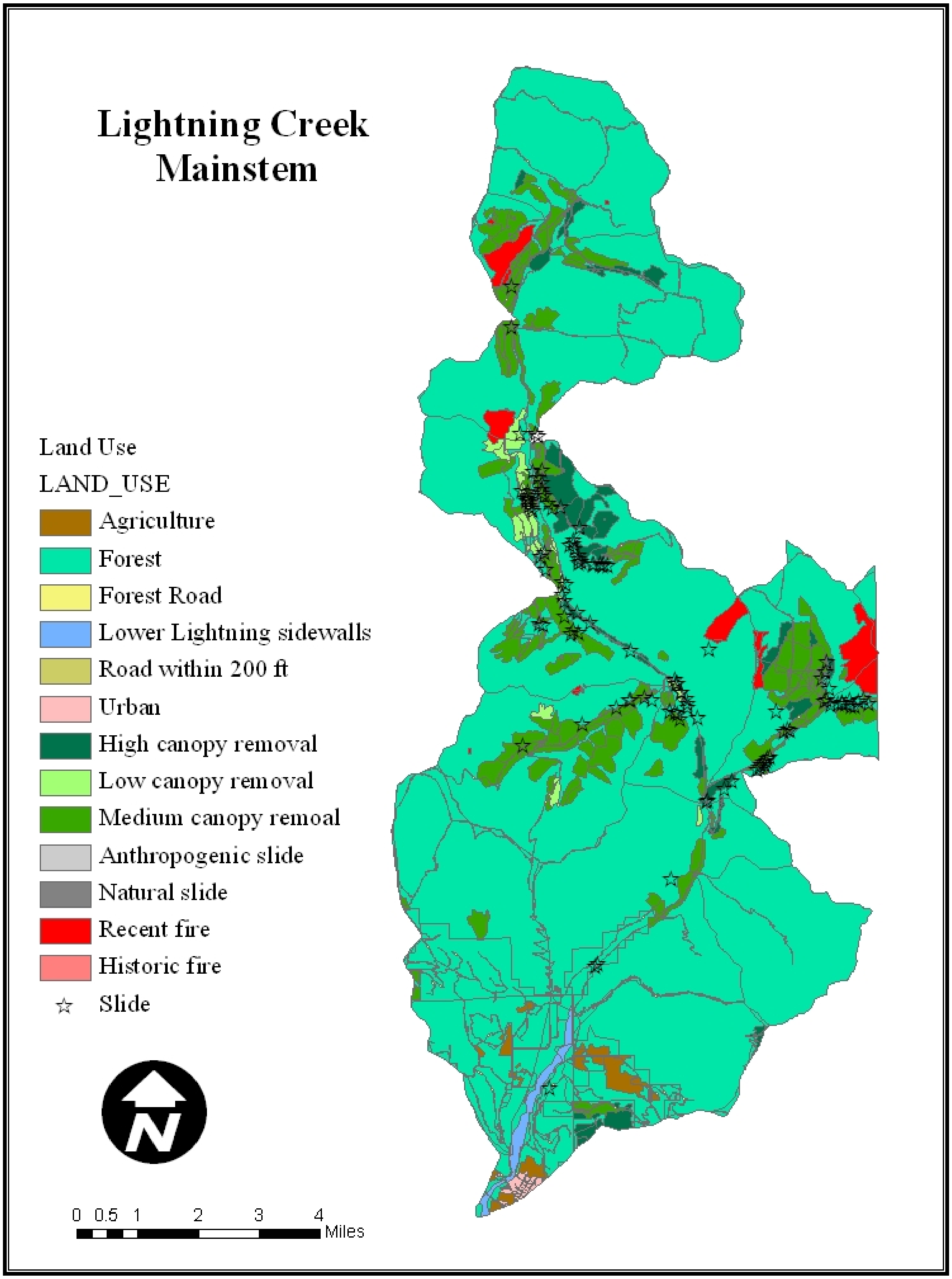

Figure G-11. Modeled land use types in Mainstem Lightning Creek and Sidewalls.

Appendix H. Daily Sediment Load Targets

Traditionally the DEQ has assigned loads and load reductions for sediment on an annual basis, but recent guidance from the EPA has focused on assigning loads on a daily basis. This appendix adjusts annual TMDL targets in section 5C to reflect daily loads. However, for implementation of TMDLs, DEQ believes it is still more practical to assess impact of load reductions on an annual basis.

It is well understood that pulses of pollutants, in this case sediment, occur during high discharge events. To better relate target sediment loads to this phenomenon, daily sediment loads were developed using stream flow data obtained from the USGS. Stream flow information has been collected for Lightning Creek near Clark Fork, Idaho. USGS gauging station 12392155 has been collecting Lightning Creek stream flow information since 1988. The Lightning Creek hydrograph will be used to represent stream flows for tributaries to Lightning Creek and tributaries to the Clark Fork River for which sediment TMDLs were developed.

After determining the monthly flow average, the percentage of flow occurring during each month was calculated. The flow percentage for each month was then multiplied by the sediment load target and divided by the number of days in the month. The end result was a flow based daily sediment load target for Lightning Creek mainstem, Rattle, Wellington, Quartz, Twin, Johnson and Savage Creeks.

Flows from April through June are the highest as are the target sediment loads. Flows in August and September are the lowest as are the target sediment loads. Table H-1 outlines the daily sediment load targets by month. By reducing the existing sediment load to the amounts listed below, sediment will be reduced in sufficient quantities to support beneficial uses.

Table H-1. Target Sediment Load (tons/day)

	Lightning Creek	**Rattle Creek**	**Wellington Creek**	**Quartz Creek**	**Twin Creek**	**Johnson Creek**	**Savage Creek**
January	5.3	0.3	0.3	0.1	0.4	0.5	0.5
February	6.6	0.4	0.4	0.2	0.5	0.6	0.6
March	7.0	0.4	0.4	0.2	0.5	0.6	0.7
April	19.8	1.2	1.2	0.5	1.5	1.8	1.9
May	34.5	2.2	2.1	0.8	2.5	3.1	3.3
June	24.0	1.5	1.5	0.5	1.8	2.2	2.3
July	4.7	0.3	0.3	0.1	0.3	0.4	0.4
August	1.1	0.1	0.1	<0.1	0.1	0.1	0.1
September	1.0	0.1	0.1	<0.1	0.1	0.1	0.1
October	2.3	0.1	0.1	0.1	0.2	0.2	0.2
November	7.1	0.4	0.4	0.2	0.5	0.6	0.7
December	6.1	0.4	0.4	0.1	0.5	0.5	0.6

