Lower North Fork Clearwater River Subbasin Assessment and TMDL

November 2002

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Cover photo by Robert D. Henderson.

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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

µ micro, one-one thousandth

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

ADB assessment database

AWS agricultural water supply

CBAG Clearwater Basin Advisory Group

BLM United States Bureau of Land Management

BMPs best management practices

BOD biochemical oxygen demand

Btu British thermal unit

BURP Beneficial Use Reconnaissance Program

°C Celsius

CNF Clearwater National Forest

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

cfs cubic feet per second

cm centimeters

Cr. Creek

CW cold water

CWA Clean Water Act

CWE cumulative watershed effects

DEQ Idaho Department of Environmental Quality

DO dissolved oxygen

DWS domestic water supply

EMAP Environmental Monitoring and Assessment Program

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

I.C. Idaho Code

ICWB-Ave Idaho Cold Water Aquatic Life - average

ISS-Ave Idaho Salmonid Spawning - average

IDAPA Refers to citations of Idaho administrative rules

IDFG Idaho Department of Fish and Game

IDL Idaho Department of Lands

IDWR Idaho Department of Water Resources

INFISH The federal Inland Native Fish Strategy

IRIS Integrated Risk Information System

km kilometer

km^2 square kilometer

LA load allocation

LC load capacity

LNFCRS Lower North Fork Clearwater River Subbasin

m meter

m^3 cubic meter

mi mile

mi^2 square miles

MBI macroinvertebrate index

MGD million gallons per day

mg/l milligrams per liter

mm millimeter

MOS margin of safety

MWMT maximum weekly maximum temperature

n.a. not applicable

NA not assessed

NB natural background

ND no data (data not available)

PCR primary contact recreation

ppm part(s) per million

NFS not fully supporting

NPDES National Pollutant Discharge Elimination System

NRCS Natural Resources Conservation Service

NTU nephlometric turbidity unit

ORV off-road vehicle

ORW Outstanding Resource Water

PACFISH The federal Pacific Anadromous Fish Strategy

PFC proper functioning condition

QA quality assurance

QC quality control

RBP rapid bioassessment protocol

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

SPZ Stream Protection Zone

SS salmonid spawning

SSOC stream segment of concern

TDS total dissolved solids

TMDL total maximum daily load

TP total phosphorus

TSS total suspended solids

U.S. United States

USC United States Code

USDA United States Department of Agriculture

USDI United States Department of the Interior

USFS United States Forest Service

USGS United States Geological Survey

WAG Watershed Advisory Group

WBAG *Water Body Assessment Guidance*

WBID water body identification number

WLA waste load allocation

WQLS water quality limited segment

WQS water quality standard

WWA Western Watershed Analysts

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 (33 USC § 1251.101). 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 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 of impaired waters, currently every two years. For waters identified on this list, states and tribes must determine if a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards, is necessary. This document addresses the water bodies in the Lower North Fork Clearwater River Subbasin (LNFCRS) that have been placed on what is known as the "303(d) list."

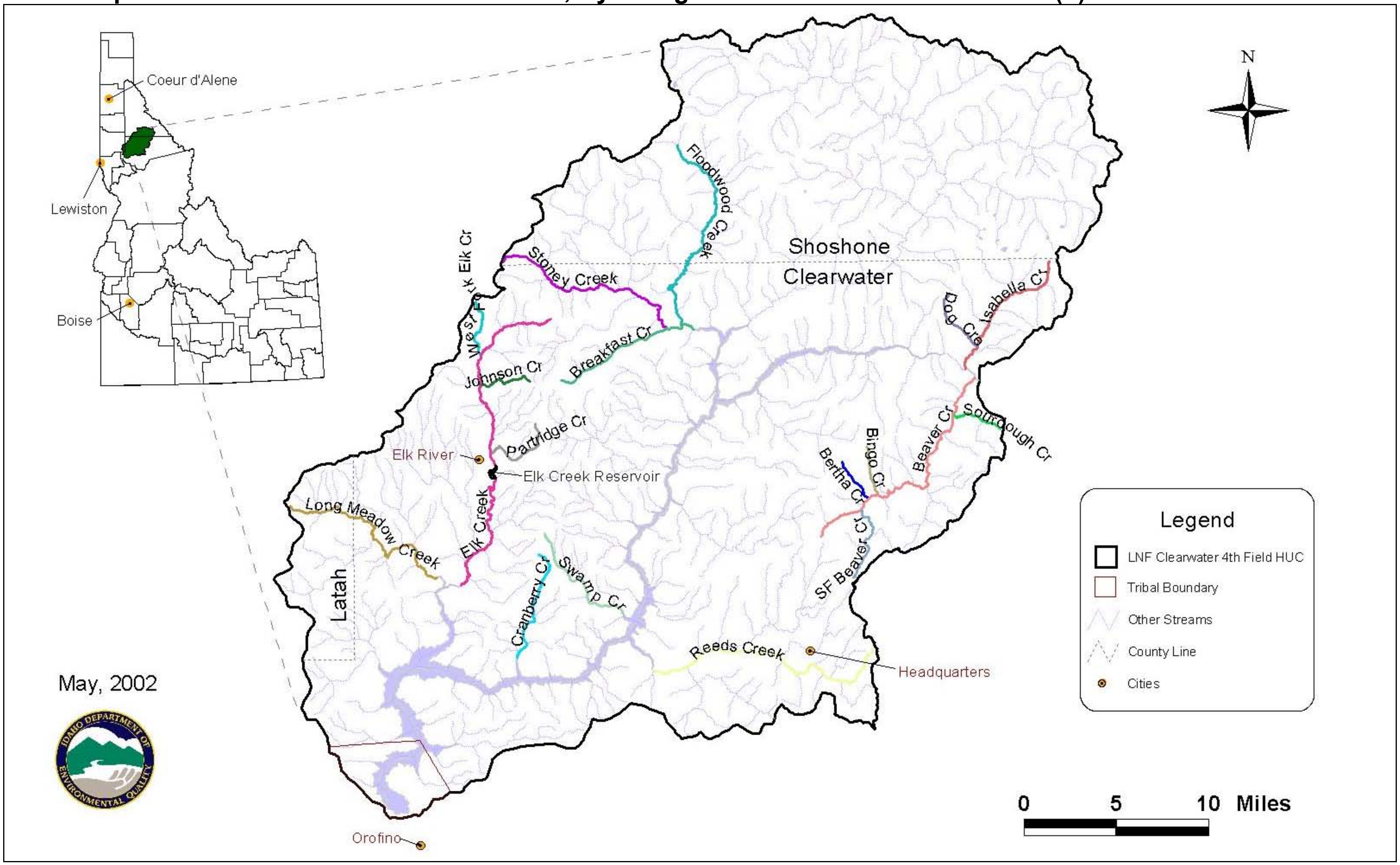
This subbasin assessment and TMDL analysis has been developed to comply with Idaho's TMDL schedule. This assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the LNFCRS located in north central Idaho. The first part of this document, the subbasin assessment, is an important first step in leading to the TMDL. The starting point for this assessment was Idaho's current 303(d) list of water quality limited water bodies. Nineteen waterbodies in the LNFCRS were listed on this list. The subbasin assessment portion of this document examines the current status of 303(d)-listed waters, and determines if a waterbody is impaired, and if it is, the extent and cause(s) of impairment. The loading analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

Subbasin at a Glance

Map A displays the general location of the LNFCRS and the location of the 303(d)-listed waterbodies. The LNFCRS is 1,145.44 square miles, which is about the same size as the state of Rhode Island. The basin is located in north central Idaho, primarily in Clearwater County, situated around Dworshak Reservoir, with all streams flowing directly or indirectly into the reservoir. Dworshak Dam was completed in 1971, and the reservoir attained full pool two years later. At full pool the reservoir is 54 miles long, 2 miles across, and has a maximum depth of 480 feet. There is no passage for migrating fish at Dworshak Dam.

Elevations range from 1,445 feet, which is minimum pool elevation of Dworshak Reservoir, to over 7,000 feet. Most elevations are within 3,000 feet to 5,500 feet and a large majority of the topography is of steep terrain with greater than 50% slope gradients. The streams in the basin have a pattern of low flows during the late summer and early fall months and high flows in the spring and early summer months. Over the past 100 years human activities, primarily silvercultural, have changed the landscape of the basin to a degree and these alterations are the primary reason TMDLs were developed for the LNFCRS.

Map A. Location of the LNFCR Subbasin, Hydrological Unit 17060308 and the 303(d) listed waterbodies.



The LNFCRS is a very sparsely populated area with only one incorporated city, Elk River, with a population of 156 people (Idaho Department of Commerce 2002). The total population in the LNFCRS is estimated at 300 people with a density of 0.262 people per square mile. Forestry and recreational activities dominate the land use of the basin, with some grazing occurring in the southern and central parts of the basin. Cattle are typically brought into these areas around June and then removed in October or early November. Federal and state governmental agencies and timber companies, primarily Potlatch Corporation, own 95% of the basin. The basin is nearly 100% forested; hence, most of the management of non-federal lands is for timber harvest. While timber harvesting has significantly decreased on the Clearwater National Forest (CNF), timber harvesting has been the primary land use in the LNFCRS and will continue to be, as Potlatch Corporation and the Idaho Department of Lands (IDL) still harvest several hundred million board feet of timber each year. The LNFCRS is also a popular destination for outdoor recreation activities such as hunting, fishing, hiking, boating, and camping.

Within the LNFCRS (HUC #17060308) there are 19 waterbodies on the 1998 303(d) list: Beaver Creek, South Fork Beaver Creek, Bertha Creek, Bingo Creek, Breakfast Creek, Cranberry Creek, Dog Creek, Elk Creek, West Fork Elk Creek, Elk Creek Reservoir, Floodwood Creek, Isabella Creek, Johnson Creek, Long Meadow Creek, Partridge Creek, Reeds Creek, Sourdough Creek, Stony Creek, and Swamp Creek. Most of these streams are listed because they did not meet CNF Plan Sediment Standards (CNF 1992) or because they were listed as impaired in *The 1992 Idaho Water Quality Status Report*, Appendix D (DEQ 1992) as being impaired. When these waterbodies were placed on the original 303(d) list in 1994, there was a very limited amount of data to support their listing, if any at all. These waterbodies were placed on the 303(d) list because of “evaluated” information, meaning best professional judgment was used at the time. Since then, sufficient data has been collected to properly assess these waterbodies. Map B shows the watershed boundaries of all 303(d)-listed streams and their geographical locations within the LNFCRS.

Map B. Geographical Location of the 303(d)-listed waterbodies and watersheds.

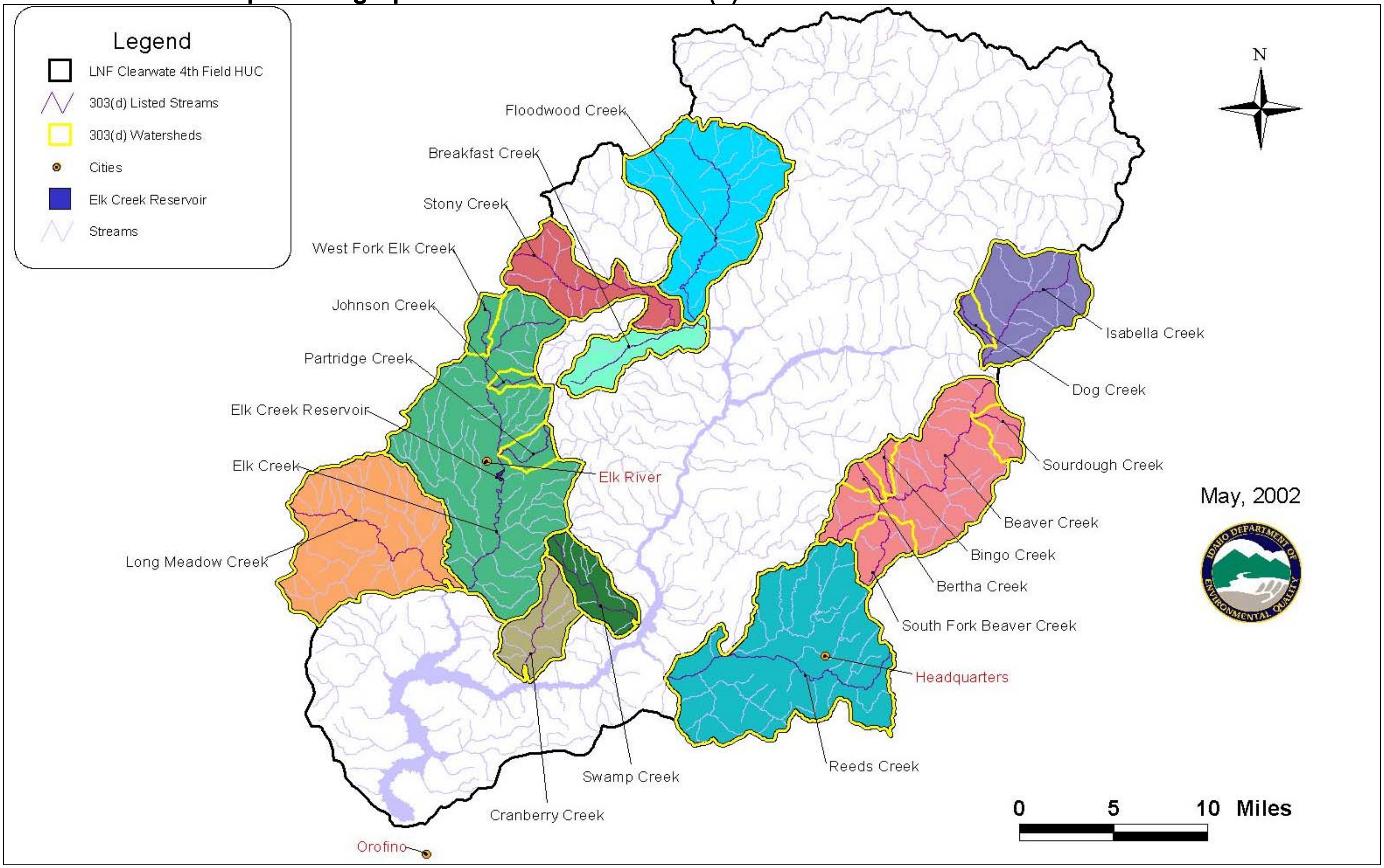


Table A displays the waterbodies for which TMDLs were written and their pollutants of concern. All the streams have salmonid spawning, aquatic cold water, and primary contact recreation or secondary contact recreation as existing or designated beneficial uses. The majority of the information used to determine the level of impairment was from the CNF, IDL, and the Idaho Department of Environmental Quality (DEQ). Based on existing information and data, a monitoring plan was developed to fill in the data gaps. Once all the data were in place, an analysis was completed on each of the 303(d) waterbodies. After the analysis, six sediment, four temperature, and two bacteria TMDLs were written. The pollutants in the LNFCRS are mainly from nonpoint sources, as the only point source is the wastewater treatment plant in Elk River. For sediment, the main sources are background, roads, mass failures, and streambank and riparian area erosion. For bacteria, the main sources are cattle and other livestock, wildlife, and humans. For temperature, the source is solar radiation. Nutrients and dissolved oxygen (DO) were also listed as pollutants of concern on the 1998 303(d) list (DEQ 1999); however, after analyzing the data, these pollutants were determined to not be impairing any beneficial uses. Desired conditions in other watersheds were used to determine the loading capacities for the sediment TMDLs, which are based on the state sediment standards. The loading capacity for the temperature TMDLs was based on the state standards and the Cumulative Watershed Effects (CWE) temperature analysis model. The loading capacity for the bacteria TMDLs was based on state numeric standards.

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

Stream (Creek)	Pollutant(s)
Breakfast	Sediment
Cranberry	Sediment, Temperature, Bacteria
Elk-lower	Temperature
Long Meadow	Sediment, Temperature, Bacteria
Partridge	Sediment
Reeds	Sediment
Swamp	Sediment, Temperature

Key Findings

The subbasin assessment was written for the entire LNFCRS; however, only the 19 listed waterbodies were intensively evaluated. Thereby, TMDLs were only considered for the listed pollutants on the 19 listed waterbodies. Twelve TMDLs were written for seven different waterbodies for three separate pollutants, while seven waterbodies are recommended for 303(d) listing for temperature. These decisions were based on data collected specifically by DEQ and/or from existing data from other agencies and entities including IDL, CNF, the Idaho Department of Fish and Game (IDFG), and Potlatch Corporation.

Sediment

Sediment TMDLs were written for six waterbodies impaired by excessive sediment. In each of these waterbodies, the beneficial uses of salmonid spawning and cold water biota are not being fully supported. For each sediment TMDL, a numeric target was calculated and a narrative target based on the state standards was also written. Various desired conditions from other watersheds were used to determine the sediment load capacities. In the Breakfast Creek, Cranberry Creek, Long Meadow Creek, Reeds Creek, and Swamp Creek watersheds, roads were the primary source of sediment. In the Partridge Creek watershed, bank and riparian area erosion is the primary source of sediment. Each numeric target for sediment is summarized in Table B. The load allocation is the total amount of sediment allowed in the waterbody in tons per year from all sources. The load allocation ensures water quality standards (IDAPA 58.01.02) and existing beneficial uses are met. The load reduction is the amount of sediment from all sources that will need be reduced in order to meet the load allocation. Seasonal variation was considered for the sediment TMDLs. These TMDLs are broken into sources: natural background, roads, mass failures and in-stream erosion. The sediment load amounts from natural background and roads are based on a yearly cycle with the majority of the erosion occurring during the high precipitation events, typically the spring (Table B-3). The sediment load from mass failures is based on a fifteen-year cycle and converted to a yearly amount. The sediment load from in-stream erosion is calculated to a yearly rate, which accounts for seasonal variation activities like grazing and ATV usage. Five years is the estimated time needed to meet the load reduction and load allocation limits. Five years was used mainly due to the Cumulative Watershed Effects (CWE) monitoring cycle. Under the Forest Protection Act (FPA) guidelines, CWE will have to be conducted in these watersheds again. Five years also gives DEQ time to re-monitor the impaired waterbodies. Due to the large size of Reeds Creek, load allocations and reductions were calculated and specified for five sub-watersheds within the Reeds Creek watershed. Margins of safety (MOS) were built into each sediment load allocation calculation. Collection of sediment data occurred in the summer to early fall as most of the LNFCRS is covered with snow during the winter months. A narrative target of sediment not to exceed a level that will impair the beneficial uses will be met when additional data is collected and macroinvertebrate, fish and habitat conditions improve to the point where each stream is meeting the beneficial uses and is within state standards. If the numeric load reductions mentioned in Table B do not allow the narrative targets to be achieved, further sediment reductions may be necessary.

Table B. Sediment load allocations and reductions for the LNFCRS.

Watershed (Creek)	Source	Current Load (tons/yr)	Load Allocation (tons/yr)	Load Reduction (tons/yr)
Breakfast	Roads	830	434	396
Breakfast	Mass Failures	373	75	298
Cranberry	Roads	218	161.5	56.5
Cranberry	Mass Failures	5	1.5	3.5
Cranberry	Bank Erosion	50	25	25
Long Meadow	Roads	2365	674	1691
Long Meadow	Mass Failures	268	27	241
Long Meadow	Bank Erosion	370	185	185
Partridge	Roads	13.8	13.5	0.3
Partridge	Bank Erosion	195	97.5	97.5
Reeds-SW[1]	Roads	328	109	219
Reeds-SW	Mass Failures	58	5	53
Reeds-HW[2]	Roads	506	455	51
Reeds-HW	Mass Failures	327	163.5	163.5
Reeds-NF[3]	Roads	205	184	21
Reeds-NF	Mass Failures	1.0	0.5	0.5
Reeds-Alder[4]	Roads	727	567	160
Reeds-Alder	Mass Failures	75	37.5	37.5
Reeds-GS[5]	Roads	807	484	323
Reeds-GS	Mass Failures	3.0	1.5	1.5
Swamp	Roads	417	161	256
Swamp	Mass Failures	17	2.3	14.7
Swamp	Bank Erosion	65	32.5	32.5

[1] SW=Sidewalls(near the mouth)
[2] HW=Headwaters
[3] NF=North Fork of Reeds Creek
[4] Alder=Alder Creek portion of Reeds Creek
[5] GS=Gold and Snake Creek portions of Reeds Creek

Temperature

Temperature TMDLs were written for four waterbodies that are impaired by temperature. In these four waterbodies, the beneficial uses of salmonid spawning and/or cold water biota are not being fully supported. For each temperature TMDL, a numeric target was calculated and a surrogate shade percentage target over the streams was developed. Stream temperatures are directly related to air temperatures, and in a forested environment, air temperatures and stream shading are the major environmental factors influencing 90% of the variability in stream temperature (Brown 1971, IDL 2000[b]). For each temperature TMDL, a numeric load allocation in watts per square meter and a percent reduction were calculated. The load allocations and percent reductions are based on the CWE temperature model, which uses stream shading to determine shade targets. Most of these surrogate shade targets are at 100% cover or the maximum cover achievable; therefore, an MOS is implicit. The critical time frame for these TMDLs is May through September depending on the species present in each particular waterbody. The numeric temperature target will be the state salmonid spawning criteria; however, if the temperature of the stream exceeds state standards, and it is determined that the temperature is a natural condition, the natural condition will become the state standard. Significant changes will have to occur to reach natural conditions in the stream riparian areas of Cranberry Creek, Elk Creek-lower, Long Meadow Creek, and Swamp Creek. Elk Creek-lower is going to require special attention as water entering this stream from Elk Creek Reservoir is about 5 ºC warmer in the summer than it would be if the reservoir were not there. An approximate load allocation of 5ºC for the months of May through September has been applied to Elk Creek Reservoir.

Bacteria

Bacteria TMDLs were written for Cranberry Creek and Long Meadow Creek. In these two waterbodies, the beneficial use of secondary contact recreation (SCR) is not being fully supported. The three main sources of bacteria are cattle, wildlife, and humans. The numeric target will be the state standard of 126 *E. coli* organisms per 100 ml. A 10% MOS was included in the load allocation and reduction calculations and is shown in Table C below. The critical time frame for the bacteria TMDLs is May through November. That is when cattle are present and typically when the SCR beneficial use is being protected.

Table C. Bacteria load allocations and reductions for the LNFCRS.

Watershed (Creek)	**Source**	**Current Load** (*E.coli* organisms/ day)	**Load Allocation** (*E.coli* organisms/ day)	**MOS** (10%) (*E.coli* organisms/ day)	**Load Reduction** (*E.coli* organisms/ day)
Cranberry	Cattle, wildlife, humans (CR2)[1]	7.4×10^{10}	5.1×10^{10}	2.3×10^{9}	2.5×10^{10}
Long Meadow	Cattle, wildlife, humans (LM2)[2]	2.5×10^{12}	5.5×10^{11}	1.9×10^{10}	2.1×10^{12}
Long Meadow	Cattle, wildlife, humans (LM4)[3]	3.2×10^{11}	1.2×10^{11}	2.0×10^{10}	2.2×10^{11}

[1] CR2 = Cranberry Creek monitoring site number 2
[2] LM2 = Long Meadow Creek monitoring site number 2
[3] LM4 =Long Meadow Creek monitoring site number 4

Table D shows the proposed outcomes for all nineteen listed waterbodies. It includes recommended changes to the 303(d) list. All recommendations are based on the most current and best data and data analysis available to DEQ.

Table D. Summary of assessment outcomes.

Waterbody Segment (Creek)	Pollutant	TMDL(s) Completed	Recommended Changes to 303(d) List	Justification
Beaver	Sed[1]	No	Remove Sed; Add Temp[2]	Data
Beaver - SF	Sed	No	Remove Sed	Data
Bertha	Sed	No	Remove Sed	Data
Bingo	Sed	No	Remove Sed; Add Temp	Data
Breakfast	Sed, DO[3]	Yes-Sed	Remove DO; Add Temp	Data
Cranberry	Sed, Temp, Bact[4], Nut[5]	Yes-Sed, Bact, Temp	Remove Nut	Data
Dog	Sed	No	Remove Sed	Data
Elk - lower	Sed, Temp, Bact, Nut	Yes-Temp	Remove Sed, Bact, Nut	Data
Elk - upper	Sed, Temp, Bact, Nut	No	Remove Sed, Temp, Bact, Nut	Data
Elk Creek Reservoir	Sed, Temp, Bact, Nut, DO	No	Remove Sed, Temp, Bact, Nut, DO	Data
Elk - WF	Sed	No	Remove Sed	Data
Floodwood	Sed, DO	No	Remove Sed, DO; Add Temp	Data
Isabella	Sed	No	Remove Sed; Add Temp	Data
Johnson	Sed	No	Remove Sed	Data
Long Meadow	Sed, Temp, Nut, Bact	Yes-Sed, Temp, Bact	Remove Nut	Data
Partridge	Sed	Yes-Sed	None	Data
Reeds	Sed	Yes-Sed	Add Temp	Data
Sourdough	Sed	No	Remove Sed	Data
Stony	Sed, DO	No	Remove Sed, DO; Add Temp	Data
Swamp	Sed, Temp, Nut, Bact	Yes-Sed, Temp	Remove Nut, Bact	Data

[1] Sed = Sediment
[2] Temp = Temperature
[3] DO = Dissolved oxygen
[4] BACT = Bacteria
[5] Nut = Nutrients

Public Input and Meetings

A public meeting was held in January 2002 to solicit citizen participation. A news release, advertisements in three local newspapers, a radio public service announcement, and an advertisement on the DEQ web site were all coordinated for the January meeting. Nearly 30 individuals were in attendance representing a variety of interests. A Watershed Advisory Group (WAG) for the LNFCRS was officially formed a few months later, and meetings have been occurring almost monthly since then. There are 25 members of the WAG, and many other people are involved and on a mailing list. Membership on the WAG includes citizens at large, landowners in the basin, Potlatch Corporation, CNF, IDL, the Nez Perce Tribe, environmental interests, and representatives from local government. The WAG has reviewed two different draft versions of this document. The WAG submitted informal comments to DEQ, which were incorporated in the final document. This informal comment process gave all the WAG members an opportunity to add significant input to the document. Several WAG members indicated they thought the informal comments were a very useful and productive format for public input. The WAG's involvement with the TMDL process and this document has been instrumental, and they should be commended for their efforts. A public meeting was held in Orofino on October 10 2002 (during the 30-day formal comment period) as part of the Clearwater Basin Advisory Group (CBAG) October meeting. Approximately 50 formal comments were received from four different commentators.

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 nations waters (33 USC § 1251.101). 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 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 of impaired waters, currently every two years. For waters identified on this list, states and tribes must determine if a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards, is necessary. This document addresses the water bodies in the Lower North Fork Clearwater River Subbasin (LNFCRS) that have been placed on what is known as the "303(d) list."

The overall purpose of this subbasin assessment and TMDL is to characterize and document pollutant loads within the LNFCRS. The first portion of this document, the subbasin assessment, 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 (Chapters 1–4). This information will then be used to develop a TMDL for each pollutant of concern for the LNFCRS (Chapter 5).

1.1 Introduction

In 1972, Congress passed public law 92-500, 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 Pollution Control Federation 1987). 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 Idaho 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, with EPA approval, water quality standards and to review those standards every three years. Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish TMDLs 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 subbasin assessment and TMDL provide a summary of the water quality status and allowable TMDL for water bodies on the 303(d) list. *The Lower North Fork Clearwater River Subbasin Assessment and TMDL* provides this summary for the currently listed waters in the LNFCRS.

The subbasin assessment section of this report (Chapters 1-4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the LNFCRS 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 (40 CFR § 130). Consequently, a TMDL is water body and pollutant specific. The TMDL also includes individual pollutant allocations among various sources discharging the pollutant. The EPA considers certain unnatural conditions, such as flow alteration, a lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutant as "pollution." TMDLs are not required for water bodies impaired by pollution, but by specific pollutants. 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.

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 antidegradation 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:

- Aquatic life support – cold water, seasonal cold water, warm water, salmonid spawning, modified
- 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 habitat, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body is unclassified, then cold water and primary contact recreation are used as additional default designated uses when water bodies are assessed.

A subbasin assessment 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.
- When water bodies are not attaining water quality standards, determine the causes and extent of the impairment.

1.2 Physical and Biological Characteristics

In this section, the physical and biological characteristics of the LNFCRS will be characterized and described. The data presented in this characterization is pertinent to issues affecting water quality in the basin and in each 303(d)-listed subwatershed. Upstream from the LNFCRS is the Upper North Fork Clearwater River Subbasin. The subbasin assessment and associated TMDLs for that subbasin were released for public comment in February of 2001 and are awaiting EPA approval. Downstream from Dworshak Reservoir is the Clearwater River. Map 1 shows the general geographical location of the LNFCRS and the location of the 303(d) waterbodies and land ownership. Bordering the LNFCRS on the east side is the Upper North Fork Clearwater River Subbasin, to the northeast is the Mallard Larkins Pioneer Area, to the north is the St. Joe National Forest and the St. Maries River drainage, to the west is the Potlatch River drainage, and to the south are the Clearwater River and the Jim Ford and Orofino Creek watersheds.

The Lower North Fork Basin covers 1,145.44 square miles, which is about the same size as the state of Rhode Island. The basin is located in north central Idaho, primarily in Clearwater County. The basin is centrally located around Dworshak Reservoir with all streams flowing directly or indirectly into this reservoir. Completed in 1971, the reservoir attained full pool two years later. The full pool elevation is 1,600 feet and the minimum operating elevation is 1,445 feet. At full pool, the reservoir is 54 miles long, 2 miles across at its widest point near Elk Creek, and has a maximum depth of 480 feet. The surface area is 17,090 acres at full pool and 9,050 acres at minimum pool. There is no passage for migrating fish at Dworshak Dam.

Climate

The basin is dominated by maritime air masses and prevailing westerly winds. During the fall, winter, and spring, cyclonic storms move towards the east and produce low intensity, long duration precipitation, which accounts for most of the annual precipitation. Prolonged gentle rains, deep snow accumulations at higher elevations with fog, cloudiness, and high humidity characterize the basin in the fall, winter, and spring. Winter temperatures are often 15 to 25 degrees F. warmer than the continental locations of the same latitude. A seasonal snowpack generally covers the area from November to June. The climate during the summer months is influenced by high-pressure stationary systems. These warm, dry, summer systems result in less than approximately 15 % of the annual precipitation. These systems sometimes produce high intensity electrical storms which cause frequent wildfires, especially during exceptionally hot and dry summers. Precipitation isohyetals and the climate station locations are shown on Map 2.

Climatic data were collected for this report from six locations: two locations on the west side of Dworshak Reservoir, Elk River (2,827 feet) and Elk Butte (5,824 feet); two locations on the east side of Dworshak Reservoir, Headquarters (3,126 feet) and Shanghi Summit (5,166 feet); and at two stations at the confluence of the North Fork Clearwater River with the Mainstem Clearwater River, Orofino (1,030 feet) and Dworshak Fish Hatchery (1,000 feet). Two very low elevation locations, two mid or average elevation locations and two high elevation locations were selected. In addition, some locations were located on each side of Dworshak Reservoir. There is a considerable temperature difference between low elevation locations (Orofino and Dworshak Fish Hatchery) and the other four locations. Orofino averages 54 days a year where air temperatures exceed 90^{o}F. Elk River, which is about 1,800 feet higher, averages 13.4 days in a year where temperatures exceed 90^{o}F, while on Elk Butte, which is almost 5,000 feet higher than Orofino, temperatures only exceed 90^{o}F approximately once every four years. A summary of this climate data is shown in Table 1. In the summer months, the average temperatures are about 20^{o}F warmer at the lower elevations than at the summit and butte locations. Hot summer temperatures are common at the mid to lower elevations in the LNFCRS and are the major factor influencing water temperatures. Air temperatures at the mid to lower elevations will exceed 90^{o} F between 20-70% of the time in the July and August. This fact needs to be taken into consideration when considering thermal heat loads to the waterbodies. Table B-3, Appendix B, displays the average monthly mean, maximum, and minimum for temperature, as well as the average monthly precipitation for each station. The summers of 1998 and 2001 were exceptionally warm and dry.

On rare occasions, mild pacific air masses meet cold continental air masses producing heavy rainfall combined with rapid snowmelt. This phenomenon is called a rain-on-snow event. These events often occur mid-winter, outside the normal spring snowmelt. They lead to soil saturation, huge amounts of run-off, and can produce large amounts of sediment through erosion and mass wasting. Low to mid elevations, up to about 4,000 feet elevation, are the most susceptible to rain-on-snow in the subbasin, since above 4,000 feet most of the precipitation still falls as snow. Several major rain-on-snow events have occurred in recent history. These events deliver a significant amount of sediment to the streams in this basin.

While these are natural climatic events, human activities, primarily logging and road building, have changed the landscape to a certain degree.

Table 1. Summary of climate data.

Station Name	Type	Eleva-tion (ft)	Period of Record	Mean Annual Temp (ºF)	Mean Annual Precipitation (inches)	# of Days > 90ºF per year
Elk River	NWS	2918	1/1/52-12/31/00	43.9	37.6	13.4
Elk Butte	NRCS	5690	10/22/82-12/1/01	38.6	59.7	0.23
Headquarters	NWS	3138	6/1/59-12/31/00	43.3	40.1	13.4
Shanghi Summit	NRCS[2]	4570	2/1/83-12/1/00	41.5	57.4	2.14
Orofino	NWS[1]	1030	8/01/48-12/30/81	51.6	25.3	54.0
Dworshak Fish Hatchery	NWS	1000	12/1/66-12/31/00	52.0	25.6	47.8

[1] NWS =National Weather Service
[2] NRCS =National Resource Conservation Service

Hydrology

Hydraulically the basin is split into three areas: waters flowing into the Little North Fork Clearwater River, waters flowing into the North Fork Clearwater River, and waters flowing into Dworshak Reservoir. Most of the 303(d) listed streams flow directly into Dworshak Reservoir, none flow into the Little North Fork Clearwater River, and two flow into the North Fork Clearwater River.

The North Fork Clearwater River flows about 74 miles from its headwaters near the Idaho/Montana border to the slack water in Dworshak Reservoir. Only the last 2.91 miles of the North Fork Clearwater River is located in the LNFCRS when the reservoir is at full pool. Since 1967, a United States Geological Survey (USGS) gauge has been on the North Fork Clearwater River 0.1 miles upstream from the mouth of Beaver Creek. The annual mean flow for the years 1967 through 2000 was 4,096 cfs. The information from this gauge is displayed in Figure 1.

The streams in the basin have a pattern of low flows during the late summer and early fall and high flows in the spring and early summer. The peak discharge is typically in late May or early June. A peak discharge on the North Fork Clearwater River was recorded on November 30, 1995 at 37,500 cfs while a minimum flow was recorded on December 5, 1972 at 200 cfs. Monthly mean flows are graphically displayed in Figure 1.

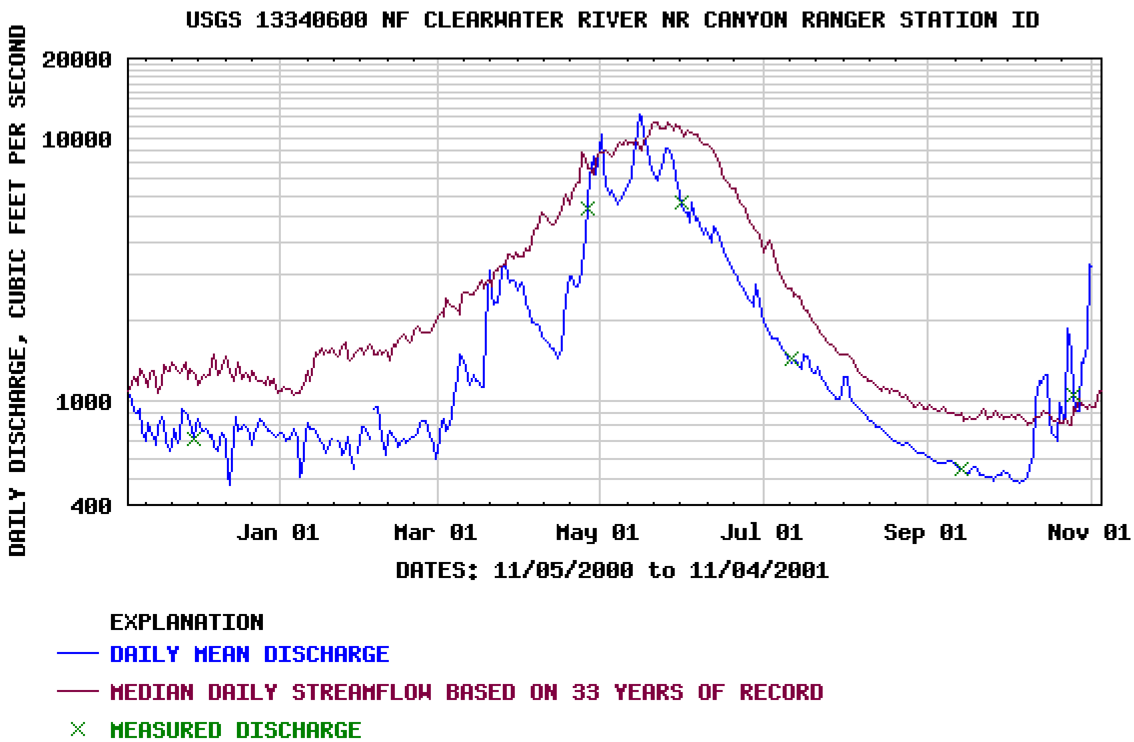


Figure 1. North Fork Clearwater River Discharge at USGS Gauge Site.