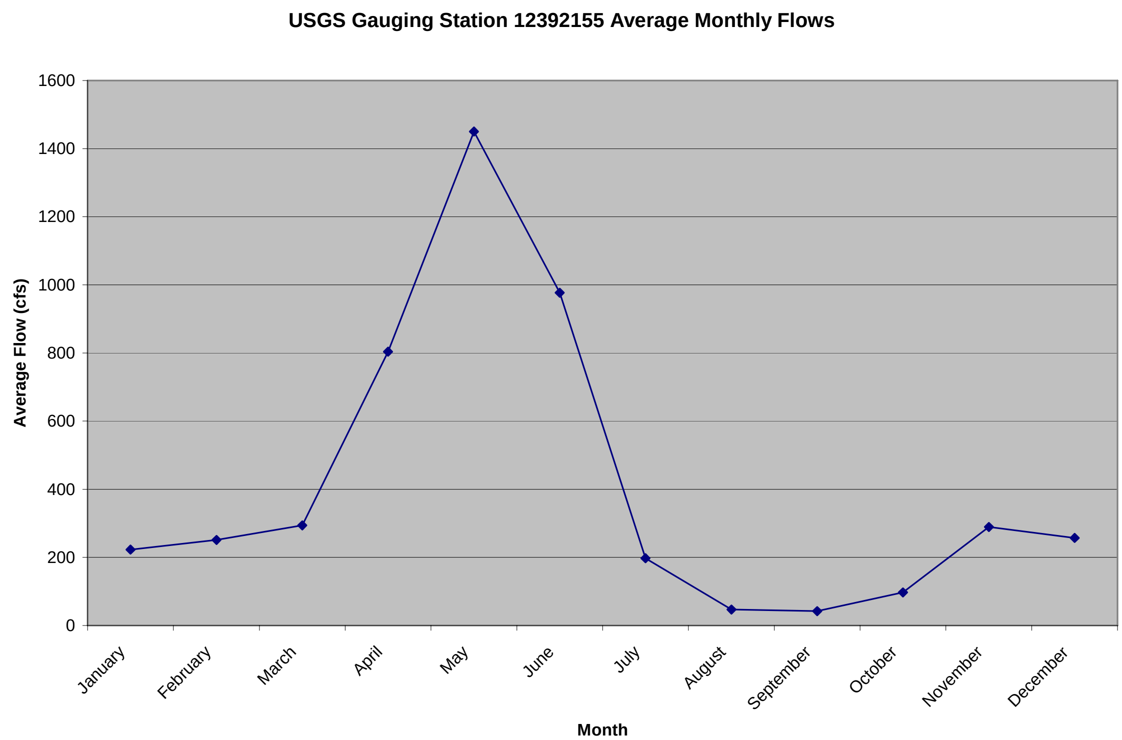

Figure H-1. Lightning Creek average monthly stream flows recorded at USGS gauging station 12392155.

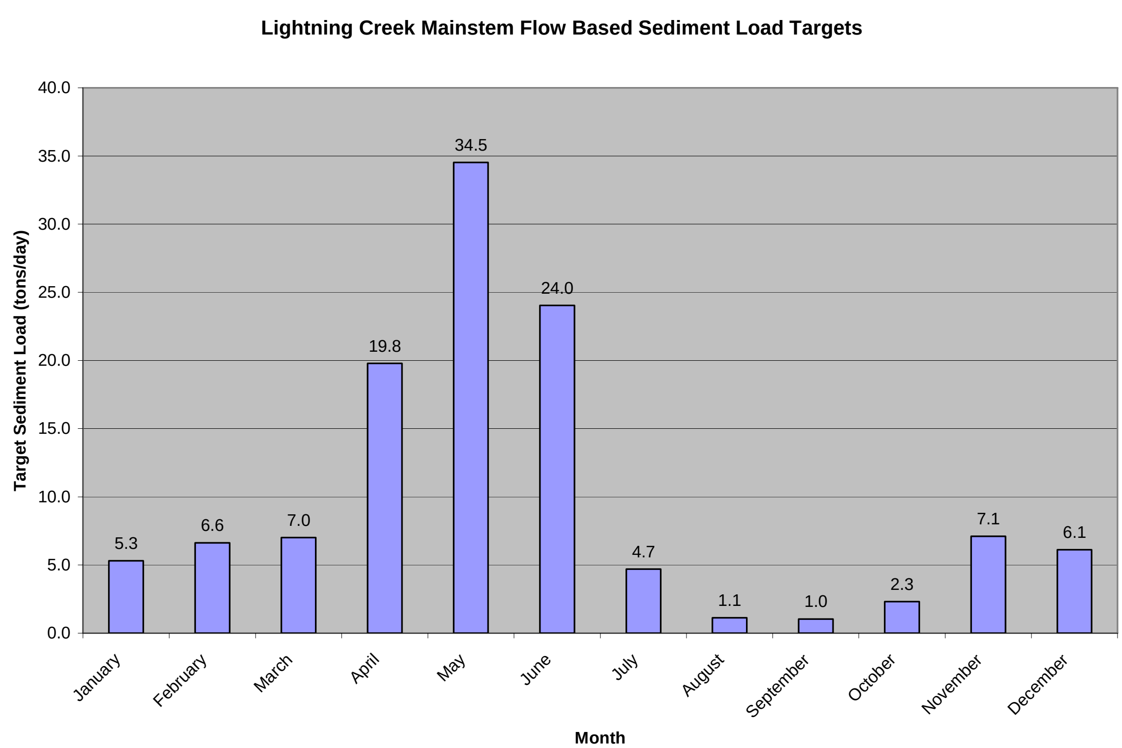

Figure H-2. Lightning Creek target sediment loads (tons/day).

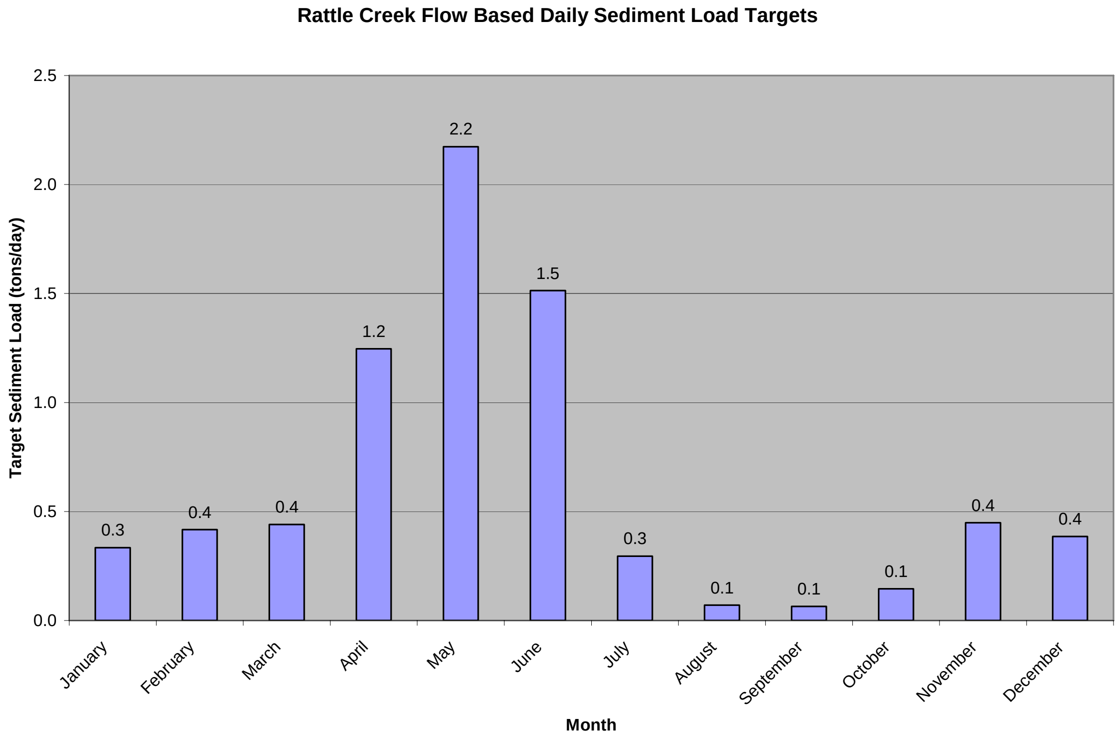

Figure H-3. Rattle Creek target sediment loads (tons/day).