Geology and Soils

The general surface geology is represented on Map 3. The geology for the majority (over 60%) of the basin is a contact zone of schist and gneiss, which is located in the central, north, and northwestern parts of the basin. This contact zone is susceptible to erosional processes resulting in a high occurrence of mass failures. The basin is on the northern edge of the Idaho Batholith as granitic formations are located along the southeastern portion of the basin. Along the north and northeast edge of the basin are metasedimentary rocks of the Belt Series. To the west and southwest of the basin are Columbia River basalt flows. Based on the best available data collected, the basin has a density of 0.26 landslides per square mile.

The soils derived from metasedimentary rocks generally weather to finer textured soils with varying amounts of course fragments. Granitics weather rapidly to grus, which are sandy and excessively well drained in composition. Basalt rock has a tendency to weather into large cobble size material. Soils from the contact zone exhibit considerable structural and weathering variability due to the different pressure and temperatures the parent rocks were subject to. These contact areas tend to result in areas with a higher percentage of mass failures. In most of the basin the soils include a layer of ash from the explosion of Mount Mazama that can be up to 20 inches thick. This layer of volcanic ash contributes substantially to the water and nutrient holding capacity of the soils and is the significant reason for the high productivity of the soils in the LNFCRS. This ash has been eroded primary on south to west facing slopes and in areas denuded by fire.

Topography

Elevations range from 1,445 feet, which is minimum pool elevation of Dworshak Reservoir, to over 7,000 feet. Most elevations are within 3,000 feet to 5,500 feet and most of the topography in the basin is steep terrain with greater than 50% slope gradients. In general, the drainage pattern tends to be dendritic with steep, V-shaped profiles of A-type stream channels. There are very few flat lands, as they are found either on ridge tops or valley bottoms. Some lower gradient areas exist in the southwest corner of the basin. The northern portion of the basin was glaciated in the last ice age, which is evident by several alpine lakes and meadows, and a few U-shape valleys. Map 4 shows the relief of the drainage in 800 feet intervals.

A natural background erosion rate of 25 tons per square mile is used for the TMDL loading allocations. This natural background rate was determined from work that occurred in the CNF (Wilson et al. 1982). This rate seems reasonable as other references state similar background rates for forested environments. The CNF has similar rates calculated by their Water Balance (WATBAL) model for each watershed. However, recent work by (Kirchner et al. 2001) which uses cosmic radiation to determine sediment yield measurements, indicates that conventional background measurements may be 17 times lower than what is actually happening on the landscape on a geological time scale (periods of at least 10,000 years). Incremental erosion prevails most of the time, but accounts for very little of the overall sediment yield. Catastrophic erosion events, although extremely rare, dominate the long-term sediment yield. In fact 70% to 97% of sediment delivery occurs during these episodes. Conventional sediment yield measurements are ineffective at measuring these catastrophic events due to the enormous size and infrequency of these events. It is possible that aquatic habitats subject to such catastrophic sediment loads will be episodically disrupted and these episodic catastrophic sediment delivery disturbances may be essential for maintaining their diversity and productivity (Kirchner et al. 2001). With these recent discoveries it would appear that human activities have very little impact on the long-term sediment yield, but still have the potential to significantly disrupt aquatic ecosystems that have evolved to cope with episodic sediment deliveries rather than persistent low-level disturbances (Kirchner et al. 2001). Human activities on the landscape can also alter the frequency or size of these catastrophic events (Kirchner et al. 2001).

Vegetation

The vegetation is dominated by coniferous forests, which is typical of steep lands in north central Idaho. Grand fir (*Abies grandis*), Douglas fir (*Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*) are the most common trees species. Other tree species of commercial value are western white pine (*Pinus monticola*), ponderosa pine (*Pinus ponderosa*), lodgepole pine (*Pinus contorta*), western hemlock (*Tsuga heterophylla*), western larch (*Larix occidentales*), and Engleman spruce (*Picea Englemanii*). Higher elevation subalpine zones are dominated by Engleman spruce, subalpine fir (*Abies lasiocarpa*), and mountain hemlock (*Tsuga mertensiana*). Alder (*Alnus* spp), birch (*Betula* spp), cottonwoods (*Populus* spp), and mixed forbes and shrubs have vegetated some areas subjected to severe forest fires. Approximately 1,500 plant species can be found in the basin, only a few of which are trees. However, the subbasin contains some of the most productive tree growing sites in Idaho. The forest understory ranges from grasslands to shrublands with all variations in between. The understory vegetation communities range from very drought tolerant, which are primarily grasslands, to communities associated with mild, moist pacific maritime climates. These damp communities typically have dense canopies made up of cedar and hemlock trees. Logging, fire and other activities have removed these tree canopies resulting in dense stands of shrubby species with diverse composition crowding these productive sites.

The vegetation of the subbasin has been significantly altered since 1900. Logging, road building, disease, insects, and fire suppression activities have changed the forest composition from being dominated by long-lived, shade-intolerant species to forests dominated by short-lived, shade-tolerant species. White pine blister rust and logging activities largely eliminated stands dominated by western white pine. The CNF estimates that western white pine as a cover type has been reduced from being the dominant type in the subbasin in the early 20th century to covering less than 2% today.

Forest fires have also affected the distribution and types of vegetation. For example, forest fire history records show that large fires in 1910, 1919, and 1934 burned major portions of the subbasin. Because some drainages burned two or three times between 1910 and 1934, forest succession there has been retarded and seral shrub fields still dominate (USFS 1997).

Fisheries

The following native fish may be found in the subbasin.

Common Name	Taxonomic Nomenclature
Westslope cutthroat trout	(*Oncorhynchus clarki lewisi*)
Bull trout	(*Salvelinus confluentus*)
Northern pike minnow	(*Ptychocheilus oregonensis*)
Redside shiner	(*Richardsonius balteatus*)
Mottled sculpin	(*Cottus bairdi*)
Paiutte sculpin	(*Cottus beldingi*)
Shorthead sculpin	(*Cottus confusus*)
Torrent sculpin	(*Cottus rhotheus*)
Chiselmouth	(*Acrocheilus alutaceus*)
Longnose dace	(*Rhinichthys cataractae*)
Speckled dace	(*Rhinichthys osculus*)
Largescale sucker	(*Catostomus macrocheilus*)
Bridgelip sucker	(*Catostomus columbianus*
Rainbow trout	(*Oncorhynchus mykiss*)
Steelhead	(*Oncorhynchus mykiss*)
Mountain whitefish	(*Prosopium williamsoni*)
Pacific lamprey	(*Lampetra tridentata*)

The following fish species have been introduced in the subbasin.

Common Name	Taxonomic Nomenclature
Brook trout	(*Salvelinus fontinalis*)
Golden trout	(*Oncorhynchus aguabonita*)
Rainbow trout	(*Oncorhynchus mykiss*)
Steelhead	(*Oncorhynchus mykiss*)
Westslope cutthroat trout	(*Oncorhynchus clarki lewisi*)
Yellowstone cutthroat trout	(*Oncorhynchus clarki bouvieri*)
Cutthroat-rainbow trout hybrids	(*Oncorhynchus clarki-mykiss*)
Bull trout	(*Salvelinus confluentus*)
Kokanee salmon	(*Oncorhynchus nerka*)
Black crappie	(*Pomoxus nigromaculatus*)
Bluegill	(*Lepomis macrochirus*)
Grayling	(*Thymallus arcticus*)
Brown Bullhead	(*Ictalurus nebulosus*)
Largemouth bass	(*Micropterus salmoides*)
Smallmouth bass	(*Micropterus dolomieui*)
Pumpkinseed sunfish	(*Lepomis gibbosus*)

Bull trout are listed by the U.S. Fish and Wildlife Service as a threatened species. In 1995 Idaho Governor Phil Batt initiated a conservation plan to restore bull trout populations in Idaho with the goal to "Maintain and/or restore complex interacting groups of bull trout populations throughout their native range in Idaho" (Batt 1996). An assessment titled *North Fork Clearwater River Basin Bull Trout Problem Assessment* was prepared for the State of Idaho by the Clearwater Basin Bull Trout Technical Advisory Team (Clearwater Basin Bull Trout Technical Advisory Team 1998). The assessment provided governmental agencies/entities and major timber landowners with a framework that identified key subwatersheds and prioritized management actions to maintain or enhance bull trout populations and habitats in those watersheds. The North Fork Clearwater River lies within the native range of bull trout; however, historic abundance and trend data are scarce because bull trout were once considered a nuisance fish. In fact, for many years, the Idaho Department of Fish and Game (IDFG) had a bounty on bull trout. Therefore, populations are considered somewhat depressed in most of the drainage. According to the *North Fork Clearwater River Basin Bull Trout Problem Assessment*, spawning and early rearing of bull trout occur in three 303(d)-listed watersheds: Upper Isabella Creek, Upper Beaver Creek, and Floodwood Creek. Subadult and adult rearing are also present in Floodwood Creek.

Westslope cutthroat trout are present in many of the drainages of the basin. The North Fork Clearwater River basin is considered to support one of the last strong westslope cutthroat trout populations in Idaho. Of the 19 listed waterbodies, cutthroat are present in nine. In the CNF, which includes all of the Upper North Fork Clearwater River Subbasin, populations are well distributed and in a strong condition in 36 out of 54 6^{th} order HUC subwatersheds.

1.3 Cultural Characteristics

The LNFCRS is a very sparsely populated area with only one incorporated city, Elk River, with a population of 156 people (Idaho Department of Commerce). The communities of Headquarters, Cardiff, and Dent are also within the LNFCRS but are not incorporated. The total population in the LNFCRS is estimated at 300 people, which is a density of 0.262 people per square mile. Forestry and recreational activities dominate the land use of the basin. The basin is nearly 100% forested; hence, most of the management of the non-federal lands is for timber harvest. The LNFCRS is a popular destination for outdoor recreation activities such as hunting, fishing, hiking, boating, and camping.

Land Use

Timber harvesting has been the primary land use in this basin, as Potlatch Corporation, the CNF and the Idaho Department of Lands (IDL) manage 87.5 % of the basin. Trends over the past 15-20 years show timber harvest activities decreasing while recreational activities, such as fishing, are increasing. Statistics show that 96.27% of the basin is forestland, 2.85% is open water, and 0.88% is dryland agriculture. There are many recreational uses, as the basin is a popular destination spot for all kinds of outdoor activities. There are several grazing leases in the central and southern portions of the LNFCRS. Excluding the larger timber companies like Potlatch Corporation, only 2.7% of the basin is owned by private landowners. The remaining portion of the basin is federal or state land. Map 5 shows the land ownership in the LNFCRS.

Land Ownership, Cultural Features, Population, and History

The LNFCRS has three primary landowners: Potlatch Corporation, the state of Idaho, and the United States Forest Service (USFS). Potlatch Corporation owns 32.9%, the Forest Service 30.1% and the state of Idaho 24.5%. Most of the population lives in the southern portion of the LNFCRS. Table 2 displays land ownership percentages. Although a large portion of the basin is managed for timber production, there are no major industries located within the subbasin.

Population in the subbasin peaked in the late 1960s and early 1970s and has steadily decreased since. At its peak in the 1950s, the town of Headquarters had a population of nearly 600 people with a post office, a drug store, a community hall, and an operating rail line to transport timber and supplies (Bennett 2002). Potlatch Corporation manages the Clearwater office in the unincorporated town of Headquarters. Population trends for the city of Elk River, Clearwater County, and some of the surrounding communities outside of the basin are displayed in Table 3.

Table 2. Land ownership of the LNFCRS.

Ownership	Percentage
Potlatch Corporation	32.9%
USFS	30.1%
State of Idaho	24.5%
Army Corps of Engineers	3.9%
Private Land Ownership - Non Industry	2.7%
Open Water	2.3%
Bureau of Land Management	1.7%
Crown Pacific	1.6%
Bennett Lumber Company	0.2%
Plum Creek Industries	0.1%

Table 3. Population trends.

City/County	1920	1930	1940	1950	1970	1980	1990	2000
Elk River	847	862	337	312	383	265	149	156
Headquarters	ND[1]	307	200	548	ND	ND	ND	ND
Orofino	ND	ND	ND	ND	3,883	3,711	2,868	3,247
Pierce	ND	ND	381	544	1,218	1,060	746	617
Weippe	ND	ND	ND	ND	713	828	532	416
Clearwater County	4,993	6,599	8,243	8,217	10,871	10,390	8,505	8,930

[1] ND = No Data

Archeologists believe that the first humans moved into Idaho about 15,000 years ago, and that they came from Asia across a broad plain when the oceans were several hundred feet lower (Arrington 1994). The Nez Perce people have been residents in the general area for over 8,000 years. They have relied and continue to rely upon salmon fishing and big game hunting for subsistence. Portions of the LNFCRS are within the Nez Perce Tribe's ceded territories. The Treaty of 1855 reserved tribal fishing and hunting rights in these areas. The Nez Perce Tribe's treaty-reserved interest in maintaining and utilizing natural resources is important to their sense of community and lifestyle. The basin has always been important for the traditional uses of the Nez Perce for gathering, hunting and fishing. Approximately 1.5% of the southern most portion of the subbasin lies within the reservation boundary line established in the Treaty of 1861 as displayed in Map 1. None of the 303(d)-listed waters are within the reservation boundary.

The first known European people to enter the area were in the Lewis and Clark expedition in 1805. The expedition camped on the Weippe prairie and at the mouth of the North Fork Clearwater River near Ashaska. Gold was discovered in 1860 in Orofino Creek by a member of the Elias Davidson Pierce party. This created opportunities for other miners and settlers to come into the area. Lewiston was Idaho's first territorial capital established in 1863; later the capital was moved to Boise (Arrington 1994). Idaho officially became a state in 1890 and soon homesteaders began to occupy lands around the Lower North Fork of the Clearwater. Due to the rugged terrain in the basin, homesteading in the basin was sparse. This is evident today, as only 2.7% of the area is owned by non-corporate private individuals. Between 1890 and 1914, many lumber mills were established in the surrounding area including sites in Orofino, Deary, Elk River, Potlatch, Weippe, Bovill, Pierce and Lewiston. In 1900 the Clearwater Timber Company was organized. Potlatch Forest, Inc., which is Potlatch Corporation today, took over the Clearwater Timber Company in 1930 (Arrington 1994). The timber industries and the 1910 fire have had the greatest influence on the landscape in the LNFCRS in the past 100 years.

Economics

The principal economic activities are forestry and recreation. Governmental agencies and timber corporations own 95% of the basin. Although the amount of timber removal on the USFS lands has decreased significantly, Potlatch Corporation and IDL still harvest several hundred million board feet of timber each year from the LNFCRS. Outdoor recreational activities are abundant as Dworshak Reservoir, the North Fork Clearwater River and the surrounding area provide excellent fishing, hunting and other outdoor recreational opportunities. Grazing allotments have been established and are active in the southern and central parts of the subbasin. Over the last few decades, mining activities have curtailed significantly. There are several aggregate mines located throughout the subbasin used primarily for road building and maintenance activities. In summary, the LNFCRS economy is driven by some of the most productive forest lands and some of the best hunting, fishing and other outdoor recreational activities in the state.

Forestry

The logging boom took off in the 1930s with salvage logging for western white pine, and logging of western red cedar for power poles. Initially, log flumes, dams, and chutes were built down major drainages to the North Fork Clearwater River. From there, logs were floated to Lewiston in the now historic Clearwater River log drives. Subsequently, logging systems utilized railroads, tractors/bulldozers, Idaho jammers, skylines with long cable reaches, and, most recently, helicopters. Logging activity and associated road construction was at its peak in the 1960s and 1970s, and has tapered off considerably (Table 4); however, logging is still important to the economies of the surrounding communities.

Table 4. Timber harvest by decade in millions of board feet from Clearwater National Forest land.

Decade	Millions of Board Feet Harvested
1930s	40
1940s	51
1950s	173
1960s	726
1970s	694
1980s	318
1990s	228

Recreation

Recreational activities include fishing, hunting, camping, boating, snowmobiling, downhill and cross country skiing, four-wheeling, kayaking, canoeing, rafting, swimming, water-skiing, mountain biking, berry picking, mushroom hunting, wildlife and scenery viewing, trapping, motorcycling, hiking, photography, driving, and sight seeing historic areas of interest. Fishing is the probably the most popular recreational activity in the area. For example, in 1995 fishermen spent an estimated 64,542 hours and caught 28,457 fish (Clearwater Basin Bull Trout Technical Advisory Team 1998) on the North Fork Clearwater River. These activities provide significant economic support to Elk River and the surrounding communities of Pierce, Weippe, Orofino, Ahsahka, Kamiah, Kooskia, Moscow, and Lewiston. The CNF maintains several campgrounds and many other unofficial campgrounds are located on CNF, IDL, and Potlatch Corporation lands. The Beaver Creek and Elk Creek watersheds are some of the more popular camping and outdoor recreational destinations. The economies of local communities like Elk River and Orofino rely primarily on recreational opportunities.

Located to the south, and attracting visitors from all over the world, is the Lolo trail system. Visitors come to see the prehistoric and historic trails. The Lolo trail primary follows the Nez Perce *Nee-Me-Poo* trail which is probably thousands of years old. The trail was used by the Nez Perce in their 1877 flight from their homelands eastward into Montana. Lewis and Clark’s trail through the region is marked as well.

Grazing

The IDL, Potlatch Corporation, and the CNF have cooperative agreements regarding grazing allotments on their lands in the central and southern portions of the LNFCRS. Some impacts from grazing have been noted in the Long Meadow, Elk, Partridge, Cranberry, and Swamp Creek watersheds. Impacts include destruction or removal of riparian vegetation, increased sedimentation levels to the streams, and fecal material deposition in or near waterways.

Cattle are typically brought into allotments listed below around June and then removed in late October or early November. An animal unit month (AUM) is the unit of measurement for cattle in these allotments. An AUM equals the amount of forage necessary to feed one cow and her calf for one month. The following allotments are located within the LNFCRS:

Round Creek Allotment – Long Meadow Creek Watershed - 340 AUMs
Elk Creek Allotment – Elk Creek Watershed - 150 AUMs
Silver Creek Allotment – Reeds Creek Watershed - 435 AUMs
Swamp Creek Allotment – Swamp, Cranberry, Cedar Creek Watersheds -1350 AUMs

All of the area is open grazing so cattle can move from one area to another, as cattle tend to roam and break into smaller groups. For example, in the Swamp Creek Allotment, grazing occurs in Swamp Creek, Cranberry Creek, Fischer Creek and Cedar Creek watersheds so the total number of AUMs is not all in the Swamp and/or Cranberry Creek watersheds. IDL does not allow grazing on its land within the Swamp Creek watershed (Nauman, 2001); however, field crews observed cattle on IDL land in the Swamp Creek watershed in 1999 and in 2001. DEQ recommends that IDL address this specific management issue. Cattle are also not permitted on United States Army Corps of Engineers lands, but they have been sighted there as well. All of the above leases have full-time livestock herders and they do not place salt or minerals within 600 feet from major streams.

Mining

Currently there is a very limited amount of mining activity affecting water quality in the LNFCRS. Historically, mining played a major role in the basin, directing the economy and changing the landscape. The majority of the mining has been placer mining in the streams and stream valleys. Aggregate mining, used primarily for road construction, still continues and is usually located on uplands away from the streams and riparian areas.

Reeds Creek, Beaver Creek, and Elk Creek along with other non-303(d)-listed streams and their tributaries were placer-mined by hand, dredge, and large machinery. These drainages have improved substantially since the end of the gold mining era in the early 1900s. Recreational dredge mining is limited in the subbasin as waters from Isabella Creek to the slack water of Dworshak Reservoir are closed, as are Beaver Creek, Isabella Creek, Little North Fork, Reeds Creek, and Elk Creek watersheds. All tributaries not listed above that flow into Dworshak Reservoir are open for recreational dredge mining. There are no current permitted mining activities in the subbasin.

Transportation

DEQ created a GIS roads layer identifying 5,800.3 miles of roads in the 1,145.4 square mile (733,085.1 acre) subbasin, yielding an average road density of 5.06 road miles per square mile. A large portion of the basin is unroaded. The concentration of roads is shown on Map 6. Most of the 303(d) stream drainages are affected by road construction, some to a much greater degree than others. In Section 2, various characteristics of roads are display in table format and discussed for each 303(d)-listed watershed.

By the late 1800s railroads were the primary transportation system in the area as they brought people and supplies to Idaho. Timber was brought out of the forest and equipment and supplies were brought into the basin to support the timber industry. Old grades and tresses remain and are found in the Beaver Creek, upper Reeds Creek, and upper Elk Creek watersheds. These abandoned railroad lines have massive fill slopes which have the potential for large mass failures as was the case in the upper Elk Creek watershed in April 1993. A slide located about five miles north of the town of Elk River moved approximately 22,511.4 cubic yards of material nearly a mile, most of it reaching Elk Creek (Philbin 1994).

Before the completion of Dworshak Reservoir, timber was also transported by water. Chutes, flumes, and temporary dam and flush operations were fairly common practices from the early to mid twentieth century. The stream channels were typically altered (usually straightened) to aid in timber harvesting activities. Streamside vegetation was also typically removed from these areas. Although much of land has recovered from these primitive timber harvesting activities, some streams are still recovering from these impacts. Physical evidence of these structures and operations is still present today in many locations.

2. Subbasin Assessment – Water Quality Concerns and Status

This section describes the water quality concerns and status of the 303(d)-listed waterbodies in the LNFCRS. Included in the discussion will be a description of the 303(d)-listed waterbodies and the justification for their 303(d) listing. This section will also provide an overview of the water quality data used in the subbasin assessment to analyze and compare the different listed waterbodies. The data presented in this section will illustrate which 303(d)-listed waterbodies are truly impaired and require a TMDL to improve water quality, and which waterbodies not in need of a TMDL because beneficial uses are being met. Various characteristics of the 303(d) waterbodies are displayed in Tables 5-13. Recommendations for each 303(d)-listed waterbodies will also be included.

2.1 Water Quality Limited Segments Occurring in the Subbasin

Within the LNFCRS (HUC #17060308) there are 19 waterbodies on the 1998 303(d) list. Table 5 lists all the 303(d) waterbodies and their boundaries, listing basis, pollutants, segment IDs, and their designated uses. Most of these streams are listed because they did not meet CNF Plan Sediment Standards (CNF 1992) or because they were listed as impaired in *The 1992 Idaho Water Quality Status Report*, Appendix D (DEQ 1992) as being impaired. When these waterbodies were placed on the original 303(d) list in 1994, there was a very limited amount of data to support their listing, if any at all. These waterbodies were placed on the 303(d) list because of "evaluated" information, meaning best professional judgment was used at the time. Since then, sufficient data has been collected to properly assess these waterbodies. Map 7 shows the watershed outlines of each 303(d)-listed stream and their geographical location within the LNFCRS.

The CNF classified streams in the *Watershed Condition Summary* (1992) as "Green", "Yellow", and "Red". "Green" streams were in a good condition, "yellow" streams were to be managed at the forest plan biological threshold (use caution), and "red" streams were not to have any more anthropogenic caused sediment inputs prior to documented channel stability recovery. The streams classified by the CNF in 1992 as exceeding the forest plan sediment standards that were reported on the 303(d) list in the LNFCRS were considered "yellow" streams. These "yellow" streams exceeded forest plan sediment standards, but were under the geomorphic threshold for the watershed for each "yellow" stream.

Table 5. 303(d) segments in the LNFCR subbasin.

Waterbody (Creek)	Segment ID #	1998 303(d)[1] Boundaries	Designated Uses[3]	Existing Uses	Pollutants[4]	Listing Basis[5]
Beaver - mainstem	5014	HW[2] to N Fork Clearwater River	CW, SCR	SS, CW, SCR	Sed	A
Beaver- South Fork	5182	HW to Beaver Cr.	CW, SCR	SS, CW, SCR	Sed	A
Bertha	5016	HW to Beaver Cr.	CW, SCR	SS, CW, SCR	Sed	A
Bingo	5020	HW to Beaver Cr.	CW, SCR	SS, CW, SCR	Sed	A
Breakfast	3197	HW to Dworshak Res	CW, SCR	SS, CW, SCR	Sed, DO	B
Cranberry	3191	HW to Dworshak Res	CW, SCR	SS, CW, SCR	Sed, Temp, Nut, Bac	B
Dog	5063	HW to Isabella Cr.	CW, SCR	SS,CW, SCR	Sed	A
Elk	3189	HW to Dworshak Res	SS,CW, PCR, DWS	SS,CW,PCR, DWS	Sed, Temp, Nut, Bac	A,B,C,D
Elk Creek Reservoir	3190		SS, CW, PCR, DWS	CW,PCR,DWS	Sed, Temp, Nut, Bac, DO	A,D
Elk - West Fork	5209	HW to Elk Cr.	CW, SCR	SS,CW,SCR	Sed	A
Floodwood	3198	HW to Breakfast Cr.	CW, SCR	SS,CW,SCR	Sed, DO	B
Isabella	5095	HW to the North Fork Clearwater River	CW, SCR	SS,CW,SCR	Sed	A
Johnson	5100	HW to Elk Cr.	CW,SCR	SS,CW,SCR	Sed	A
Long Meadow	3188	HW to Dworshak Res.	CW, SCR	SS,CW,SCR	Sed, Temp, Nut, Bac	B
Partridge	5140	HW to Elk Cr.	CW, SCR	SS,CW,SCR	Sed	A
Reeds	3193	HW to Dworshak Res.	SS, CW, PCR, DWS	SS,CW,PCR	Sed	B

Waterbody (Creek)	Segment ID #	1998 303(d)[1] Boundaries	Designated Uses[3]	Existing Uses	Pollutants[4]	Listing Basis[5]
Sourdough	5181	HW to Beaver Cr.	CW, SCR	SS,CW,SCR	Sed	A
Stony	3199	HW to Breakfast Cr.	CW, SCR	SS,CW,SCR	Sed, DO	B
Swamp	3192	HW to Dworshak Res.	CW, SCR	SS,CW,SCR	Sed, Temp, Nut, Bac	B

[1] A list created in 1998 of water bodies in Idaho that did not fully support at least one beneficial use. This list is required under Section 303(d) of the Clean Water Act.
[2] HW = Headwaters
[3] CW = Cold Water, SS = Salmonid Spawning, PCR = Primary Contact Recreation, SCR = Secondary Contact Recreation, DWS = Domestic Water Supply
[4] Sed = Sediment, Temp = Temperature, Nut = Nutrients, Bac = Bacteria, DO = Dissolved Oxygen
[5] [A] Streams did not meet forest plan sediment standards in *Watershed Condition Summary* (Clearwater National Forest 1992)
[B] Streams were on the 1992 305(b) report
[C] Data submitted by Idaho Conservation League
[D] Data submitted by Columbia River Intertribal Fish Commission

2.2 Applicable Water Quality Standards

This section covers the applicable water quality standards and water quality criteria for the 303(d)-listed segments in the LNFCRS. The beneficial uses will be discussed in this section. Idaho State Law requires surface waters of the state of Idaho to have the following designated beneficial uses (aquatic life, recreation, water supply, wildlife habitats, and aesthetics) protected (IDAPA 58.01.02.100).

Water Quality Standards

Aquatic Life

Cold water (COLD): waters quality appropriate for the protection and maintenance of a viable aquatic life community for cold water species.

Salmonid spawning (SS): waters which provide or could provide a habitat for active self-propagating populations of salmonid fishes.

Seasonal cold water (SC): water quality appropriate for the protection and maintenance of a viable aquatic life community of cool and cold water species, where cold water aquatic life may be absent during, or tolerant of, seasonally warm temperatures.

Warm water (WARM): water quality appropriate for the protection and maintenance of a viable aquatic life community for warm water species.

Recreation

Primary contact recreation (PCR): water quality appropriate for prolonged and intimate contact by humans or for recreational activities when the ingestion of small quantities of water is likely to occur. Such activities include, but are not restricted to, those used for swimming, water skiing, or skin diving.

Secondary contact recreation (SCR): water quality appropriate for recreational uses on or about the water and which are not included in the primary contact category. These activities may include fishing, boating, wading, infrequent swimming, and other activities where ingestion of raw water is not likely to occur.

Water Supply

Domestic: water quality appropriate for drinking water supplies.

Agricultural: water quality appropriate for the irrigation of crops or drinking water for livestock. This use applies to all surface waters of the state.

Industrial: water quality appropriate for industrial water supplies. This use applies to all surface waters of the state.

Wildlife habitats

Water quality appropriate for wildlife habitats. This use applies to all surface waters of the state.

Aesthetics

This use applies to all surface waters of the state.

For waters that are undesignated, DEQ asserts in IDAPA 58.01.02.101.01 that cold water aquatic life and primary or secondary contact recreation will be applied to all waters that do not have designations.

Criteria For Protecting Existing Uses

The following general water quality criteria apply to all surface waters of the state in addition to the water quality criteria set forth for specifically designated waters

Hazardous Materials: Surface waters of the state shall be free from hazardous materials concentrations found to be of public health significance or to impair designated beneficial uses. These materials do not include suspended sediment produced as a result of nonpoint source activities.

Toxic Substance: Surface waters of the state shall be free from toxic substances in concentrations that impair designated beneficial uses. These substances do not include suspended sediment produced as a result of nonpoint source activities.

Deleterious Materials: Surface waters of the state shall be free from deleterious materials in concentrations found to be of public health significance or to impair designated beneficial uses. These materials do not include suspended sediment produced as a result of nonpoint source activities.

Radioactive Materials: Radioactive materials or radioactivity shall not exceed the values listed in the Code of Federal Regulations, Title 10, Chapter 1, Part 20, Appendix B, Table 2, Effluent Concentrations, Column 2. Radioactive materials or radioactivity shall not exceed concentrations required to meet standards set forth in Title 10, Chapter 1, Part 20 of the Code of Federal Regulations for maximum exposure of critical human organs in the case of foodstuffs harvested form these waters for human consumption.

Floating, Suspended or Submerged Matter: 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.

Excess Nutrients: Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or nuisance aquatic growths impairing designated beneficial uses.

Oxygen-Demanding Materials: Surface waters of the state shall be free from oxygen-demanding materials in concentrations that would result in an anaerobic water condition.

Sediment: Sediment shall not exceed quantities specified in IDAPA 58.01.02 section 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 350.02.

Natural Background Conditions: When natural background conditions exceed any applicable water quality criteria set fourth in IDAPA 58.01.02 sections 210, 250, 251, 525, 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 IDAPA 58.01.02 section 401.

In addition to the general water quality criteria there are specific criteria which apply to waters of the state. Selected criteria from IDAPA 58.01.02. which are applicable to LNFCS are listed in Table 6.

Table 6. Surface water quality criteria.[1]

PCR[2]	For areas within waters designated PCR that are additionally specified as public swimming beaches, a single sample of 235 *E. coli* organisms per 100ml. A single sample of 406 *E. coli* organisms per 100ml or a geometric mean of 126 *E. coli* organisms based on a minimum of five samples taken every three to five days over a 30 day period is a violation.
SCR[3]	A single sample of 576 *E. coli* organisms per 100ml or a geometric mean of 126 *E. coli* organisms based on a minimum of five samples taken every three to five days over a 30 day period is a violation.
Cold Water Aquatic Life	Surface waters are not to vary from the following characteristics due to human activities: pH between 6.5 and 9.0. DO[4] must be greater than 6.0 mg/L at all times in the water column. In lakes and reservoirs this does not apply to the bottom 20% where depths are less than 35 meters. Turbidity below any mixing zone set by the DEQ shall not exceed background turbidity by more than 50 NTU[5] instantaneously or more than 25 for NTU more than 10 consecutive days. Water temperature must be equal to or less than 22^{o}C with a maximum daily average of no greater than 19^{o}C.
Salmonid Spawning	Surface waters are not to vary from the following characteristics due to human activities: pH between 6.5 and 9.0. DO must be greater than 6.0mg/L or 90% of the saturation, whichever is greater. Water temperature must be equal to or less than 13^{o}C with a maximum daily average of no greater than 9^{o}C. Bull trout- water temperatures shall not exceed 13^{o}C maximum weekly maximum temperature during June, July and August for juvenile bull trout rearing, 9^{o}C daily average during September and October for bull trout spawning.
Temperature Measuring Purposes—the daily average shall be generated from a recording device with a minimum of six (6) evenly spaced measurements in a 24-hour period. Exemption -Exceeding the water quality temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth (90th) percentile of the seven (7) day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station. * *These above two standards do not apply to the federally promulgated bull trout streams or temperature criteria.* EPA Bull Trout Temperature Criteria: Water Quality standards for Idaho (40 CFR Part 131.33(a)): “A temperature criterion of 10^{o}C expressed as average of daily maximum temperatures over a seven-day period which applies…during the months of June, July, August and September.”	

[1] IDAPA58.01.02
[2] PCR = Primary Contact Recreation
[3] SCR = Secondary Contact Recreation
[4] DO-Dissolved Oxygen
[5] NTU- nephlometric turbidity unit

2.3 Summary and Analysis of Existing Water Quality Data

In this section the various data sets that were collected and analyzed are discussed. The data is summarized in Tables 7-13. Below is a list of the various water quality data used in this document:

Geographic Informational Systems (GIS) Analysis
Mass failure data
Beneficial Use Reconnaissance Program (BURP) data, WBAG II process
CWE data
CNF data and WATBAL model
CNF Stream Bio-Physical Studies reports
Stream temperature data
Fish data
Flow data
DEQ-LRO 2001 monitoring season data

GIS Analysis

Using GIS software, watersheds were delineated for 303(d)-listed streams so that the following analysis could be calculated: road density, number of roads crossing a perennial stream, miles of streams within 100 feet of a road, and miles of roads in high mass failure and high surface erosion areas. This information is displayed in Table 7, along with the total area, road and stream miles, and the number of mass failures for each 303(d)-listed watershed. While GIS is a great tool used to illustrate, compare, calculate, and analyze data in a way not previously possible, it is important to note that the data used for GIS analysis may not be 100% accurate at all times. There is no one central GIS database, so we were required to gather, compile, change, modify, and create data from various sources. In addition landscape conditions change somewhat rapidly: roads are obliterated or built, timber is removed while trees growing, ownership changes, streams shift, etc. To update the database for the LNFCRS continually at this scale, which is as large as some eastern states, would be impossible given the resources available. However, with that said, the best data currently available has been compiled as is presented in this report. The following is the disclaimer from DEQ regarding data usage in GIS Analysis. "Restriction of liability: Neither the State of Idaho nor the Idaho Department of Environmental Quality, nor any of their employees make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness or usefulness of any information or data provided. Metadata is provided for all data sets, and no data should be used without first reading and understanding its limitations. The data could include technical inaccuracies or typographical errors. The Department of Environmental Quality may update, modify, or revise the data used at any time, without notice."

The roads coverage was pulled together from Potlatch Corporation, IDL, and CNF data. Road density was one of the GIS factors evaluated during this subbasin assessment process. The higher the road density, the greater the potential for sediment to be delivered to a stream. Since roads are constructed and maintained differently in different geology and terrain, road density is only one of many indicators to consider when estimating sediment input to a stream. Many roads are closed, or have restrictions as to what type of vehicles are permitted and when travel is permitted, so just looking at road density numbers could be misleading. Road crossing points to a perennial stream were delineated and totaled for each watershed, as these crossings are potential sediment delivery points. Roads close to a stream have a greater potential to deliver sediment just by their sheer proximity to the stream although not all roads do. The miles of roads on landscapes with high mass failure and high surface erosion ratings were also calculated using CWE data. Road design and maintenance greatly impact the amount of sediment delivered from these roads. This data was looked at collectively as an indicator as to which watersheds needed a closer evaluation of sediment conditions, especially if it was determined they are not meeting beneficial.

Mass Failure Data

Mass failures are a major sediment source in the subbasin and are part of the natural geomorphic process. The combination of highly weathered and metamorphosed bedrock, steep slopes, substantial road building, fire and logging-reduced vegetative cover, and rain-on-snow events have mostly liked resulted in an increase of the total number of landslides. Mass failure data came from three main sources: the CNF, IDL, and Potlatch Corporation. This data was collected in GIS format and then organized, and edited by DEQ-LRO. The resulting database identified 751 landslides for a density of 0.67 per square mile. This coverage at the subbasin level is not nearly complete and the density calculated is probably low, as the LNFCRS is a very large and extensive area. However, CWE field surveys conducted by the IDL and Potlatch Corporation have provided an extensive coverage for landslides in Global Positioning Systems (GPS) format for the majority of the 303(d)-listed watersheds. The mass failure data is displayed in Table 7.

Table 7. GIS analysis of the 303(d)-listed water bodies.