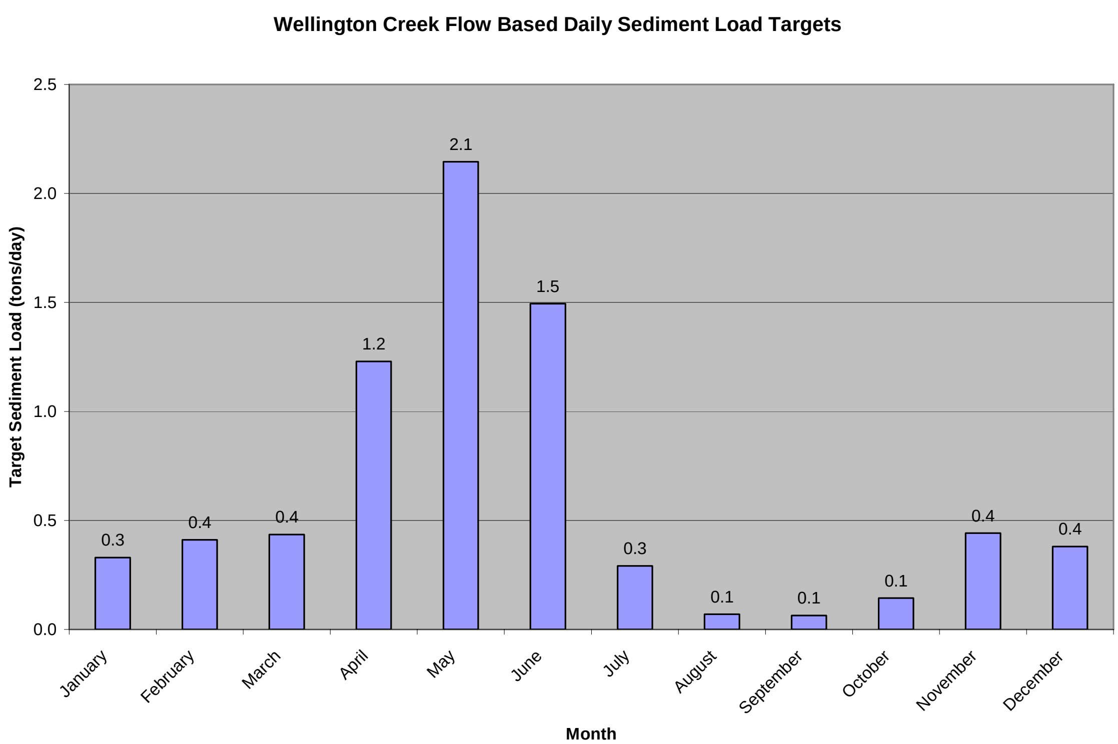

Figure H-4. Wellington Creek target sediment loads (tons/day).

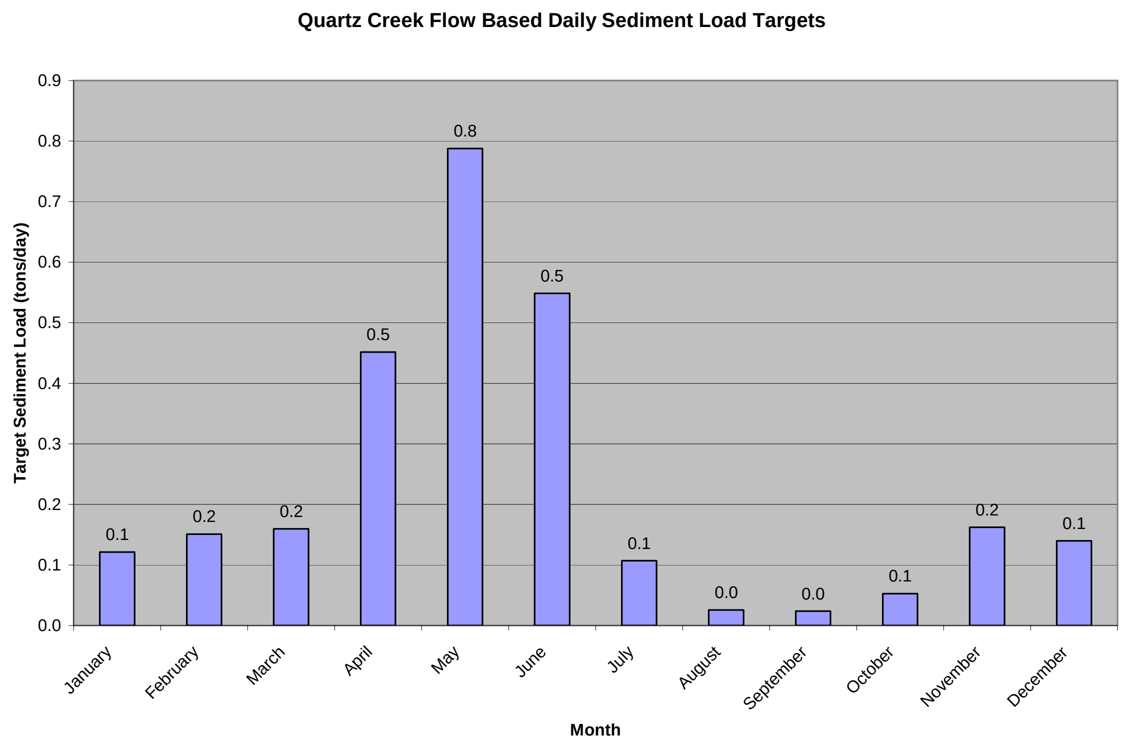

Figure H-5. Quartz Creek target sediment loads (tons/day).

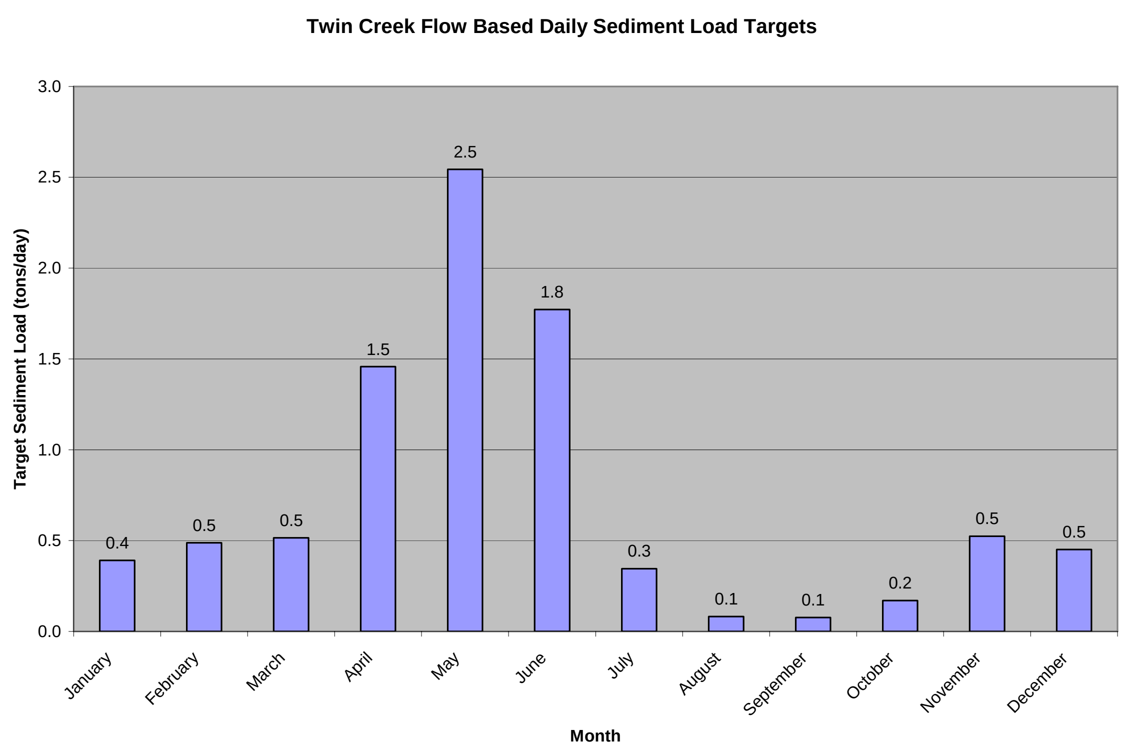

Figure H-6. Twin Creek target sediment loads (tons/day).