Water Body (Creek)	Area (mi^2)	Road Miles	Road Density (mi/mi^2)	Number of Road Crossings	Miles of Streams Within 100 ft of Road	Stream Miles	Miles of Roads in High Mass Failure Ratings	Miles of Roads in High Surface Erosion Ratings	Total Number of Mass Failures/ Density ($\#/mi^2$)
Beaver	61.79	401.9	6.5	467	43.4	185.4	50.74	105.45	50 / 0.8
Beaver-SF	8.04	45.7	5.7	55	5.0	30.0	0.0	4.0	0 / 0
Bertha	2.73	8.8	3.2	13	1.0	8.5	0.0	0.0	0 / 0
Bingo	2.65	18.9	7.1	9	3.3	6.5	0.02	0.0	3 / 0.38
Breakfast	13.67	125.9	9.2	109	7.1	32.1	24.02	9.49	77 / 5.6
Cranberry	14.63	86.8	5.9	80	7.0	24.5	1.83	0.03	6 / 0.41
Dog	2.76	10.8	3.9	44	2.1	17.5	1.58	1.22	2 / 0.73
Elk-upper	41.09	121.3	3.0	304	23.1	232.8	1.99	7.79	6 / 0.15
Elk-lower	59.44	379.2	6.4	403	44.9	184.4	11.51	1.54	7 / 0.12
Elk Cr. Res.[1]	n.a.[2]	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Elk-WF	3.97	4.7	1.2	9	0.5	24.6	0.15	0.15	0 / 0
Floodwood	51.74	186.7	3.6	186	10.3	122.1	50.28	9.96	76 / 1.5
Isabella	30.46	21.4	0.7	74	4.5	122.1	8.37	1.89	23 / 0.8
Johnson	1.91	3.3	1.7	10	0.5	8.5	0.00	0.12	0 / 0
Long Meadow	56.09	362.3	6.5	534	51.2	185.0	14.43	0.00	68 / 1.2
Partridge	4.62	7.3	1.6	28	1.8	31.9	0.08	0.09	0 / 0
Reeds	79.36	535.7	6.8	571	83.5	224.4	25.73	20.00	57 / 0.7
Sourdough	4.85	31.6	6.5	65	3.1	18.0	4.27	67.49	3 / 0.62
Stony	23.13	201.2	8.7	178	13.5	54.9	30.12	2.96	23 / 1.0
Swamp	12.17	86.5	7.1	98	8.5	32.8	4.75	0.06	11 / 0.9

[1] Res = Reservoir
[2] N/A = Not applicable

BURP Data and WBAG II

BURP is a DEQ water-monitoring program that has been in existence for nearly a decade in the state of Idaho. Each year BURP crews collect biological, chemical, and physical data between July and September. The program was developed from rapid bioassessment concepts developed by EPA. BURP surveys were completed on the 303(d) streams in the LNFCRS during the summer monitoring seasons of 1997, 2000, and 2001. BURP is a good tool to evaluate changes in the environment based on biological changes. BURP data is easily reproducible and a database has been established with this data. Information collected in this BURP will be valuable in future years to evaluate the condition of the water bodies in the state including the LNFCRS. The BURP process collects data on macroinvertebrates, fish, other aquatic life, and stream physical habitat. This data in turn is used to determine whether a water body is supporting its designated beneficial uses. WBAG II is a guidance document that DEQ uses to determine whether a water body fully supports designated and existing beneficial uses, relying on physical, chemical, and biological parameters typically collected during the BURP process (Grafe et al. 2002). Data collected outside of DEQ can be used to assist with designated beneficial use calls provided that the data is less than 5 years old and that it meets certain requirements outlined in WBAG II. Table 8 displays the WBAG II results for the 303(d)-listed streams in the LNFCRS. Some streams have multiple BURP sites and/or multiple years of BURP data collection.

WBAG II is a guidance document intended to determine the beneficial use support of a water body, provide descriptive information about the water body, and determine the degree of biological integrity of a waterbody. Its primary purpose is for 303(d) listing and 305(b) reporting. Once a waterbody is on the 303(d) list a subbasin assessment must be completed to determine if a TMDL is necessary. Typically a subbasin assessment compiles more information about the waterbody(s) in question and in a subbasin assessment WBAG II assessment calls are used as part of the information to determine beneficial use status. Therefore, the subbasin assessment is the document that determines if a TMDL is necessary not the WBAG II.

WBAG II stratifies streams into segments based on stream order and land use. First and second order streams are combined as there are so many miles of these streams in Idaho and typically these streams are similar. BURP data is used to determine the index scores (stream macrobiotic index [SMI], stream fish index [SFI], and stream habitat index [SHI]). In determining the total SMI, SFI, and SHI scores numerous indicators and metrics are evaluated to get the total score for that index. For example the SHI metrics include parameters like large organic debris, % canopy cover, embeddedness, and channel shape; SMI metrics include parameters like total number of taxa, number of mayflies, number of stoneflies, and number of caddisflies. These metrics scores are compared to a reference condition for the appropriate Bioregion and given a index score (0, 1, 2, or 3). The index scores are then added, and divided by three to get an average composite score for each segment. If two BURP sites are located in a steam segment the lower of the two scores is used to interpret aquatic life support calls. If more than two sites are on a segment they are averaged to determine an aquatic life support call. An averaged composite score of two or greater passes (full support, FS) while a score of less than two fails (not full support, NFS).

Table 8. WBAG II beneficial use status calls for 303(d)-listed water bodies.

Water Body (Creek)	Stream Macrobiotic Index (SMI)	Stream Fish Index (SFI)	Stream Habitat Index (SHI)	Average Score FS/NFS
Beaver-upper	66.23 (3)	83.92 (3)	66 (3)	(3) FS[1]
Beaver-lower	51.23 (1)	91.15 (3)	61 (2)	(2) FS
Beaver-3rd site	65.71 (3)	96.28 (3)	69 (3)	(3) FS
Beaver-SF	64.65 (3)	80.01 (2)	68 (3)	(2.67) FS
Bertha	62.03 (3)	80.28(2)	71 (3)	(2.67) FS
Bingo-DEQ data	47.54 (1)	98.86 (3)	57 (1)	(2.0) FS
Bingo-Potlatch data	87.06 (3)	ND[2]	ND	
Breakfast-upper	42.64 (1)	NFP[3]	72 (3)	(2) FS
Breakfast-lower	56.89 (2)	52.06 (1)	74 (3)	(2) FS
Cranberry-upper	35.35 (0)	NFP	32 (1)	(0.5) NFS[4]
Cranberry-lower	42.51 (1)	91.85 (3)	72 (3)	(2.3) NFS
Dog	64.12 (3)	69.8 (2)	84 (3)	(2.7) FS
Elk-upper (97)	53.31 (1)	68.33 (2)	56 (1)	(2.0) FS
Elk-upper (00)	75.78 (3)	NFD[5]	62 (2)	
Elk-upper-below WF Elk	78.62 (3)	NFD	77 (3)	(3) FS
Elk-lower-above falls	55.01 (1)	53.36 (1)	70 (3)	(1.67) NFS
Elk Cr. Reservoir	n.a.[6]	n.a.	n.a.	n.a.
Elk-WF	56.8 (2)	43.88 (1)	72 (3)	(2) FS
Floodwood-upper	86.05 (3)	63.31 (1)	83 (3)	(2.33) FS
Floodwood-lower	64.06 (3)	59.91 (1)	85 (3)	(2.33) FS
Floodwood-3rd site	62.92 (3)	73.34 (2)	77(3)	(2.67) FS
Isabella-upper	76.64 (3)	81.51 (3)	90 (3)	(3) FS
Isabella-lower	57.91 (2)	72.78 (2)	78 (3)	(2.3) FS
Johnson	75.28 (3)	49.93 (1)	85 (3)	(2.3) FS
Long Meadow-upper	49.65 (1)	25.26 (0)	66 (3)	(1.3) NFS
Long Meadow-lower	58 (2)	36.74 (1)	51 (1)	(1.3) NFS
Partridge	39.21 (1)	56.26 (1)	51 (1)	(1) NFS
Reeds-upper	43.19 (1)	25.67 (0)	50 (1)	(0.7) NFS
Reeds-lower	55.16 (2)	91.57 (3)	62 (2)	(2.3) FS
Sourdough	72.38 (3)	88.83 (3)	81 (3)	(3) FS
Stony-97	66.53 (3)	51.36 (1)	73 (3)	(2.3) FS

Water Body (Creek)	Stream Macrobiotic Index (SMI)	Stream Fish Index (SFI)	Stream Habitat Index (SHI)	Average Score FS/NFS
Stony-00	69.81 (3)	71.01 (2)	61 (2)	(2.33) FS
Swamp-upper	45.16 (1)	NFP	49 (1)	(1) NFS
Swamp-lower	60.74 (2)	61.59 (1)	82 (3)	(2) NFS

[1] FS = Full support
[2] ND = No data
[3] NFP = No fish present
[4] NFS = Not full support
[5] NFD = Not fished at time of survey
[6] n.a.= Not applicable

Idaho's Cumulative Watershed Effects Process

CWE is a watershed model that evaluates a variety of conditions related to timber activities on the ground to determine impacts to the environment. The CWE process is a framework for collecting and organizing data on mass failures, surface erosion hazards, stream temperature, watershed canopy conditions, hydrologic risks, sediment production and delivery to a waterway, stream channel stability, and water nutrient conditions. The process relies on the WBAG II beneficial use support determination as the measure of whether or not a stream is water quality impaired. The CWE methodology analyzes data collected from on-the-ground conditions, and determines whether forest practices are creating "adverse conditions" due to sediment, temperature, nutrients, and/or hydrologic impacts (IDL 2000[b]). CWE roads data were collected on all of the 303(d)-listed water bodies except for Elk Creek-West Fork, and Elk Creek Reservoir, and CWE assessments were completed for all the waterbodies except Isabella Cr., Dog Cr., Elk Creek-upper, Elk Creek-West Fork, and Elk Creek Reservoir.

The intent of CWE is to allow forest managers to respond to the CWA when forest practice standards are not being met. Adverse conditions are not defined using the state's water quality standards but do allow forest managers to pinpoint the condition impacting water quality. CWE is physically conducted in the watershed and the results are an up-to-date, systematic assessment of on-the-ground conditions. When CWE identifies an adverse condition for sediment, temperature, nutrients or hydrologic function, managers and area foresters should investigate that particular area and determine what corrective actions are needed.

While CWE produces in the final analysis a pass/fail for each of the pollutant types, the CWE scores derived from the data collected provide a continuous-scale rating of the situation. When a CWE assessment conclusion does not agree with conclusions of the DEQ WBAG assessment or the 303(d) list, the CWE data can be analyzed to help explain the discordance and arrive at a conclusion about the status and causes of water quality problems (Dechert et al. 2001).

All of the CWE data in the reports listed in the reference section of this document were thoroughly examined. The adverse condition results and the total sediment delivery rating/scores were of particular interest and are displayed in Table 9. The sediment delivery score gives a total score from all sources of sediment from the watershed including roads, mass failures and trails. The ratings for sediment are low, moderate or high, with low being a high-quality condition and high being a low quality condition. These results were used in this evaluation to help determine water quality impairment from adverse sediment conditions. Stream segments with high temperatures were addressed in each temperature TMDL. In watersheds that are listed for temperature as a pollutant, the CWE stream temperature assessment model was used as the foundation for the temperature TMDL. The model will give local foresters the percent shade amount needed at each elevation to bring stream temperatures back into compliance. The model also allows for local foresters to account for natural conditions where the canopy cover percentage cannot be achieved. These include rock bluffs, meadows, or large streams typically 3rd or 4th order or higher where the canopy cannot stretch across the entire width of the stream. Elk Creek-lower is a good example of 4th order stream where the canopy cannot fully cover the width of the stream; therefore, 100% canopy cover is unachievable.

Clearwater National Forest Service data and WATBAL Model

A significant amount of data directly or indirectly generated by the CNF was used in this report. The CNF uses their Water Balance (WATBAL) model to assist management with decisions regarding allocation of resources. In its forest plan, the CNF states its management goal for water quality is to "manage watersheds, soil resources, and streams to maintain high quality water that meets or exceeds State and Federal water quality standards, and to protect all beneficial uses of the water, which include fisheries, water-based recreation, and public water supplies," (USFS 1987). In this assessment, WATBAL data helped DEQ evaluate whether a given waterbody was water quality limited.

WATBAL was originated from the R1-R4 model in the Boise National Forest. Then in the 1970s Walt Megahan, Dale Wilson, and Rick Patten collected data in the Clearwater National Forest and created WATBAL (Jones 2002). The major inputs are landtype characteristics like mass wasting potential, sediment delivery potential, and surface erosion; precipitation; roading; fire; and logging. Its outputs include the amount of sediment being produced naturally from a given land type, peak runoff, and annual runoff. WATBAL is a dynamic model. As roading, logging, and other management activities take place in a watershed, it predicts the additional amount of sediment produced by these activities. These predictions were calibrated against data collected in the late 1970s and 1980s (Dechert et al. 2001). The CNF's WATBAL predictions for water quality objective over natural background and the current sediment condition over natural are presented in Table 9. Desired and current cobble embeddedness from the 1997 CNF Watershed Condition (Jones Murphy 1997) was used in conglomeration with the other data in this section to help determine beneficial use status.

CNF Stream Bio-Physical Studies

The CNF contracted comprehensive stream surveys for many streams on their lands. The following 303(d)-listed streams have had surveys performed: Beaver, South Fork-Beaver, Bertha, Bingo, Sourdough, Elk, West Fork-Elk, Isabella, Dog, Partridge, and portions of the Long Meadow. The results of these studies are contained in a series of reports identified in the reference section of this document as authored by "Clearwater Biostudies, Inc." or "Isabella Wildlife Works." Each of these studies includes a stream survey of the whole stream divided into numerous reaches, surveys and calculations of substrate embeddedness, riffle stability surveys, fish surveys, and stream flow calculations. The stream surveys included determining Rosgen channel types and major hydrologic features. The physical and hydrological data is fairly extensive and thorough. The only biological data collected in these reports are fish surveys, typically performed by snorkeling.

Gradient, bank stability index, length of raw banks, width and depth, percent pools, and acting and potential woody debris were some of the indicators selected out of those reports to help assess sediment conditions. These measures were used to assess the level of water quality impairment. For example, length of raw banks, and bank stability were looked at as an indicator of in-stream erosion. Acting and potential woody debris tell a lot about fish habitat and canopy cover for each stream, while percent pools, gradient, and width and depths are all good habitat parameters to analyze, especially over an extended period of time. Collectively this data was used to help determine the level of water quality impairment and beneficial use status. Data from these bio-physical studies are displayed in Tables 10 and 11 of this report and are discussed in detail for the above waterbodies in the subbasin assessment discussion presented later in this section.

Stream Temperature Data

Stream temperature data came from several sources. In May and June 2001, DEQ-LRO placed continuous temperature data logger probes in all the 303(d)-listed streams with temperature as a possible pollutant. The location of the temperature probes are shown on Map 8. These continuous temperature loggers recorded temperature every hour for each 24-hour period. The CNF has continuous temperature data on Isabella Creek and Elk Creek from 1994-2000. Temperature probes were also placed in Floodwood, Breakfast, Stony, Reeds, Isabella, and Goat Creek drainages (non-303(d)-listed) by the DEQ BURP crew in early July of 2001 and removed in September 2001. The temperature probe in Breakfast Creek was missing when crews went to recover it; possibly stolen by vandals.

Instantaneous stream temperatures have been taken by DEQ BURP crews, CNF biostudy crews, and during the 2001 monitoring season by DEQ-LRO personnel. In general most streams exceed the salmonid spawning temperature standard for July and August. Each specific section of the creek and their associated graphs will be discussed in more detail in the subwatershed characteristic section found later in this section. It is interesting to note that Goat Creek, which is not 303(d)-listed; used by DEQ as a reference stream; has not been altered, logged, mined, or physically altered by humans; in a wilderness area; still exceeds the numeric salmonid spawning temperature criteria.

Table 9. CWE, WATBAL, and instantaneous temperature results for 303(d) listed streams.

Waterbody or CWE HUCs (Creek)	Water Quality Sediment Objective (% O.N.)[1]	Current Sediment (% O.N.)	Future Desired (C.E.)[2]	Current (C.E.)	CWE[3] Sediment Score & Rating	CWE Adverse Conditions (T,S,N,H)[4]	Temp. Inst. °C
Beaver-Sidewalls	75[5]	50[5]	35-40	28	65.8 / Med	T, S-NV	14
Beaver-Headwaters	75[5]	50[5]	35-40	28	70.6 / Med	T, S, H	13
Beaver-East Fork	75[5]	50[5]	35-40	28	74.5 / Med	T, S, H	ND
Bertha	ND[6]	ND	ND	ND	ND	ND	13
Bingo	ND	ND	ND	ND	ND	ND	15
Breakfast	ND	ND	ND	ND	209.3 / High[6]	T, S, H	19.8
Cranberry	ND	ND	ND	ND	37.3 / Low[7]	T, S-NV[8]	17
Dog	110	27	25-30	28	ND	ND	13
Elk-Upper	55	ND	30-35	41	ND	ND	10
Elk-Lower	200	ND	40-45	20	11.6 / Low	T, S-NV, H	22
Elk Creek Reservoir	ND	ND	ND	ND	ND	ND	ND
Elk-West Fork	55	ND	30-35	ND	ND	ND	10
Floodwood[9]	ND	ND	ND	ND	25.8 / Low	T, S-NV, H	18.9
Isabella-Upper	55	4	30-35	37	ND	ND	13
Isabella-Lower	55	0	30-35	36	ND	ND	15
Johnson	55	0	30-35	ND	18 / Low	S-NV	10
Long Meadow-Sidewalls	200	ND	ND	ND	67.4 / Med	T, S, N	12
Long Meadow-Headwaters	200	ND	ND	ND	63.2 / Low	T, S-NV	18
Long Meadow-3 Bear	200	ND	ND	ND	99.1 / Med	T, S, N, H	ND

Waterbody or CWE HUCs (Creek)	Water Quality Sediment Objective (% O.N.)[1]	Current Sediment (% O.N.)	Future Desired (C.E.)[2]	Current (C.E.)	CWE[3] Sediment Score & Rating	CWE Adverse Conditions (T,S,N,H)[4]	Temp. Inst. °C
Long Meadow-Oviatt	200	ND	ND	ND	101.9 / Med	T, S, N, H	ND
Partridge	200	8	40-45	67	21 / Low	T, S-NV	11
Reeds-Sidewalls	ND	ND	ND	ND	51.6 / Med	T, S-NV, N	17
Reeds-Headwaters	ND	ND	ND	ND	36 / Med	T, S-NV, H	19
Reeds-North Fork	ND	ND	ND	ND	42 / Med	T, S-NV, H	ND
Reeds-Alder Creek	ND	ND1	ND	ND	54.9 / Low	S-NV	12.7
Reeds-Gold and Snake	ND	ND	ND	ND	47.1 / Med	T, S-NV	ND
Sourdough	150	56	35-40	63	ND	ND	12
Stony-Lower	ND	ND	ND	ND	21 / Low	T, S-NV, H	15
Stony-Upper	ND	ND	ND	ND	27.5 / Low	T, S-NV,H	16
Swamp	ND	ND	ND	ND	45.6 / Low	T, S-NV, H	16

[1] O.N. = Over natural
[2] C.E. = Cobble embeddedness
[3] CWE = Cumulative Watershed Effects
[4] T = Temperature, S = Sediment, N = Nutrients, H = Hydrologic impacts
[5] WATBAL data for Beaver Creek included all 303(d) watersheds within the Beaver Creek watershed
[6] ND = No data
[7] L = Low sediment volume input, M = Moderate sediment volume input, H = High sediment volume input
[8] NV = Needs verification, more data
[9] West Fork Floodwood only

Table 10. Stream data from CNF-contracted studies on 303(d)-listed waterbodies.