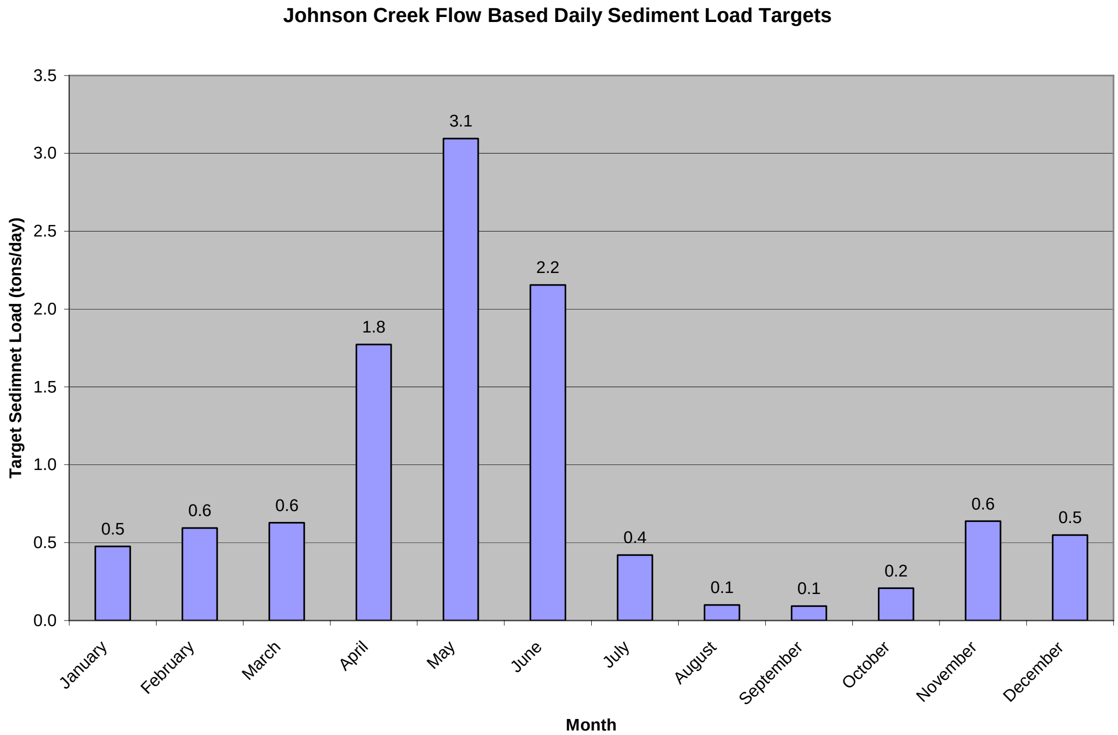

Figure H-7. Johnson Creek target sediment loads (tons/day).

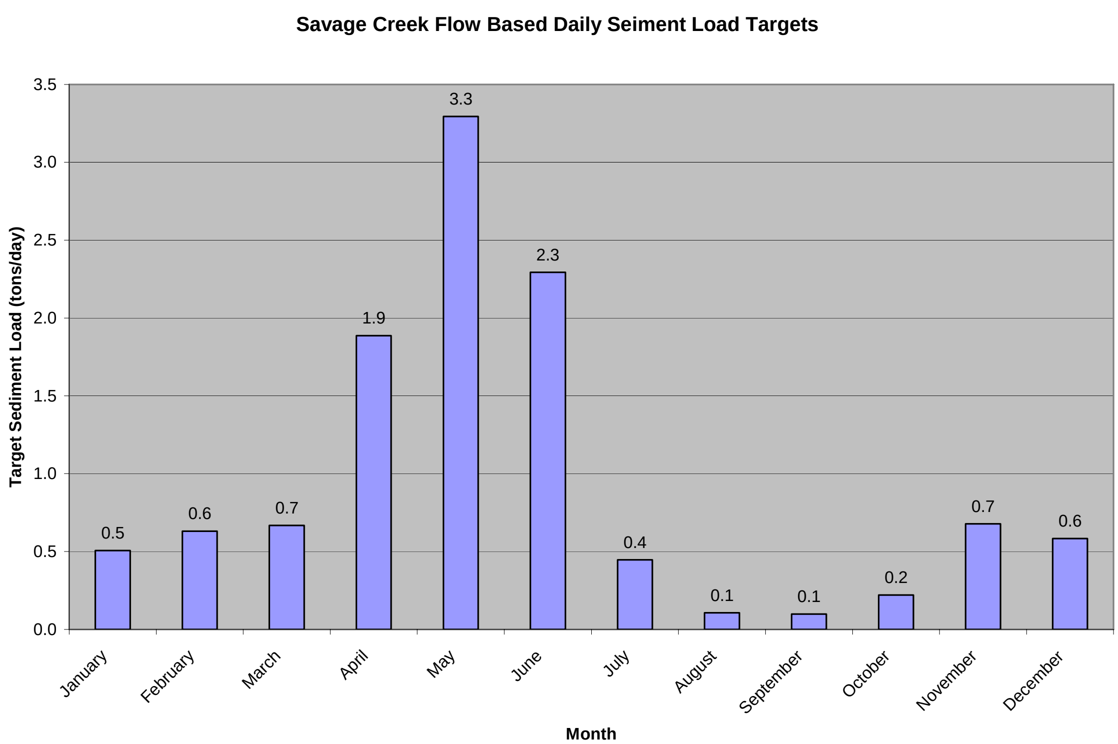

Figure H-8. Savage Creek target sediment loads (tons/day).

Appendix I. Total Dissolved Gas Summary

Data from 1996-2003 Avista's annual TDG reports (Parametrix 1996, 1997, 1999a, 1999b, 2000, 2001, 2003, 2004) are summarized below. Hourly measurements and detail on data collection are available in each report.

Table I-1. Existing TDG levels below Cabinet Gorge Dam.

Year	TDG Maximum	Range TDG during spill	Days with >110%	Dates*	Notes
1996	138%	108-138%	18	5/28/1996-7/10/1996	Transect sampling on limited days was done before June 26. Continuous measurement began 6/26. Various spill gate configurations used.
1997	158%	119-158%	71	5/5/1997 - 7/14/1997	Spill was still occurring when monitoring stopped for the year, therefore exceedances likely continued beyond the monitoring dates.
1998	131%	102-131%	41	5/5/1998 - 7/28/1998	
1999	137%	102- 137%	44	5/22/1999 - 7/7/1999	There was a 17 day period where spill occurred, but the equipment malfunctioned. These days are counted in the days >110%.
2000	132%	103 - 132%	34	4/21/2000-6/30/2000	
2001	108%	No spill	0	4/30/2001-7/2/2001	There was no spill at either Noxon Rapids or Cabinet Gorge during 2001.
2002	139%	102-139%	53	4/24/2002-7/29/2002	
2003	130%	101-130%	26	5/1/2003-6/30/2003	Peak TDG level is estimated based on flow due to equipment error during peak flow. Nine days of spill were assumed to exceed based on spill level during the failure period.

*Spill may have begun before recording started, or continued beyond the end date of range. Some years there are gaps in the middle for equipment repair. After 1999, the recorded period typically begins before spill and ends after spill. See individual monitoring reports for specifics of each year. During some time periods, experimentation with spill gates contributed to higher TDG levels. Current operations minimize TDG production.

Table I-2. TDG levels in Cabinet Gorge forebay.

Year	Maximum TDG	Range	Days > 110%	Dates of Record	Notes
1996	126%	109-126%	18	6/6/1996-7/2/1996	Different spill gate operation was experimented with during this time to determine the optimum operation scenarios to reduce TDG levels
1997	126%	104-126%	55	5/5/1997-7/14/1997	
1998	119%	100-119%	6	6/16/1998-7/28/1998	
1999	111%	99-111%	2	4/7/1999-7/13/1999	
2000	107%	99-107%	0	5/10/2000-6/29/2000	
2001	106%	99-106%	0	4/26/2001-7/2/2001	
2002	116%	99-116%	35	4/24/2002-7/29/2002	
2003	111%	100-111%	4	5/1/2003-6/24/2003	

Appendix J. Unit Conversion Chart

Table J-1. Metric - English unit conversions.

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 1 km = 0.62 mi	3 mi = 4.83 km 3 km = 1.86 mi
Length	Inches (in) Feet (ft)	Centimeters (cm) Meters (m)	1 in = 2.54 cm 1 cm = 0.39 in 1 ft = 0.30 m 1 m = 3.28 ft	3 in = 7.62 cm 3 cm = 1.18 in 3 ft = 0.91 m 3 m = 9.84 ft
Area	Acres (ac) Square Feet (ft^2) Square Miles (mi^2)	Hectares (ha) Square Meters (m^2) Square Kilometers (km^2)	1 ac = 0.40 ha 1 ha = 2.47 ac 1 ft^2 = 0.09 m^2 1 m^2 = 10.76 ft^2 1 mi^2 = 2.59 km^2 1 km^2 = 0.39 mi^2	3 ac = 1.20 ha 3 ha = 7.41 ac 3 ft^2 = 0.28 m^2 3 m^2 = 32.29 ft^2 3 mi^2 = 7.77 km^2 3 km^2 = 1.16 mi^2
Volume	Gallons (gal) Cubic Feet (ft^3)	Liters (L) Cubic Meters (m^3)	1 gal = 3.78 L 1 L= 0.26 gal 1 ft^3 = 0.03 m^3 1 m^3 = 35.32 ft^3	3 gal = 11.35 L 3 L = 0.79 gal 3 ft^3 = 0.09 m^3 3 m^3 = 105.94 ft^3
Flow Rate	Cubic Feet per Second (cfs)[a]	Cubic Meters per Second (m^3/sec)	1 cfs = 0.03 m^3/sec 1 m^3/sec = 35.31cfs	3 ft^3/sec = 0.09 m^3/sec 3 m^3/sec = 105.94 ft^3/sec
Concentration	Parts per Million (ppm)	Milligrams per Liter (mg/L)	1 ppm = 1 mg/L[b]	3 ppm = 3 mg/L
Weight	Pounds (lbs)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lbs	3 lb = 1.36 kg 3 kg = 6.61 lb
Temperature	Fahrenheit (°F)	Celsius (°C)	°C = 0.55 (F - 32) °F = (C x 1.8) + 32	3 °F = -15.95 °C 3 °C = 37.4 °F

[a] 1 cfs = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 cfs.

[b] The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water.

Appendix K. Data Sources

Table K-1. Data sources for Lower Clark Fork River Subbasin Assessment.

Water Body	Data Source	Type of Data	When Collected
All	BURP	Marcroinvertebrate, fish counts and habitat quality	1995-2002
Clark Fork River and tributaries	Various Reports produced for the Avista Clark Fork Project license proceedings and Settlement Agreement available at: www.avistautilities.com/resources/hydro/clarkfork/	TDG, fisheries, flow, extensive background on hydropower operations and on-going mitigation and fisheries restoration projects	1995-present
Lightning Creek and tributaries	Lightning Creek Watershed Assessment, Phillip Williams and Associates	Road surveys, landslide delivery, GIS coverages, fisheries data, summary of restoration needs	2004
All	Fish and Game Technical Reports	Redd counts, bull trout densities	1983-2001
All	WAG personal communication	Land use, condition, restoration needs, priorities, fact checking	2005-2006
Clark Fork River and Lightning Creek	USGS	Flows and water quality data	1990s-2002
Clark Fork River	Tri-State Water Quality Council	Trends Analysis Water Quality data	1998-present

Appendix L. Distribution List

Copies of the final report will be provided to the Idaho Department of Environmental Quality State Office, U.S. Environmental Protection Agency Region 10, and the Lower Clark Fork Watershed Advisory Group participants, including:

Avista Utilities	Joe Dos Santos
Bonner County	Brad Bluemer
Bonner County Commissioners	
Bonner Soil and Water Conservation District	Jamie Davis
Bureau of Land Management	Mike Stevenson
Citizen at Large	Alan Roach
Citizen at Large	Lowell Ruen
Idaho Department of Fish and Game	Mary Terra Burns
Idaho Department of Lands	Bill Love
Idaho Department of Lands	Scott Marshall
Idaho Parks and Recreation	David White
Kalispel Tribe	Michele Wingert
Kootenai Environmental Alliance	Mike Mihelich
Montana Department of Environmental Quality	Dean Yashan
Revett Incorporated	Paul Kukay, Doug Parker
Rock Creek Alliance	Mary Mitchell
Selkirk Conservation Alliance	Liz Sedler
Stimson Limber Company	Tom Warden
Tri-State Water Quality Council	Ruth Watkins
United States Forest Service	Kevin Davis
United States Forest Service	Jason Gritzner
Washington Department of Ecology	Jon Jones

The final document can be viewed or downloaded from the Idaho Department of Environmental Quality's homepage at:
http://www.deq.idaho.gov/water/data_reports/surface_water/tmdls/sba_tmdl_master_list.cfm
Copies of the final document can also be obtained by contacting the Idaho Department of Environmental Quality, Coeur d'Alene Regional Office at:
2110 Ironwood Parkway
Coeur 'd Alene, Idaho 83814
Phone: (208) 669-1422
Fax: (208) 769-1404

Appendix M. Public Comments

Document Section	Commenter	Comments	Response	Page
Section 4: Nonpoint sources, Forest land/roads	KEA	The Nonpoint Source discussions on page 66 include the following statements concerning INFISH. "All forested land managed (by) the Forest Service and the Bureau of Land Management must meet INFISH (the Inland Native Fish Strategy) guidelines. These guidelines prescribe 300-foot buffers for fish-bearing streams. These stream buffers contribute to increases in shade and to reaching temperature TMDL targets." The Idaho Panhandle National Forests (IPNF) is in the process of replacing the 1987 Forest Plan with a new Forest Plan. An IPNF Draft Revised Plan released in May 2006 did not mention INFISH and there is no indication in the Draft Revised Plan document there will be any INFISH buffer requirements in the new Forest Plan. The Draft Revised Plan document included an Introduction and three chapters; these chapters are Vision, Strategy, and Desired Criteria. There was no explanation in the Introduction or any of the three chapters as to why INFISH requirements are being removed as part of the Forest Plan revision.	Both current and revised forest plan guidance include USFS commitment to implementing the Clean Water Act. This includes insuring activities are consistent with existing TMDL targets, regardless of the specific direction related to riparian area management under either the existing or the proposed revised forest plans. While a court order has put the new Forest Plan guidance on hold, INFISH is still in practice. Regardless, specific references to Forest Service using INFISH were revised and instead, reflect the USFS commitments to implementing the Clean Water Act, which are consistent throughout all management plans. Detailed questions regarding the implementation of the Forest Plan are best addressed by the Forest Service.	67
Section 5B: Temperature TMDL (general)	KEA	If INFISH requirements are removed and logging activities are planned to occur within 300-foot buffers on fish-bearing streams on the National Forest System (NFS) lands in	Existing shade estimates were based on ariel photography interpretation. Target shade was modeled using potential natural vegetation. Neither existing nor target	n/a