Waterbody or CWE HUCs (Creek)	Study Area Length (m)	Average Stream Gradient (%)	Bank Stability Index(1-5)-and/ or-Raw Banks (m) per 1 (km)	Average Width (m)/ Average Thalweg Depth (cm)	% Pools	Acting/Potential Woody Debris (pieces/100 m)
Beaver	27,880	2.0	4.4	8.2/46.6	4.3	14.2/10.4
Beaver-SF	8,075	2.3	4.3	3.2/17.5	36.2	10.9/13.5
Bertha	3,795	5.8	4.3	2.8/10.7	23.4	30.8/22.7
Bingo	3,735	4.0	4.5	2.0/17.7	16.6	5.7/0.8
Breakfast	ND[1]	ND	ND	ND	ND	ND
Cranberry	ND	ND	ND	ND	ND	ND
Dog	1,320	13.9	3.7	3.4/21.3	23.7	13.6/82.6
Elk-upper	19,220	2.4	3.0/ 686 m	5.3/55.7	56.1	8.4/11.4
Elk-res. to falls	5,880	1.5	4.8/41.6 m	10.0/47.4	17.1	1.6/9.2
Elk-below falls	8,400	4.5	4.8/41.8 m	10.9/54.9	11.8	1.6/15.7
Elk Cr. Reservoir	ND	ND	ND	ND	ND	ND
Elk-WF	5,205	3.7	4.8/37.8 m	2.4/31.7	30.8	14.1/20.5
Floodwood	ND	ND	ND	ND	ND	ND
Isabella (90)-lower	9,185	4.4	5.0	10.3/49.8	10.3	15.5/55.2
Isabella (95)-upper	3,900	8.9	4.9	4.77/32.48	16.0	ND
Johnson	ND	ND	ND	ND	ND	ND
Long Meadow[2]	8820	5.5	4.8/52.3 m	2.5/31.7	23.0	8.4/6.3
Long Meadow[3]	1350	2.8	5.0/4.9 m	0.9/9.1	10.9	8.4/3.9
Long Meadow[4]	5190	1.8	4.9/20.2 m	0.9/12.3	24.0	6.3/7.3
Partridge	9,120	2.1	10.7 m	1.36/37.3	43.2	ND

Waterbody or CWE HUCs (Creek)	Study Area Length (m)	Average Stream Gradient (%)	Bank Stability Index(1-5)-and/ or-Raw Banks (m) per 1 (km)	Average Width (m)/ Average Thalweg Depth (cm)	% Pools	Acting/Potential Woody Debris (pieces/100 m)
Reeds	ND	ND	ND	ND	ND	ND
Sourdough (90)	3,088	8.2	4.9	3.9/13.4	11.4	41.0/51.3
Sourdough (95)	3,240	8.25	5.0	3.57/13.99	4.49	ND
Stony	ND	ND	ND	ND	ND	ND
Swamp	ND	ND	ND	ND	ND	ND

[1] N/D = No data
[2] Oviatt Creek (tributary to Long Meadow Creek)
[3] Tributary to Oviatt creek
[4] Butterfield Creek (tributary to Oviatt Creek)

Fish Data

Tables 11 and 12 summarize the salmonid fish data for the 303(d)-listed streams. The data was derived from BURP electrofishing, CNF snorkeling by the CNF, IDFG, and biostudies crews. Table 11 displays age classes of salmonids, and the total number of sculpin and whitefish. Table 11 also notes when young of the year were observed, an indicator that successful spawning and rearing occur in the stream. Table 11 shows age classes and table 12 shows fish density (number per 100m^2). In these tables the density of fish at each site varied from zero (sites without fish) to over 30 fish (sites with numerous age classes). Table 12 displays density of fish for two different sites over four-year period in the Beaver Creek and four different sites over a four-year period in Isabella Creek. Age class determination was based on information in the CNF surveys, which indicated the determination was made by the CNF fish biologist. This data demonstrates whether or not the water quality of each waterbody provides protection, maintenance, and propagation of a salmonid fish population.

Table 11. Fish data.

Waterbody (Creek)	BURP Data 1997	DEQ Fish Survey 2001	CNF Surveys	IDFG Surveys
Beaver-upper	CT-3+j, WF-1, SC-13	ND[a]	RB-3+j, CT-3+j BL-1, BT-3+j, KN	ND
Beaver-lower	RB-3+j, CT-1, SC-10	WF-1, RB-3+j, CT-2, SC-15		ND
Beaver-3rd site	(RB-3+j, SC-14)[b]	CT-2+j, RB-1, SC-10		ND
Beaver-SF	CT-2+j, SC-26	CT-2, SC-13	CT-2, BT-3+j	ND
Bertha	CT-2+j, SC-8	SC-8, CT-2+j	ND	ND
Bingo	CT-3+j	(CT-3+j)[c]	ND	CT-3+j
Breakfast-upper	0.0	0.0	ND	ND
Breakfast-lower	RB-1+j	ND	ND	ND
Cranberry-upper	0.0	0.0	ND	ND
Cranberry-lower	RB-3+j	ND	ND	ND
Dog	CT-1+j	CT-2	ND	ND
Elk-upper	BT-3+j, SC-13	ND	BT-6+j	ND
Elk-lower	BT-3+j, RB-1, SC-38	BT-1, RS-18, SC-12	BT-6+j, RB-4+j	ND
Elk Cr. Reservoir	[d]	[d]	[d]	[d]
Elk-WF	BT-3+j	BT-4+j	BT-4+j	ND
Floodwood-upper	CT-3+j	ND	ND	WF-6, CT-4+j RB-3+j Hybrid-3
Floodwood-lower	(RB-2+j, SC-17, RB-2+j)[b]	RB-2, CT-1, SC-28	ND	
Floodwood-mouth	RB-2+j, SC-8	RB-3+j, D-1, SC-8	ND	
Isabella-upper	CT-3+j	ND	RB-2, CT-3+j, BL-1, KN, (90); CT-3+j (95)	ND
Isabella-lower	RB-2+j, SC-4, BL-1	ND		
Johnson	BT-2+j	BT-3+j	ND	ND
L Meadow-upper	BT-2+j	RB-3+j, BT-4+j, SC-9	(CT-2+j, BT-5+j)[d]	ND
L Meadow-lower	RB-2, SC-16, D-6	ND		ND
Long Meadow-3rd Site	BT-2+j	BT-4+j, D-1		ND
Partridge	BT-3+j	BT-4+j	BT-5+j	ND
Reeds-upper	BT-3+j	ND	ND	ND

Waterbody (Creek)	BURP Data 1997	DEQ Fish Survey 2001	CNF Surveys	IDFG Surveys
Reeds-lower	RB-3+j, BT-2+j	ND	ND	ND
Reeds-middle 3rd	RB-3+j, SC-6	RB-2, BT-4+j	ND	ND
Sourdough	CT-3+j, (CT-2+j)[f]	CT-2+j	CT- 2+j	ND
Stony-upper	CT-3+j	CT-4+j, RB-3+j, Hybrid-3, SC-12	ND	ND
Stony-lower	RB-3+j		ND	ND
Swamp-upper	0.0	0.0	ND	ND
Swamp-lower	RB-3+j	ND	ND	ND

CT-Cutthroat
RB-Rainbow
Hybrid- Rainbow/Cutthroat hybrids
BT-Brook Trout
BL-Bull Trout
D-Dace-total numbers only-non species specific
RS-Redside Shiner-total numbers only-non species specific
WF-Whitefish-total numbers only
KN-Kokanee-total numbers only
SC-Sculpin-total numbers only-non species specific
#+j-number of ages classes including young-of-the-year juvenile
[a] No data
[b] 2000 BURP data
[c] 1998 Potlatch Corporation data
[d] see subwatershed characteristic section
[e] Oviatt Cr.-Tributary to Long Meadow Creek
[f] 1998 BURP

Table 12. Additional IDFG snorkeling fish data (#fish/100m²).

Waterbody-yr. (Creek)	Area (square meters)	RB 0[1]	RB 1[2]	RB 2[3]	RB >2[4]	CT <305 mm[5]	CT >305 mm[6]	BT[7]	WF[8]
Beaver 1-94[9]	156	0	7.70	1.93	0	0	0	0	0
Beaver 1-95	236	6.36	2.54	0.42	0	0	0	0	0
Beaver 1-96	331	2.42	2.72	2.42	3.02	0	0	0	0
Beaver 1-97	260	0	0	0	0	0.77	0	0	0
Beaver 2-94	324	0	2.47	1.24	0	0	0	0	0
Beaver 2-95	236	0	0	0	0	0	0	0	0
Beaver 2-96	231	0	0.87	0.43	0	0	0	0	0
Beaver 2-97	260	0	0.70	3.50	0.70	0	0	0	0
Isabella 1-94	109	0	11.91	5.50	0	0	0	0	0
Isabella 1-95	131	1.53	3.05	0	0	0	0	0.76	0
Isabella 1-96	ND[10]	ND	ND	ND	ND	ND	ND	ND	ND
Isabella 1-97	166	0	1.20	0	0.60	0	0	0.60	0
Isabella 2-94	100	1.00	7.02	4.01	0	0	0	0	0
Isabella 2-95	90	5.56	2.22	0	0	2.22	0	0	0
Isabella 2-96	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isabella 2-97	92	0	2.17	0	0	2.17	0	0	0
Isabella 3 94	40	0	12.64	0	0	0	0	0	0
Isabella 3-95	98	7.14	22.45	4.08	0	0	0	1.02	1.02
Isabella 3-96	44	2.30	0	2.30	0	0	0	2.30	2.30
Isabella 3-97	92	0	2.17	1.08	1.08	1.08	0	0	1.08
Isabella 4-94	99	0	6.06	3.03	1.01	0	2.02	0	0
Isabella 4-95	202	1.98	43.56	0	0	0	0	0	0
Isabella 4-96	68	2.95	8.86	4.43	2.95	0	0	0	0
Isabella 4-97	ND	ND	ND	ND	ND	ND	ND	ND	ND

1 RB 0=Rainbow trout yearling (juvenile)
2 RB 1=Rainbow trout 1 year old
3 RB 2=Rainbow trout 2 year old
4 RB >2=Rainbow trout older than 2 years old
5 CT <305 mm=Cutthroat trout less than 305 millimeters in length
6 CT >305 mm=Cutthroat trout greater than 305 millimeters in length
7 BT=Bull trout
8 WF=Whitefish
9 Beaver 1-94=Beaver Creek site number one for the year 1994, Beaver Creek 2-95= Beaver Creek site number two for the year 1995, etc.
10 ND=No Data

Flow data

Flow data was collected, compared, averaged, and calculated from a variety of sources. These sources included long-term continuous flow data by the CNF, flow measurements taken in the field by field crews, and data provided by the USGS. The USGS used a model to derive flow for all of the 303(d)-listed streams in the LNFCRS with the exception of Cranberry Creek as part of the Snake River Adjudication process. Long-term flow data is very limited in the subbasin. The CNF maintained a flow gauge recorder on Isabella Creek from the mid 1980s until the flood of 1995-1996 just above the mouth, and one the South Fork-Beaver Creek from 1984-1991. The CNF currently maintains a pressure transducer flow site on Elk Creek about 1 mile upstream of Elk Creek Reservoir. The USGS has a gauge on the North Fork Clearwater River located just outside of the LNFCRS and, upstream from the mouth of Beaver Creek. These four locations provide the only long-term flow data available.

Flow measurements taken in the field came from the DEQ-LRO monitoring in 2001 or from BURP and CNF survey crews. During the 2001 monitoring season, flow data was collected on Elk, Cranberry, Long Meadow, and Swamp Creeks every two weeks from June through October. Other flow data are one-time window measurements taken by the BURP crews and the biostudies crews. These measurements are the least useful of all the data as they are of one place at one time. However, flow data from the 2001 monitoring season was compared closely to the USGS derived flow data. The USGS document *Hydrologic Classifications and Estimation of Basin and Hydrologic Characteristics of Subbasins in Central Idaho* (USGS 1998) gives monthly mean discharge and discharge rates. The summer 2001 was a very low water year, which was reflected by the measurements in the field. All of the flow data were compared and for TMDL calculations the flow data were reanalyzed to detect any inaccuracies.

2001 Monitoring Efforts

A monitoring plan was developed to gain more information about the five waterbodies that are listed for nutrients, bacteria, and DO. Map 8 shows the locations of the monitoring stations on the following water bodies: Long Meadow Creek, Elk Creek, Elk Creek Reservoir, Cranberry Creek, and Swamp Creek. Several analyses were performed on collected water samples: total phosphorus (TP), nitrate and nitrite (NO^2/NO^3), ammonia (NH^4), total suspended solids (TSS), and fecal and total coliform counts. Other parameters collected in the field included flow, DO, and air and water temperatures. Diurnal dissolved oxygen readings were also performed in Breakfast, Stony, and Floodwood Creeks in mid-August.

Sample collection began in June and continued through October. The terrain and accessibility made sampling somewhat difficult. There were also time constraints, as the bacteria samples had to be sent to the state laboratory in Coeur d'Alene within 24 hours of being collected. Budget constraints limited the number of sites, while the weather limited the schedule of the monitoring plan. Generally all of waterbodies are only accessible by a four-wheel drive and hiking, or by boat and hiking and only between May and October. From

November to April the area is typically covered with snow and many of the waterbodies are iced over. Therefore, the monitoring season is limited between June and October.

Flow measurements were collected by wading and using a Marsh McBirney flow meter for the sites in the headwaters and a USGS Pygmy current meter for the sites at the mouth. The six-tenth-depth method (0.6 of the total depth below water surface) was used when the depth of water was less than or equal to 3 feet. For depths greater than 3 feet the two-point method (0.2 and 0.8 of the total depth below the water surface) was used. At each sampling station, a transect line was established across the width of the creek at an angle perpendicular to the flow. The mid-section method was used to compute cross-sectional area and the velocity-area method was used to determine discharge. The discharge was computed by summing the products of the partial areas (partial sections) of the flow cross-sections and the average velocities for each of those sections. This method was used to calculate cubic feet per second at each of the monitoring stations. Collectively this data was used to determine whether or not the streams in question are water quality impaired.

2.4 Subwatershed Characteristics

This section determines which waterbodies are water quality limited by a pollutant and hence will need a TMDL, and which waterbodies are not water quality limited. The physical and biological parameters and associated data in tables 7-13 are described within this next section to help determine beneficial use status of the 303(d)-listed waterbodies. Recommended additions to the 303(d) list will also be included in this section.

Table 13. Watershed geomorphic characteristics.

Waterbody (Creek)	Watershed Area (square miles)	Stream Miles	Relief Ratio	Mean Elevation	Dominant Slope[1]	Mean Annual cfs[2]	Rosgen Channel Types[3]
Beaver	61.79	359.27	0.057	3670	60%	94.0	B, C
Beaver-SF	8.04	65.1	0.088	3962	31-60%	15.8[4]	A, B, C
Bertha	2.73	18.61	0.162	4128	N/A[5]	ND[6]	Aa, A, B, C
Bingo	2.65	22.67	0.130	3978	N/A	ND	A, B, C
Breakfast	13.67	89.90	0.083	3698	31-60%	280.0	A, B[7]
Cranberry	14.63	100.10	0.059	2966	30%	ND	A, C[7]
Dog	2.76	17.48	0.242	4211	N/A	ND	Aa
Elk-upper	41.09	232.77	0.057	3850	N/A	90.0	A, B, C, E
Elk-lower	59.44	184.4	0.100	3140	30%	140.0	Aa, B, C
Elk Cr. Res.	N/A	n.a.[8]	n.a.	N/A	n.a.	n.a.	n.a.
Elk-WF	3.97	24.63	0.127	4040	N/A	ND	Aa, A, B, E
Floodwood	51.74	122.11	0.084	4270	31-60%	98.0	A, B, C, D[9]
Isabella	30.46	122.06	0.130	4589	N/A	79.8[10]	Aa, A, B
Johnson	1.91	8.54	0.187	4277	31-60%	ND	A, B[7]
Long Meadow	56.09	493.97	0.059	3133	60%	52.0	A, B, C, E[7]
Partridge	4.62	31.90	0.096	3353	30%	ND	B, C, E
Reeds	79.36	699.4	0.054	3434	31-60%	120.0	A, B, C, E[7]
Sourdough	4.85	13.64	0.200	4149	N/A	ND	Aa, A, B
Stony	23.13	54.91	0.078	3820	31-60%	62.0	A, B, C[7]
Swamp	12.17	98.26	0.083	3104	30%	10.0	A, C[7]

[1] From CWE reports
[2] U.S. Geological Survey Professional Paper 1604
[3] CNF Biostudies/Isabella Wildlife Works
[4] CNF flow data (84-91)
[5] N/A = Not accessed
[6] N/D = No data
[7] Data from BURP and field reviews
[8] n.a. = Not applicable
[9] Data from Floodwood Management Unit Study Area
[10] Average of U.S. Geological Survey Professional Paper 1604 and CNF flow data (86-96)

Beaver Creek and Beaver Creek Watershed Drainage

The Beaver Creek Watershed drainage encompasses five stream segments that are on the 303(d) list for sediment as a pollutant. These streams are Beaver Cr., South Fork-Beaver Cr., Bingo Cr., Bertha Cr., and Sourdough Creek Collectively the Beaver Creek Watershed is 61.79 square miles in size (39,545 acres) and is a fifth order tributary at the mouth where it flows into the North Fork Clearwater River across from Aquarius Campground. A map of the entire basin is shown on Map 9. Land ownership is shared among Potlatch Corporation, the CNF, and the IDL with the primary land uses being forestry and recreational activities.

Beaver Creek generally flows from the southwest to northeast, and the basic drainage pattern could be described as dendritic. Elevations range from 1670 feet at the mouth to 5708 feet on Sheep Mountain. The primary geology of the watershed is highly weathered granitics of the Idaho Batholith with some areas of schist and gneiss. Granitics weather fairly easily to sand; therefore, the streams in this drainage have higher cobble embeddedness naturally. The streams within this drainage typically start out as high-energy streams with extremely steep stream gradients and are classified as steep Aa channels. For the most part, the gradient lowers as the stream continues downstream. In places, low gradient C channels occur in meadow areas. The Rosgen classification for the streams in the drainage varies from steep Aa, and A channels, moderately steep B channels, and low-gradient C channels, although most of the streams are steep A or B channels.

This watershed has been subject to extensive timber harvesting and road building activities. Portions of the riparian areas in this basin were altered by old transportation methods to remove timber from this watershed; however, the area is currently regenerating trees which provide shade and future woody debris recruitment. Methods such as dams and flush operations, flumes, chutes and skidding logs all utilized the streams or the flatter areas of the stream riparian zones. Some of the streams in the Beaver Creek drainage lack woody debris and have a low potential for future recruitment, while some of the streams have trees species like red alder, willow, and other deciduous trees growing in the riparian areas. Woody debris provides excellent habitat for salmonids and acts a hydraulic control, which can minimize downstream accumulations of sediment and reduce erosional processes. Potlatch Corporation and the CNF in the late 1980s did a habitat improvement by placing logs and large rocks in Beaver Creek. From the mouth of Bingo Creek to the mouth of Beaver Creek there are a lot of old cedar and Grand fir trees and a significant amount of second growth providing woody debris recruitment.

Beaver Creek

Beaver Creek is 303(d)-listed for sediment and the boundaries are classified as headwaters to the North Fork Clearwater River. The headwaters of Beaver Creek are located at Beaver Creek Divide, while the mouth of Beaver Creek is just across from Aquarius Campground located on the North Fork Clearwater River. In the Beaver Creek Drainage, Potlatch Corporation has obliterated 5.6 miles of road and abandoned 3.29 miles of road. A paved road runs parallel to Beaver Creek for its entire length. Although the road surface itself is well maintained there are places where the road prism constricts the flow or is located within the floodplain of the creek. There are also large cut slope failures along this road that contribute some amount of sediment to the creek. Parts of the floodplain have been altered historically to transport timber with a variety of transport mechanisms: chutes, flumes, dams, roads, or railways. Although these types of practices have not occurred for many years, there are numerous locations where physical evidence from these historic logging practices can be seen in Beaver Creek and throughout the rest of the watershed drainage. One example is the old Sourdough Dam, which is in Beaver Creek just downstream from the mouth of Sourdough Creek. Most of the original canopy in the riparian areas has been removed from these past logging practices, but is regenerating and providing some shade and future woody debris.

Status of Beneficial Uses

DEQ recommends Beaver Creek be delisted for sediment as conclusions drawn from the data indicate that beneficial uses are being met, and that sediment is not impairing the water quality of Beaver Creek. Biological data indicate a self-propagating salmonid population, a diverse and thriving stream macroinvertebrate population, and the presence of other aquatic lifeforms. The Clearwater Biostudies reports note that Beaver Creek might lack diverse habitat for salmonids and in places the habitat is probably not as diverse as it should be; however, the stream habitat index score for Beaver Creek rated high under WBAG II guidance criteria (Clearwater Biostudies 1991[a]). The lack of diverse habitat for salmonids in Beaver Creek could be due to past logging operations, which in places, increased fine sediment levels in the stream and altered the channel.

Beaver Creek has more fish data than most other streams in the subbasin. DEQ fished Beaver Creek in three different locations, the Clearwater Biostudies crews, and CNF personnel performed snorkel surveys throughout the stream, and the IDFG snorkel-fished two locations over four consecutive years in the mid to late 1990s. Even in a drainage somewhat lacking a diverse salmonid habitat there is an abundance of biological data indicating that a self-propagating salmonid population exists. WATBAL results support the delisting for sediment. WATBAL indicates the percent sediment over natural background is below the water quality objective. The CNF's 1997 *Watershed Condition* report (Jones and Murphy 1997) indicates the current cobble embeddedness is below the desired cobble embeddedness for Beaver Creek. The bank stability index for Beaver Creek was rated at 4.4 on a scale of one to five (with one being of low value and five being of a high value).

Natural sedimentation rates in granitic watersheds are fairly high so the fact that the CWE sediment scores indicated a moderate rating is not a surprise. Road density was fairly high in this drainage and roads are the primary anthropogenic source of sediment input to the creek. Even with an increase in fine sediment macroinvertebrate, fish, and other aquatic life populations appear to be thriving; therefore, sediment levels are within state narrative standards and are not impairing the beneficial uses of Beaver Creek. DEQ recommends Beaver Creek be removed from the 303(d) list for sediment.

Beaver Creek has been identified as bull trout habitat under federal regulations. Instantaneous temperature measurements recorded a temperature violation of the EPA federal bull trout temperature standard; this temperature measurement is also a violation of the state standards for salmonid spawning. Based on instantaneous stream temperature data, aerial photography over the stream, and field verification, Beaver Creek is limited by temperature and DEQ recommends Beaver Creek be listed for temperature during the next 303(d) listing cycle.

South Fork - Beaver Creek

The South Fork of Beaver Creek (SFBC) is 303(d)-listed for sediment and the boundaries are defined as headwaters to Beaver Creek. The SFBC is a third order stream at its confluence with Beaver Creek and the headwaters originate from Dull Axe Saddle. Nearly all of SFBC is managed by Potlatch Corporation and harvesting activities are frequent in this watershed. There are about 44 miles of roads within the SFBC watershed giving the watershed a road density of 5.48 miles per square mile. This value is somewhat high a majority of these roads are closed to most forms of motorized vehicles except for motorcycles and ATVs. None of these roads are in high mass failure zones and only 4 miles of these roads are in high surface erosion areas. About 1 mile upstream from the mouth of SFBC is a historical logging camp called Camp 10.

Status of beneficial uses

DEQ recommends SFBC be delisted for sediment as conclusions drawn from the data indicate that beneficial uses are being met, and that sediment is not impairing the water quality of SFBC. Biological data indicate a self-propagating salmonid population, a diverse and thriving stream macroinvertebrate population, and the presence of other aquatic lifeforms. The Clearwater Biostudies reports note SFBC might lack diverse habitat for salmonids and in places this is true (Clearwater Biostudies 1991[a]); however, the stream habitat index score for SFBC rated high under WBAG II guidance criteria. The lack of diverse habitat for salmonids in SFBC could be due to past logging operations, which in places increased fine sediment levels in the stream and altered the channel. Additional fish data indicate a self-propagating salmonid population exists even in a drainage somewhat lacking a diverse salmonid habitat.

Natural sedimentation rates in granitic watersheds are fairly high, so the fact that the CWE sediment scores indicated a moderate rating is not a surprise. Road density was fairly high in this drainage and roads are the primary anthropogenic source of sediment input to the creek. Even with an increase in fine sediment, macroinvertebrate, fish, and other aquatic life populations appear to be thriving; therefore, sediment levels are within state narrative standards and are not impairing the beneficial uses of SFBC. In conclusion, DEQ recommends SFBC be removed from the 303(d) list for sediment.

Bertha Creek

Bertha Creek is 303(d)-listed for sediment and the boundaries are defined as headwaters to Beaver Creek. Bertha Creek is a third order stream at its confluence with Beaver Creek and the headwaters originate off of Bertha Hill and Black Bear Saddle. Nearly all of Bertha Creek is managed by Potlatch Corporation and harvesting activities are frequent in this watershed. Bertha Creek is a steep creek with an average gradient of 5.8% and a streambed dominated by gravel and sand substrates. Bank stability index for Bertha Creek was rated at 4.3. The road density is fairly low in the Bertha Creek watershed (3.2 miles per square mile). There are only 8.8 miles of roads and no roads located in high mass failure or high surface erosion areas.

Status of Beneficial Uses

DEQ recommends Bertha Creek be delisted for sediment as conclusions drawn from the data indicate that beneficial uses are being met, and that sediment is not impairing the water quality of Bertha Creek. Biological data indicate a self-propagation salmonid population, a diverse and thriving stream macroinvertebrate population, and the presence of other aquatic lifeforms. The Clearwater Biostudies reports noted that Bertha Creek might lack diverse habitat for salmonids and in places this is true; however, the stream habitat index score for Bertha Creek rated high under WBAG II guidance criteria (Clearwater Biostudies 1991[a]). The lack of diverse habitat for salmonids in Bertha Creek could be due to past logging operations, which in places, increased fine sediment levels in the stream and altered the channel. Additional fish data indicate a self-propagating salmonid population exists even in a drainage somewhat lacking a diverse salmonid habitat.

Natural sedimentation rates in granitic watersheds are fairly high so the fact that the CWE sediment scores indicated a moderate rating is not a surprise. Roads are the primary anthropogenic source of sediment input to the creek. Even with an increase in fine sediment, macroinvertebrate, fish, and other aquatic life populations appear to be thriving; therefore, sediment levels are within state narrative standards and are not impairing the beneficial uses of Bertha Creek. In conclusion, DEQ recommends Bertha Creek be removed from the 303(d) list for sediment.

Bingo Creek

Bingo Creek is 303(d)-listed for sediment and the boundaries are defined as headwaters to Beaver Creek. Bingo Creek is a fourth order stream at its confluence with Beaver Creek and the headwaters originate off of Bingo Saddle. Most of Bingo Creek is managed by Potlatch Corporation and harvesting activities are frequent in this watershed. Bingo Creek is a moderately steep, to steep stream with an average gradient of 4.0% and a streambed dominated by cobble, gravel and rubble with the streambed materials being cemented together by fine sediment (Clearwater Biostudies 1991[a]). Bank stability index for Bingo Creek was rated at 4.5 (Clearwater Biostudies 1991[a]). Road density is very high (7.14 miles per square mile) but there are no roads in high mass failure or high surface erosion areas.

Status of beneficial uses

DEQ recommends Bingo Creek be removed from the 303(d) list for sediment as conclusions drawn from the data indicate that beneficial uses are being met, and that sediment is not impairing the water quality of Bingo Creek. Biological data indicates a self-propagating salmonid population and the presence of amphibians. Fish populations are strong as Bingo Creek has a very high density of cutthroat. Data from a 1998 Potlatch Corporation survey found 3 age classes (including juveniles) and high densities of cutthroat. Results from the *IDFG Native Fish Enhancement Project on the Potlatch Corporation Operating Area in Northern Idaho, 2000 annual report*, were similar, 3 age classes (including juveniles) and high densities (75 fish per 100 m^2 of cutthroat (Shreiver and Murphy 2001). Macroinvertebrate scores were mixed. The SMI results from the BURP data indicate a lack of diversity and lower total number in the macroinvertebrate population while SMI results from data collected by Potlatch Corporation indicated a well diversified and thriving macroinvertebrate population. The Clearwater Biostudies reports noted that Bingo Creek might lack diverse habitat for salmonids and in most places this is true as the stream habitat index score for Bingo Creek rated low within the WBAG II (Clearwater Biostudies 1991[a]). The lack of diverse habitat for salmonids in Bingo Creek could be due to past logging operations which, in places, increased fine sediment levels in the stream and altered the channel. There is also a road that parallels a significant portion of Bingo Creek, which to some degree has altered the habitat. Fish data from the DEQ BURP surveys, IDFG, and Potlatch Corporation indicate that a strong, self-propagating salmonid population exists even in a drainage that appears to lack diverse salmonid habitat. In conclusion, DEQ recommends Bingo Creek be removed from the 303(d) list for sediment.

Instantaneous temperature measurements recorded a temperature violation of the state standards for salmonid spawning. Based on instantaneous stream temperature data, aerial photography over the streams, and field verification, Bingo Creek is limited by temperature and DEQ recommends Bingo Creek be listed for temperature during the next 303(d)-listing cycle.

Sourdough Creek

Sourdough Creek is part of the Beaver Creek watershed as shown on Map 9. Sourdough Creek is 303(d)-listed for sediment and the boundaries are defined as headwaters to Beaver Creek. Sourdough Creek is a third order stream at its confluence with Beaver Creek and the headwaters originate off the northern end of the Sheep Mountain Range. Most of Sourdough Creek is managed by the CNF and current harvesting activities are very limited in this watershed. Sourdough Creek is a steep to very steep stream with an average gradient of 8.2% and a streambed dominated by sand, gravel or boulder-cobble substrate. The bank stability index rating was 4.9. Out of the six reaches that were surveyed by Clearwater Biostudies, two were Aa channel, three were steep A channels, and the reach near the mouth is a moderately steep B channel. In 1995 Sourdough creek was extensively surveyed again by Isabella Wildlife Works (Clearwater Biostudies 1991[a]) with results similar to the Clearwater Biostudies report in 1990. Average steam gradient was 8.25%, average cobble embeddedness was high, bank stability index rating was 5.0, and there were 5.7m of unstable banks per 1000m (Isabella Wildlife Works 1996). Results indicated that there were 10.93 primary pools per mile (Isabella Wildlife Works 1996).

Status of beneficial uses

DEQ recommends Sourdough Creek be delisted for sediment, as conclusions drawn from the data indicate that beneficial uses are being met, and that sediment is not impairing the water quality of Sourdough Creek. Biological data indicate a self-propagation salmonid population, a diverse and thriving stream macroinvertebrate population, and the presence of other aquatic lifeforms. The Clearwater Biostudies reports note that Sourdough Creek might lack diverse habitat for salmonids, and in places this is true; however, the stream habitat index score for Sourdough Creek rated high using the WBAG II criteria (Clearwater Biostudies 1991[a]). The lack of diverse habitat for salmonids in Sourdough Creek could be due to past logging operations, which in places, increased fine sediment levels in the stream and altered the channel. DEQ BURP surveys indicate that a self-propagating salmonid population exists even in a drainage somewhat lacking a diverse salmonid habitat.

Natural sedimentation rates in granitic watersheds are fairly high so the fact that the CWE sediment scores indicated a moderate rating is not a surprise. Road density is fairly high in this drainage and roads are the primary anthropogenic source of sediment input to the creek. Even with an increase in fine sediment, macroinvertebrate, salmonid, and other aquatic life populations appear to be thriving; therefore, sediment levels are within state narrative standards and are not impairing the beneficial uses of Sourdough Creek. In conclusion, DEQ recommends Sourdough Creek be removed from the 303(d) list for sediment.

Breakfast Creek

Breakfast Creek is a fifth order stream at the mouth, and is 303(d)-listed for sediment and DO, with the boundaries are defined as headwaters to Dworshak Reservoir. The headwaters of Breakfast Creek originate off the east side of Elk Butte and the mouth is at the confluence with Dworshak Reservoir. The entire basin is shown on Map 10. Breakfast Creek is 13.67 square miles in size (8749.7 acres). Most of the land in Breakfast Creek is managed by IDL and Potlatch, with the primary land uses being forestry and recreational activities. IDL has abandoned about 10.4 miles of road in Breakfast Creek. Breakfast Creek generally flows from the West to East and the basic drainage pattern could be described as dendritic. Elevations range from 1,600 feet to 5,202 feet. The geology of the watershed is comprised primarily of schist and gneiss that have been subjected to a high level of metamorphism. This has resulted in high levels of mica schist and anorthosite. Anorthosite weathers very readily to clay, and tends to form deep clay-silt soils, which are moisture sensitive and consequently weak and unstable. The mica schist also weathers rapidly and deeply (IDL 2000[a]). Breakfast Creek has experienced significant timber removal and has the highest density of landslides for any of the 303(d)-listed streams in the LNFCRS.

Some of the tributaries of Breakfast Creek, and parts of the upper watershed lack woody debris and the potential for future recruitment. The lower two thirds of Breakfast Creek itself has substantial woody debris and potential for future recruitment. Woody debris in the creek provides excellent habitat for salmonids and acts as a hydraulic control, which minimizes downstream accumulations of sediment and reduces the erosional processes. DEQ recommends that the management agencies in this drainage consider ways to maximize future woody debris recruitment and consider methods that would address the current need for woody debris.

Status of beneficial uses

DEQ recommends Breakfast Creek be delisted for DO based on a 24 hour DO study conducted the summer of 2001 indicating DO levels are well above the state standard of 6.0 mg/l as shown in Figure 2. Figure 3 displays diurnal air and water temperatures.

Based on CWE sediment scores, BURP data, GIS analysis, and aerial and ground surveys, sediment levels are impairing water quality to a degree that beneficial uses are not being met; therefore, DEQ will complete a sediment TMDL for Breakfast Creek. Under the WBAG II guidance criteria biological data demonstrated very low macroinvertebrates scores, and there was an absence of fish in the upper reach. With these indicators additional data was needed. GIS analysis revealed the Breakfast Creek watershed has the highest mass failure density and the highest road density (9.21 mile/mile^2) of any of the 303(d)-listed streams in the LNFCRS. CWE data showed that Breakfast Creek has the highest CWE sediment delivery score (Table B-2). In fact the CWE sediment score of 209.3 was more than double that of the next highest score of any 303(d)-listed stream in the LNFCRS. There are also over 24 miles of roads in high mass failure rating areas. A natural fish barrier for resident fish species was found in June 2002, which explains the absence of salmonids in the upper reach. However, the macroinvertebrate population appears to be impaired. The SMI scores for Breakfast Creek were compared to the SMI scores for Stony Creek and Floodwood Creek as Stony and Floodwood Creek watersheds have similar geology, topography, relief ratios, hydrology, climate, mean elevation and management regimes as Breakfast Creek. The SMI scores for Stony and Floodwood Creeks were high and each creek received the maximum composite score of a 3. Upper Breakfast Creek was low with a composite score of 1 and the lower end received a composite score of a 2. These scores, combined with the high sediment levels from roads and mass failures indicate that sediment levels are impairing the beneficial uses in Breakfast Creek; therefore, a sediment TMDL was written. The CWE Breakfast Creek report noted adverse sediment and hydrologic conditions.

Temperature is also an issue in this watershed. Based on instantaneous stream temperature data shown in Figure 3, cover over the streams, CWE results, and field verification DEQ concludes that Breakfast Creek is limited by temperature and recommends that Breakfast Creek be listed for temperature during the next 303(d) listing cycle.

Stony Creek

Stony Creek is 303(d)-listed for sediment and DO with the boundaries are defined as headwaters to confluence with Breakfast Creek. Stony Creek is a 4th order stream at the mouth; the headwaters originate off Stony, Hemlock, and Elk Buttes. A map of the entire basin is shown in Map 11. Stony Creek is 23.12 square miles (14,796 acres) in size. The land in Stony Creek is primarily managed by IDL and Potlatch Corporation with the land uses being forestry and recreation activities. Approximately 2.4 miles of road have been abandoned on state land in the Stony Creek watershed. Stony Creek generally flows from the west to east and the basic drainage pattern is dendritic. Elevations range from 1,820 feet to 5,861 feet. The geology of the watershed is primarily that of schist and gneiss that have been subjected to a high level of metamorphism. In the Stony Creek drainage this has resulted in higher levels of mica schist and anorthosite. Anorthosite weathers very readily to clay, and tends to form deep clay-silt soils, which are moisture sensitive and consequently weak and unstable (IDL 2001[l]). The mica schist also weathers rapidly and deeply (IDL 2001[l]).

Status of beneficial uses

DEQ recommends Stony Creek be delisted for DO based on the results of a 24 DO study conducted the summer of 2001 indicating DO levels are well above the state standard of 6.0 mg/l as shown in Figure 4. Figure 5 displays diurnal air and water temperatures.

DEQ also recommends Stony Creek be delisted for sediment as conclusions drawn from data indicate that beneficial uses are being met, and Stony Creek is not water quality impaired by sediment. Biological data indicate a self-propagation salmonid population, a diverse and thriving stream macroinvertebrate population, and the presence of other aquatic lifeforms. In late July 2001 an intensive fish survey was conducted by DEQ-LRO. Eleven sites that were about 100 m in length were fished from the mouth into the headwaters using an electroshocker. Fish were found in all of the reaches except for one near the headwaters, which most likely had a fish barrier below the reach. Table B-1 in Appendix B displays the results from the survey while Map 11 shows the locations of each site. Stony Creek also had bull trout residing in it during the summer of 2001 (IDFG 2001). Stony Creek has a very high road density, but the CWE sediment rating was low implying that the roads in Stony Creek are better maintained than in other drainages. Additional data collect by DEQ-LRO indicated a self-propagating salmonid population and the presence of other forms of aquatic life. Even with an increase in fine sediment macroinvertebrate, fish, and other aquatic life populations appear to be thriving; therefore, sediment levels are within state narrative standards and are not impairing the beneficial uses of Stony Creek.