Document Section	Commenter	Comments	Response	Page
		the Lower Clark Fork River Subbasin, it appears the shade and temperature assumptions may need to be revisited and reanalyzed in the Final Document.	shade estimates are impacted by this potential change in the forest plan. However, the method of implementation of shade targets may be impacted by this change in management. Details of TMDL implementation are the jurisdiction of the land management agency, in this case the Forest Service.	
Appendix H: *Daily Sediment Loads*	KEA	Daily Loads and EPA direction: Appendix H contains information regarding Daily Sediment Load Targets. It is stated on page 235 "… but recent guidance from EPA has focused on assigning loads on a daily basis." … The Final Document should include information that will indicate whether the Coeur d'Alene Regional Office has received from EPA Region 10 a technical document, technical fact sheets, or case studies mentioned on page four of the EPA Memo. If EPA has supplied any of the documents or fact sheets, there should be information that will indicate whether they are available for public inspection as part of the TMDL process.	At the time of public comment, and to date, DEQ has not received final fact sheets or guidance on developing daily loads beyond the EPA Memo from the Assistant Administrator to all EPA Regions dated November 15, 2006 referenced by KEA. When receives DEQ fact sheets and technical guidance from EPA, DEQ will make the information available.	n/a
Section 5A: Metals TMDLs	Revett Genesis	The need for a copper TMDL is apparently based on one or two values that exceed the Idaho water quality standard. These two values appear to be for total, not dissolved, copper…(see comment letter for completed	Earlier versions of the TMDL reported some total recoverable as well as dissolved metals. Only dissolved metals information is reported in the public comment draft and the final TMDL. See Appendix C for a	184

Document Section	Commenter	Comments	Response	Page
		comment)	summary of data used. The two values that have exceeded Idaho water quality standards were collected by USGS and are dissolved copper.	
Section 5A: Metals TMDLs	Revett Genesis	When looking at data collected since 2000, there are 136 analyses (including both total and dissolved); 19 sample dates) with no exceedances of standards. Using current data including the Tri-State Council data, a TMDL for copper is not warranted.	Copper has been identified as an impairment in the Clark Fork River. The Tier I, II and III data distinctions are primarily for 303(d) listing determination. Metals have been listed as an impairment in the Clark Fork River since 1994.Questions about data used as baseline for the listing process are more appropriately addressed in the Integrated Report format. Furthermore, WBAG II is a guidance document. IDEQ uses the best available data, with no date restrictions. WBAG II Section 4 clearly states that WABG II is used primarily for assessment of BURP data, and that "Tier II and Tier III data are not used in 303(d) listing determinations but are used in ***other water quality*** decisions requiring assessment information." IDEQ, supported by the Lower Clark Fork WAG, believes that TMDLs are warranted for the three metals in the TMDL document based on the available data. It is understood	

Document Section	Commenter	Comments	Response	Page
			that there are many current conditions where water quality standards are likely being met, however, it is necessary to write TMDLs to be protective of critical conditions and to meet Idaho water quality standards.	
Section 5A: Metals TMDLs	Revett Genesis	The apparent need for a cadmium TMDL is based on three values above the standard out of a total of 61 values listed in your database.	Cadmium levels exceeded Idaho water quality standards. A TMDL is warranted. Many of the samples taken for cadmium were processed with a detection limit below the Idaho water quality standard. See discussion in Section 2 regarding use of cadmium samples and analysis by USGS.	53
Section 5A: Metals TMDLs	Revett Genesis	The zinc TMDL is apparently based on one value where DEQ interprets the data to indicate that zinc exceeds the standard. This value for dissolved zinc was (0.0808) in Tri-State's October 2003 sample. The paired sample analyzed for total zinc at the same time indicates a lower zinc concentration of 0.0774 mg/l during this sampling event, which his less than the dissolved value …	In March 2007, the contractor to the Tri-State Water Quality Council responsible for data collection reported apparent zinc contamination possibility in their sampling technique (PBS&J 2007). This is consistent with the commenter's observation. It is likely that the variation between the dissolved and total recoverable samples is a data quality issue. The zinc TMDL remains in the document. IDEQ has added discussion in the document that describes the data issue and indicates that the Zinc TMDL targets are likely being met at this time, but the TMDL remains for advisory purposes.	72

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Section 5A: Metals TMDLs	Revett Genesis	The data available are all grab samples and do not provide evidence of exceedance of the CCC.	DEQ must use the best available data. See discussion in Section 2. Single samples are all that is available. The USGS data samples are depth integrated samples. The Tri-State data are grab samples, but a comparability analysis was done between data collected by the USGS and the Tri-State Council's contractor and data were deemed comparable (R. Watkins, personal communication).	50
Section 5A: Metals TMDLs	Revett Genesis	A number of states use a "once per three years" guide to determine if grab samples that exceed chronic values indicate impairment. What is Idaho's policy on this issue?	Chemical criteria are generally expressed as "not to exceed more than once every three years". When the Clark Fork River was identified as impaired by metals based on the USGS dataset, samples did exceed the standard more than once per three years (USGS 2005). The data used as the basis for this TMDL are those data collected up until 2003. Because there was not a consistent recent monitoring record to show with confidence three years of attainment of water quality standards, the TMDLs for copper and zinc were developed. During the 5-year review, there should be a consistent, recent data record sufficient to evaluate whether TMDL goals and water quality standards are being met. IDEQ believes that any exceedance of the standard was cause for a TMDL due to the limited number of samples, and the	72

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			magnitude of the flows and potential for variation. To exceed Idaho water quality standards, there is a substantial load of metals in the Clark Fork River. Conservation assumptions are appropriate where data are limited.	
Section 5A: Metals TMDLs	Revett Genesis	The assumption that there are no metal loads in Idaho is an oversimplification.	Idaho DEQ is unaware of any significant sources of metals in Idaho within the Clark Fork River.	63
Section 5A: Metals TMDLs	Revett Genesis	Application of the entire TMDL metal load reduction to the Clark Fork at the State line is not appropriate. Montana has an obligation to meet water quality standards at the border, but does not have an obligation to meet load reductions based on multiple conservative and questionable assumptions.	Comment noted. The load reduction calculations presented are illustrative. The load allocation at the border is set at the Idaho water quality standard and IDEQ believes that this is appropriate.	73
Section 5.4D: Load Allocation TDG	MDEQ	Comment #1: Montana recognizes that it is appropriate to incorporate a margin of safety (MOS) into your TDG TMDL to ensure compliance with the TDG standard within both Montana and Idaho. However, until a TDG TMDL is developed within Montana, we believe that the TDG allocation at the border should be based completely on the necessary loading capacity to meet the water quality standard at the border. Montana will develop a TMDL and associated load allocations to ensure compliance with the TDG standard in Montana including at the border. As a necessary part of this process we will take into consideration the need to	The load allocation at the border was adjusted to the Idaho water quality standard. IDEQ appreciates MDEQ's commitment to evaluate compliance with the TDG standard at the border and allocate a margin of safety as appropriate.	125

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		incorporate an MOS to address uncertainties such as measurement instrument accuracy.		
Section 5.4A: Load Allocation Metals	MDEQ	Comment #2: Montana agrees to meet a metals allocation at the border consistent with the TMDL loading capacities, as defined in the draft document, for Copper, Cadmium, and Zinc. We do not agree to any further breakdown of this total loading allocation into load and wasteload allocations as currently defined in the document. Instead, Montana only agrees that this loading allocation will be the sum total of all existing or future point source waste load allocations, and all nonpoint source load allocations including natural background loading. At this time, we do not accept any further definition of these load or wasteload allocations as defined within the document. Instead, Montana will pursue metals remediation work, point source permitting, and TMDL development such that water quality standards are met in Montana and such that the total metals loading at the border satisfies the loading capacity as defined in the document.	Text was clarified to indicate that the allocation at the border is a total load allocation from all sources (point and nonpoint) in Montana. Text was clarified to reflect MDEQ's concerns. All of the available load capacity is assigned to non-point and background sources at the border.	73
Executive Summary	EPA	p. xx, Table 2. TMDLs Completed. EPA and IDEQ count the number of TMDLs completed by assessment unit per impairment…EPA's understanding is that 3 mainstem temperature TMDLs will be	The Assessment Unit-Impairment count was checked with EPA and IDEQ records and reflects that 48 TMDLs were completed (see Table 55): • 3 Clark Fork River Assessment	130-131

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		addressed in the future, and that one unknown listing, Clark Fork River - Idaho/Montana border to Cabinet Gorge Dam is being removed.	Units have TDG TMDLs • 3 Clark Fork River AUs have metals TMDLs for cadmium, copper and zinc • 23 AUs have completed temperature TMDLs • 19 sediment TMDLs were completed o 11 were unknown listings in Lightning Creek that were identified as sediment o 2 East Fork Creek AUs o 2 Johnson Creek AUs o 1 Rattle Creek AU sediment added as a pollutant and TMDL completed o 1 Wellington Creek AU sediment added as a pollutant and TMDL completed o 2 Twin Creek AUs sediment added as pollutant and TMDL completed • 1 Unknown listings was removed from the Clark Fork River AU ID17010213PN005_08.	
Section 5.4A: Load Allocation Metals	EPA	<u>p. 73, Metals Load Allocations.</u> It appears that all the loading capacity is being allotted to the load allocation, since wasteload allocations are zero and the margins of safety	Comment noted, see response to MDEQ comment #2.	73

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		are implicit. It would be helpful to state this and that the load allocations are flow-based.		
Section 5.1C: Sediment In-stream water quality targets	EPA	p. 109, Sediment reference stream target. Though discussed in Appendix G, it may be worthwhile to include in the body of the text that 54% above natural background is derived by taking the 75th percentile value of percent over background sediment loads from reference sites. Since this is a key part of the loading capacity, it may be useful to include in the main report.	Text was edited to reflect this comment.	104
	EPA	Temperature Impairments on the Mainstem Clark Fork. We agree that temperature impairments on the mainstem Clark Fork should be coordinated with Montana Department of Environmental Quality and EPA Region 8 in the future and look forward to talking with you and other agencies about the timelines for evaluating these impairments.	Comment noted.	
Section 5A: Metals TMDL (general)	Rock Creek Alliance	(See Project Record for full comments)… In sum, we support the adoption of TMDLs for copper, zinc and cadmium due to past exceedances, and the potential for new significant sources of loading. We also support the development of TMDLs for additional metals due to the mines' long-term	Comments regarding the specific outfalls where metals may be discharged to the Clark Fork River in Montana that could impact compliance with Idaho water quality standards are noted, and will be considered during future review of MDEQ permits for the Rock Creek Mine and its	n/a

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		discharge of these metals and their deleterious effects on aquatic life.	compliance with TMDLs and Idaho water quality standards. It is the responsibility of MDEQ to meet total load allocations at the Idaho/Montana border. Current monitoring for cadmium, copper, zinc, arsenic and lead is on-going through a partnership with the Tri-State Water Quality Council. The Corps of Engineers is also monitoring a suite of metals constituents in 2005-2006. During the 5-year TMDL review in 2009, these data will be examined to determine if Idaho water quality standards are exceeded and a TMDL is warranted for additional metals. Even without a TMDL in place, Idaho Water Quality standards for all metals constituents must be met at the Idaho/Montana border and throughout Idaho's waters.	
Section 5.4D: TDG TMDL	Avista	The conceptual design for re-opening the old diversion tunnels described in the Gas Supersaturation Control Program for the Clark Fork Project (GSCP), which is relied upon in the TMDL Report, has been studied extensively with both numerical and physical modeling techniques. The results of these studies indicate that the tunnels, as designed, will not meet the expectations described	Changes to the abatement methods are best discussed in the GSCP revision process. The TMDL does not supersede this process, nor does DEQ believe that issuing the TMDL will cause any conflict with on-going discussions regarding the GSCP. However, DEQ is under a court ordered deadline to complete TMDLs, and the Clark Fork River TMDLs were due in	127

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		within the GSCP for the TDG abatement related to performance, cost and schedule. A final report that presents these findings will be completed in late fall 2007. In the meantime, a number of alternatives will be evaluated that may potentially provide some level of mitigation to high TDG levels below Cabinet Gorge. Given the less than favorable results of ongoing studies to achieve lower TDG levels, it would be prudent to delay formulating the TDG requirements of the TMDL until a better understanding of TDG mitigation at Cabinet Gorge becomes available. The GSCP contains adaptive management provisions that allow for revisions and changes throughout the life of the Project. The GSCP will be revised to reflect a plan for further study and implementation as agreed to by IDEQ and consistent with the goals and objectives of the TMDL process.	2004, with 2007 as the final deadline for completion of all outstanding TMDLs. While IDEQ understands the engineering concerns related to the current GSCP, it does not seem necessary to delay the TMDL any further. IDEQ will work with Avista and the Management Committee to discuss revised TDG abatement measures. Also, it is important to note that the TMDL will be reviewed in 2011. At that time, if timelines or strategies for meeting the TDG standard have changed from those proposed in the current GSCP, the TMDL can be withdrawn and modified accordingly. IDEQ believes that the 10 year implementation timeframe and the planned 5-year review allow the opportunity to adequately address any future changes to the GSCP and does not feel that the current TMDL needs to be delayed. IDEQ recognizes the technical challenges of the current GSCP, however, even when revised, meeting Idaho's water quality standard will be still be the goal of a revised GSCP. The implementation timeline for the TMDL of 10 years allows for time to revise the GSCP and applicable TMDL targets based on the state of	

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			technical analysis.	
Section 5.4D: TDG TMDL	Avista	2. Avista believes that the TMDL for TDG does not address the level of flexibility provided under Idaho Water Quality Standards with respect to addressing total dissolved gas from dams. The TMDL assumes that the state standard for TDG at 110% exists at all times no matter what the flow, cost, or biological impacts. Rather IDEQ has the discretion to determine site-specific levels of gas supersaturation under certain excess stream flows and to only require "reasonable" measures to protect the fishery. See IDAPA 58.01.02.300,01. In spite of high TDG levels below Cabinet Gorge, studies conducted during relicensing and afterwards, have not identified a quantifiable biological impact to the fishery population down river of Cabinet Gorge. Avista does not believe the TMDL reasonably addresses IDEQ flexibility under state law.	Comment noted. Idaho Fish and Game, IDEQ and USFWS have expressed concerns as to whether the study design referenced accurately reflects the full impact of TDG at peak flows. See discussion in document. TMDLs must meet current EPA approved water quality standards. DEQ does not have the flexibility to change Water Quality Standards in a TMDL. If changes to the numeric Idaho water quality standard are warranted or desired, a site-specific standard would need to be scientifically justified and a rule-making process initiated. By allowing alternative mitigation measures in the GSCP, IDEQ has already granted flexibility in addressing the 110% water quality standard. Any further discretion is more appropriately addressed through GSCP revision process. DEQ sees the Director's exemption as a limited tool and reference to the exact language in Idaho water quality standards was added to the document.	122
Section	Avista	3. The TMDL requires Avista to mitigate	The TMDL is not more stringent than the	127

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5.4D: TDG TMDL		TDG below Cabinet Gorge to levels more stringent than required in the approved GSCP. Since the structural modification envisioned in the GSCP will not achieve TDG performance levels and will be too costly, Avista believes it is unreasonable for IDEQ to expect Avista to achieve more stringent TDG levels in the subject TMDL.	401 certification. See discussion in document.	
Section 5.4D: TDG TMDL	Avista	For the foregoing reasons Avista believes finalizing the TMDL for TDG should be delayed at least until the TMDL Report 5 year review. Such an approach would be consistent with how IDEQ is addressing development of a TMDL for temperature in the Clark Fork River.	IDEQ does not feel it is necessary to delay the Clark Fork River TDG TMDL. The reasons for delaying the temperature TMDL are not applicable to TDG. It is clearly documented that there is a violation of Idaho water quality standards for TDG and that a TMDL is necessary, and is overdue. The 10-year timeline for implementation should be adequate to address concerns with methods of implementation. For temperature, it has been found in the Pend Oreille River that numeric temperature violations are still within natural temperature conditions. While IDEQ does not have enough data to fully support this same conclusion in the Clark Fork River at this time, EPA has agreed to allow additional time for IDEQ and MDEQ to coordinate efforts to examine whether	

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			temperature is impairing beneficial uses. This uncertainty does not exist for TDG.	
Section 5.4D: TDG TMDL	Avista	Avista has specific technical comments to the draft TMDL Report, which are listed in the attachment. Since Avista's intent is to revise the GSCP, further information concerning the GSCP implementation and development is necessary. Thus Avista requests delay in the TMDL until the GSCP is modified or revised. A similar approach is used with temperature in the Table A-2 on page-160. This type of approach should-describe TDG in Table A-2 on page 160 and the text changed accordingly throughout the TMDL Report.	Language to address the status of the GSCP has been added to the TMDL. However, the current plan is a part of the legally binding Settlement Agreement and 401 certification, and therefore will still be referenced in the TMDL.	127
Section 5.4D: TDG TMDL	Avista	The TMDL Report states the TDG TMDL targets are as follows: - The goal of the TDG TMDL is to insure that Idaho Water Quality Standards for TDG (110% saturation) are met in the mainstem Lower Clark Fork River in order to protect aquatic life in the Clark Fork/Pend Oreille system. - The standard is set at Idaho Water Quality Standard less than a 2% Margin of Safety at the Montana border. - No net increase of TDG will be allowed between Cabinet Gorge forebay and below	The purpose of state 401 certification is to certify compliance with Idaho water quality standards. IDEQ is disappointed that the current operation plan proposed in the GSCP will not mitigate TDG levels as expected. Furthermore, if this is the case and alternative abatement measures are developed, it is more appropriately addressed in the GSCP. Since revisions to the GSCP have not yet been completed, or reviewed by the Settlement Management Committee, and are not approved by IDEQ	127

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		Cabinet Gorge dam. - All these targets are unattainable and do not accurately or reasonably address the level of flexibility provided under Idaho Water Quality Standards. Therefore sections that refer to these unattainable targets, such as Sections 5.1D – 5.5D on pages 124 – 129 should be extensively modified.	or other regulatory agencies, it is premature to state that the 110% water quality standard is unattainable. Additional information discussing the relationship between the GSCP and the TMDL has been added.	
Section 5.4D: TDG TMDL	Avista	The 108% margin of safety goal is neither reasonable nor justified. IDEQ water quality standards do not require 110% TDG below dams at all times. Rather IDEQ has the discretion to set site-specific levels under high flows with the goal of protecting the fishery. Avista is unaware of any information which suggests that the 108% standards is necessary to protect the fishery. As noted below, significant studies have demonstrated that much higher TDG levels than 110% are not having a negative affect on the fishery in the lower Clark Fork River.	Idaho water quality standards are set to be protective of beneficial uses. The 2% margin of safety is measurement error in the equipment. A MOS is applied to insure that the standard is not exceeded and typically, MOS is set at 10%. However, IDEQ agrees that the 110% standard has been found to be protective of beneficial uses and is a conservative standard. Due to the fluctuating nature of TDG saturation and temperature variation, and to be consistent with requests from the State of Montana for the upstream Assessment Unit, IDEQ will remove the 2% explicit MOS from the TDG TMDL. As noted earlier, Idaho Fish and Game, IDEQ and USFWS have expressed concerns as to whether study designs referred to in this comment accurately reflects the full impact of TDG at peak	126

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			flows. The water quality standards is 110%.	
Section 5.4D: TDG TMDL	Avista	Further, the TMDL ignores TDG levels which come into Cabinet Gorge from upstream. Avista believes this is inequitable and an unreasonable expectation. Avista should not be required to mitigate for TDG levels from upstream.	The 110% TMDL target applies at the Idaho/Montana border for the Assessment Unit from the Idaho/Montana border to Cabinet Gorge Dam. It is expected that waters entering the state of Idaho will be at or below the 110% saturation target.	
Section 5.4D: TDG TMDL	Avista	In addition, the TMDL has no limitation addressing high levels of TDG generated by infrequent, excessively high flow. There should be no requirement to mitigate TDG that occurs during extraordinary flood events. With the knowledge that we have today; the Cabinet Gorge tunnels will not meet the expectations with respect to TDG performance, schedule, and cost that were anticipated in the GSCP, the GSCP will be revised. Therefore all references to the Cabinet Gorge Tunnels should be omitted. Also references to GSCP should state that any alternative(s) implemented through a revised GSCP will "reduce, offset, or otherwise mitigate the increase in TDG due to spill at the Cabinet Gorge Dam". (i.e. page 128, 1st full paragraph, 4th paragraph, and last paragraph; page 129, 1st, 2nd, & 3rd full paragraphs)	The current and approved GSCP allows Avista to operate its project with a license in good standing with FERC and in compliance with its 401 certification and it references the tunnel project. References to the tunnels were not removed from the document, however the document now reflects that the plan may be revised to include alternative abatement strategies.	127
Section 4	Avista	Avista's actions with respect to Noxon Rapids Spillgates, Cabinet Gorge Spillgates,	References to these activities were added in Section 4 of the TMDL document.	68-69

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		increased flows through the Cabinet Gorge powerhouse, and the mitigation fund should be clearly identified as examples of efforts that "reduce, offset, or otherwise mitigate the increase in TDG due to spill at the Cabinet Gorge Dam".		
Section 1	Avista	Page 6, 4th sentence 2nd full paragraph—change "licensed to product 231 megawatts" to "licensed to produce 263 megawatts".	Document revised.	6
Section 2	Avista	Page 55, 1st paragraph. The most complete work associated with TDG and associated effects in the Lower Clark Fork River can be found in Weitkamp, D.E., R.D. Sullivan, T. Swant and J. DosSantos. 2003. Behavior of Resident Fish Relative to Total Dissolved Gas Supersaturation in the Lower Clark Fork River. Transactions of the American Fisheries Society 132(5): 856-864, and Weitkamp, D.E., R.D. Sullivan, T. Swant and J. DosSantos. 2003. Gas Bubble Disease in Resident Fish of the Lower Clark Fork River. Transactions of the American Fisheries Society 132(5): 865-876. Aside from this site specific work, numerous report/studies and peer reviewed literature exist, especially on the mainstem of the Columbia River, that conclude there is little impact to native salmonids with TDG levels at or slightly above 120%. The TDG standard should be	These references are included in the report. Site-specific standards are not developed through the TMDL process, but through negotiated rule-making process, and DEQ's triennial reviews of water quality standards. The 110% standard has been found to be protective of beneficial uses and is the applicable standard at this time.	55

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		more site-specific and based upon the degree of quantifiable biological impact.		
Section 3	Avista	Page 62, 1st sentence, last paragraph—Cabinet Gorge powerhouse now has a capacity of about 38,000 cfs. Also, the increase in flows through the powerhouse and change in spillgate operation, discussed in the second sentence, are examples of efforts that "reduce, offset, or otherwise mitigate the increase in TDG due to spill at the Cabinet Gorge Dam".	Comment noted and document revised accordingly.	63
Section 4	Avista	Page 67, last sentence, 3rd paragraph—omit the whole sentence and all references to the bypass tunnel project.	Document revised to reflect current GSCP status.	
Section 4	Avista	Page 67, last paragraph—Besides the studies referenced and the conclusions stated, numerous reports/studies and peer reviewed literature exist, especially on the mainstem of the Columbia River that conclude there is little impact to native salmonids with TDG levels at or slightly above 120%.	Comment noted. The Water Quality Standard for TDG is 110%.	