Instantaneous temperature readings taken by DEQ in the summer of 2001 indicate that stream temperatures are above the state standards. Based on these results in Figure 5, cover over the streams, CWE results, and field verification, DEQ concludes that Stony Creek is limited by temperature and recommends Stony Creek be listed for temperature during the next 303(d) listing cycle.

Floodwood Creek

Floodwood Creek is 303(d)-listed for sediment and DO with the boundaries being defined as headwaters to Breakfast Creek. Floodwood Creek is a fourth order stream at its confluence with Breakfast Creek and the headwaters originate off several peaks and ridges including Orphan Point and Crater Peak. Floodwood Creek is 51.74 square miles (33,115 acres) in size and is shown in Map 12. The land in Floodwood Creek is primary managed by IDL with Potlatch Corporation and the St. Joe National Forest managing smaller portions of the basin. IDL manages the landboard state park with this basin. IDL has abandoned 8.4 miles of 15.2 miles of road in the Floodwood Creek watershed. The land uses are forestry and recreation.

Floodwood Creek generally flows from the north to south and the basic drainage pattern is dendritic. Elevations range from 1,700 feet to 6,630 feet. The geology of the watershed is primarily that of schist and gneiss that have been subjected to a high level of metamorphism. The result is high levels of mica schist and anorthosite. Anorthosite weathers very readily to clay, and tends to form deep clay-silt soils, which are moisture sensitive and consequently weak and unstable. The mica schist also weathers rapidly and deeply (IDL 2001[n]).

Status of beneficial uses

DEQ recommends Floodwood Creek be delisted for DO based the results of a 24 hour DO study conducted during the summer of 2001 which indicated DO levels well above the state standard of 6.0 mg/l (Figure 6). Diurnal air and water temperatures are shown in Figure 7.

DEQ also recommends that Floodwood Creek be delisted for sediment as conclusions drawn from data indicate that beneficial uses are being met, and Floodwood Creek is not water quality impaired by sediment. Biological data indicate a self-propagation salmonid population, a diverse and thriving stream macroinvertebrate population, and the presence of other aquatic lifeforms. . The SMI and SHI raw scores are excellent. Floodwood Creek has a fairly low road density of 3.53 miles per square mile; a mass failure density of 1.5 mass failure per square mile and received a low sediment rating from the CWE sediment score. Additional fish data collected by IDFG and DEQ-LRO crews confirm that a self-propagating salmonid population and other aquatic life exist throughout the watershed. Floodwood Creek also had bull trout residing in it during the summer of 2001 (IDFG 2001). Even with an increase in fine sediment macroinvertebrate, fish, and other aquatic life populations appear to be thriving; therefore, sediment levels are within state standards and are not impairing the beneficial uses of Floodwood Creek.

Instantaneous temperature readings taken by DEQ in the summer of 2001 (Figure 7) and continuous temperature data taken in 1997 by IDL (IDL 1997) indicate that stream temperatures are out of compliance. Based on stream temperatures data, cover over the streams, CWE results, and field verification, DEQ concludes that Floodwood Creek is limited by temperature and recommends that Floodwood Creek be listed for temperature during the next 303(d)-listing cycle.

Cranberry Creek

Cranberry Creek is 303(d)-listed for sediment, temperature, nutrients, and bacteria with the boundaries are defined as headwaters to Dworshak Reservoir. Cranberry Creek is a second order stream at the mouth with Dworshak Reservoir, and the headwaters originate off the south end of Jericho Mountain. The watershed is 14.63 square miles in size and is displayed on Map 13. IDL and Potlatch Corporation manage the land in Cranberry Creek for the primary land uses of timber production, open grazing and recreational activities. Cranberry Creek generally flows from the north to south and the basic drainage is dendritic. Elevations range from 1,600 feet to 3,720 feet. The road density is fairly high (5.96 miles per square mile) in the Cranberry Creek watershed. Out of the 87.2 miles of road only 2 miles of road are located in high mass failure areas.

Highly weathered schist and gneiss, and basalts predominantly underlie the Cranberry Creek drainage. The basalts, where dissected, are covered with sediments, including considerable loess. The geologic structure results in three distinct geomorphic zones in the watershed: the steeply rolling northern ridge of metamorphic rocks, the central undulating basalt plateau, and the southern strongly dissected areas where the channel is cutting down to the level of the North Fork Clearwater (IDL 2001[c]).

Status of beneficial uses

Results from the 2001 field season are displayed in Figures 8-13. Excessive nutrients are not a problem in Cranberry Creek. Nuisance algae was not a problem as indicated by field verification and biweekly DO levels were well within state standards. Nutrient data (NO^2/NO^3, NH^4, TP) displayed in Figures 8-10 indicate that there is not a problem with nutrients; therefore, DEQ recommends that Cranberry Creek be removed from the 303(d) list for nutrients. Continuous temperature data from the stream indicate stream temperatures are above state standards (Figures 11-12); therefore, a temperature TMDL will be completed for Cranberry Creek. Bacteria levels (Figure 13) were also above the state standard for secondary contact recreation; therefore, a bacteria TMDL will also will be completed.

Based on CWE sediment scores, BURP data, GIS analysis, and aerial and ground surveys, sediment levels are impairing water quality to a degree that beneficial uses are not being met; therefore, DEQ will complete a sediment TMDL for Cranberry Creek. Biological data demonstrated very low macroinvertebrate scores within the WBAG II process. This was the case in both BURP reaches, and in the upper reach there was a complete absence of fish. The habitat score was also very low in the upper reach. With these indicators additional data was needed. GIS analysis indicates there are a fairly high number of road crossings and a fairly high density of roads in the watershed. Although the CWE sediment delivery scores are low and there are a relatively low number of mass failures, field reviews indicate the sediment sources may not be limited to just roads or mass failure. Field reviews indicated that some erosional processes were from bank erosion and riparian areas. Therefore, the bank erosion field estimate procedure (NRCS 1983) was conducted in the watershed, and results indicated that excessive bank erosion was occurring. These sediment sources combined with the biological data made it apparent that sediment levels are impairing the beneficial uses in Cranberry Creek; therefore, a sediment TMDL will be written.

Elk Creek Watershed Drainage

The Elk Creek Watershed drainage encompasses five water body segments (Elk Cr., West Fork Elk Cr., Partridge Cr., Johnson Creek and Elk Creek Reservoir) that are on the 303(d) list for sediment as a pollutant. Additionally Elk Creek is listed for temperature, bacteria, and nutrients. Elk Creek Reservoir is listed for temperature, bacteria, nutrients, DO and sediment. The entire basin with the monitoring sites and major features is shown on Map 14. The Elk Creek Watershed is 100.53 square miles in size (64,338 acres) making it the largest watershed complex of all the 303(d)-listed streams. Elk Creek is a 5th order tributary at the mouth where it flows into the Dworshak Reservoir. Ownership is mixed between Potlatch

Corporation, the Palouse District of the CNF, IDL, and some private owners. The primary land uses are forestry, grazing and recreational activities. Elk Creek generally flows from the north to south, and the basic drainage pattern is dendritic. Elevations range from 1,600 feet at the mouth at Dworshak Reservoir to 5,861 feet on Hemlock Butte. The landscape in the Elk Creek drainage greatly varies and includes meadows, brushy bottomlands, rolling uplands, low relief hills, mountain slopelands, and dissected breaklands (CNF 1999). Significant portions of the Elk Creek drainage have been harvested and there have been extensive anthropogenic disturbances that include roads, railroads, and livestock grazing.

Geology is mixed in this basin with schist and gneiss in the upper, eastern, and western flanks, basalt towards the southern end of the watershed and granitics in the central upper portions. Hydrologically, the Elk Creek watershed could be split into three sections, above Elk Creek Reservoir, above the Elk Creek Falls and below Elk Creek Reservoir, and below the falls. Elk Creek Falls is an upstream fish migration barrier to all species of fish. Therefore, the fact that Elk Creek Reservoir is another fish migration barrier is much less significant, as fish have never migrated above the falls. From a water quality framework it is probably best to describe Elk Creek in two sections; therefore, it is being broken into two parts for this report. This is based on the changes in water quality from the effects of Elk Creek Reservoir. For example, during June through late September of 2001 the monitoring site below the reservoir (EC2) averaged 4.9^{o} F warmer than the monitoring site above the reservoir (EC 3), yet the two sites are close in elevation (within 100 feet) and distance (within 2 miles). Above Elk Creek Reservoir IDFG manages a very health population of brook trout in the upper basin. IDFG also manages Elk Creek Reservoir as a lowland put'n'take, mixed lake fishery.

Elk Creek lower- below Elk Creek Reservoir

Elk Creek-lower is defined as Elk Creek below Elk Creek Reservoir to the mouth at Dworshak Reservoir. Elk Creek-lower includes Elk Creek Falls, which are an upstream fish migration barrier to all species of fish, and aesthetically a spectacular site especially during the spring runoff. A hiking trail leads to several scenic overlooks at Elk Creek falls.

Status of beneficial uses

Results from the 2001 field season indicate that there is not a problem with nutrients or bacteria (Figures 14-17); therefore, DEQ is recommending to remove nutrients and bacteria from the 303(d) list for Elk Creek-lower. Bacteria counts were below the state numeric standards. Excessive nutrients are not a problem in Elk Creek-lower. Nuisance algae was not a problem as indicated by field verification and biweekly DO levels were well within state standards. Temperature data (Figures 18-19) shows an exceedance for cold water biota and salmonid spawning beneficial uses; therefore, a temperature TMDL will be completed for Elk Creek-lower. Information from the Clearwater Biostudies report support the temperature TMDL as acting and potential woody debris are very low with less than two pieces per 100 meters acting and averaging about 12.5 pieces potential woody debris per 100 meters (Clearwater Biostudies 1997).

DEQ recommends Elk Creek-lower be delisted for sediment as conclusions drawn from the data indicate that beneficial uses are being met, and Elk Creek-lower is not water quality impaired by sediment, but by temperature. Biological data indicate a self-propagating salmonid population, the presence of other aquatic lifeforms, but a very low stream macroinvertebrate index (SMI) score. In fact the score was so low (1) that the average WBAG II rating score made Elk Creek lower fail. The stream habitat index (SHI) score was good, and rated a 3 out of 3, and the stream fish index (SFI) score rated poorly a 1 out of three. The low SFI score is due to the presence of warm water species, like dace and non-native species like Brook trout. A maximum SFI score can only be achieved if native, cool water species, like cutthroat trout are present. The Clearwater Biostudy reports indicated an abundant and varied fish population with warm water species like dace and bass, and cool water species like brook and rainbow trout. Local fisherman claim to have taken bass out of Elk Creek just below the reservoir. One bass was found in a reach between the falls and the reservoir (Clearwater Biostudies 1997). Each of the stream macroinvertebrate index scores was looked at closely which revealed that temperature sensitive species were absent from the collected population, meaning that the higher temperatures have impacted the stream. Elk Creek Reservoir has changed the temperature régime below Elk Creek (almost 5ºC warmer) in the summer so that aquatic populations are reflective of the anthropogenic changes in temperature. Introduced fish species to the drainage and the reservoir have flourished under these conditions, as fishing is reportedly good in Elk Creek and Elk Creek Reservoir. The CWE sediment scores indicate a very low rating; in fact Elk Creek-lower received the lowest sediment score out of any stream in the LNCRS. The CNF indicates that the current cobble embeddedness of 20% is below the desired condition of 40-45% (Jones and Murphy 1997). Therefore, DEQ concluded that sediment is not impairing Elk Creek-lower but rather temperature is impairing the beneficial uses. DEQ recommends that Elk Creek-lower be removed from the 303(d) list for sediment.

Elk Creek Upper- above Elk Creek Reservoir

Elk Creek-upper is defined as the headwaters of Elk Creek to Elk Creek Reservoir. A gravel road parallels Elk Creek for many miles. Even though the road surface and the cut and fill slopes are in a fairly good condition, the road prism and fill slopes encroach and occupy portions of the floodplain and the natural channel of Elk Creek-upper. Results from the 1997 Clearwater Biostudies report showed that Elk Creek-upper had an average gradient of 2.4% and a streambed dominated by heavily sedimented gravel or rubble substrates (Clearwater Biostudies 1997). Stream types included A, B, C, and E type channels. The CNF indicated the current cobble embeddedness of 41% was very close to the desired cobble embeddedness condition of 30-35%. The average width was 5.3 m, while the average depth was .0324 m.

Status of beneficial uses

Results from the 2001 field season indicate that there is not a problem with nutrients or bacteria data displayed in Figures 14-17. DEQ is recommending that bacteria and nutrients be removed from the 303(d) list for Elk Creek-upper. Temperature data is displayed in Figures 20-21. Temperatures are below the salmonid spawning temperature criteria. Brook trout are the species present, and they are fall spawners when the temperatures are cooler and below the salmonid spawning criteria. Therefore, a temperature TMDL will not be completed for Elk Creek-upper, and DEQ recommends Elk Creek-upper be removed from the 303(d) list for temperature.

DEQ also recommends that Elk Creek-upper be delisted for sediment as conclusions drawn from the data indicate that beneficial uses are being met, and Elk Creek-upper is not water quality impaired by sediment. Biological data indicate a self-propagating salmonid population, the presence of other aquatic lifeforms, and a well-diversified macroinvertebrate population. One SMI score in 1997 was low, in fact it was a 1, while the other two scores were perfect 3s, including one in 2000 at the same location as the low SMI score in 1997. Upon further investigation, the difference between the two scores was in the total number of species in the sample. Both samples had a well-diversified community but the 1997 SMI had a lower number of total macroinvertebrates in the sample. Checking the field conditions for that day revealed a high flow condition and a rainstorm the night before. This high flow condition could be the cause for the low SMI score in 1997. The bank erosion field estimate procedure (NRCS 1983) was conducted in the watershed and results showed there was limited bank erosion occurring or none at all. There are a high number of road crossings and a high number of road miles within 100 feet of a stream but a relatively low road density in the watershed. Even with an increase in fine sediment from the roads and road crossings macroinvertebrate, fish, and other aquatic life populations appear to be thriving; therefore, sediment levels are within state standards and are not impairing the beneficial uses of Elk Creek-upper. In conclusion a sediment TMDL will not be completed for Elk Creek-upper and DEQ recommends Elk Creek-upper be removed from the 303(d) list for sediment.

Elk Creek-West Fork

Elk Creek –West Fork (ECWF) is 303(d)-listed for sediment and the boundaries are defined as headwaters to Elk Creek. ECWF is a 2nd order stream at its confluence with Elk Creek and the headwaters originate off of the southwest side of Hemlock Butte. ECWF is managed by the Palouse Ranger District of the CNF with the primary land uses being recreation and timber harvest. This watershed is completely closed to all motorized vehicles and very few roads have ever been constructed. The geology of ECWF is composed of highly weathered metasediments, primarily schist and gneiss, and highly weathered granitics.

Status of beneficial uses

DEQ recommends ECWF be removed from the 303(d) list for sediment, as conclusions drawn from the data indicate that beneficial uses are being met, and ECWF is not water quality impaired by sediment. Biological data indicate a self-propagation salmonid population, a diverse and thriving stream macroinvertebrate population, and the presence of other aquatic lifeforms. GIS analysis supports the de-listing for sediment as the road density is very low, there are a limited number of stream crossings, and an extremely low number of roads in the SPZ, high mass failure zones and high surface erosion areas. Management activities have kept this drainage fairly protected from anthropogenic sediment sources as the roads in the ECWF are closed to all motorized vehicles. Temperatures are below the salmonid spawning temperature criteria and are not an issue in ECWF as Brook trout are the present, and they are fall spawners when the temperatures are cooler and below the salmonid spawning criteria.

Johnson Creek

Johnson Creek is 303(d)-listed for sediment and the boundaries are defined as headwaters to Elk Creek. Johnson Creek is a 1st order stream at its confluence with Elk Creek and the headwaters originate off of the west side of Elk Butte. Elevations range from 2,945 feet at the mouth to 5,540 feet. Johnson Creek is managed by the Palouse Ranger District of the CNF with the primary land uses being recreation and timber harvest. The geology of Johnson Creek is composed of highly weathered metasediments, primarily of schist and gneiss, and highly weathered granitics. An upstream fish barrier to brook trout does exist about a 0.5 miles upstream from the mouth. Several attempts have been made to find fish above this barrier, but none have been discovered. Even though no fish have been found above the fish barrier, sediment does not appear to be impacting water quality. Brook trout do not have the same swimming ability as do cutthroat and rainbow trout, which may also explain to why there are no resident salmonids above the barrier.

Status of beneficial uses

DEQ recommends Johnson Creek be removed from the 303(d) list for sediment as conclusions drawn from data indicate that beneficial uses are being met and Johnson Creek is not water quality impaired by sediment. Biological data indicate a self-propagation salmonid population, a diverse and thriving stream macroinvertebrate population, and the presence of other aquatic lifeforms. GIS analysis supports the de-listing for sediment as the road density is very low, there are a limited number of stream crossings, an extremely low number of roads in the SPZ, and low number of roads in the high mass failure and high surface erosion zones. Temperatures are below the salmonid spawning temperature criteria and are not an issue in Johnson Creek as Brook trout are present, and they are fall spawners when the temperatures are cooler and below the salmonid spawning criteria. CWE and WATBAL results also support the de-listing for sediment. The CWE sediment scores indicate a low rating, with roads being the primary source of sedimentation, while WATBAL indicates that current sediment levels over natural are at zero percent.

Partridge Creek

Partridge Creek is 303(d)-listed for sediment, and the boundaries are defined as headwaters to Elk Creek. Partridge Creek is a 3rd order stream at its confluence and the drainage pattern is dendritic. The headwaters originate off northern edge of a ridge that runs south off of Elk Butte. Elevations in the watershed range from 2,818 feet at the mouth to 4,000 feet at the ridge top. As shown on Map 14, ownership in Partridge Creek is shared between the Palouse Ranger District of the CNF, the IDL, and Potlatch Corporation with the primary land uses being timber production and recreational activities. The geology of Partridge Creek is composed of highly weathered metasediments, primarily of schist and gneiss, and highly weathered granitics

Status of beneficial uses

Based on BURP data, GIS analysis, bank erosion surveys, and aerial and ground surveys, sediment levels are impairing water quality to a degree that beneficial uses are not being met; therefore, DEQ will complete a sediment TMDL for Partridge Creek. Biological data demonstrated very low macroinvertebrate scores within the WBAG II process. The habitat index score was very low and because of the low SMI and SHI scores DEQ concluded that Partridge Creek was impaired. Although the CWE sediment delivery scores are low and there were no mass failures found, field reviews indicated excessive bank and riparian area erosion. Therefore, the bank erosion field estimate procedure (NRCS, 1983) was conducted in the watershed, and results indicated that excessive bank erosion was occurring. Temperatures are below the salmonid spawning temperature criteria and are not an issue in Partridge Creek as brook trout are present, and they are fall spawners when the temperatures are cooler and below the salmonid spawning criteria.

Elk Creek Reservoir

Elk Creek Reservoir is 303(d)-listed for sediment, temperature, DO, bacteria, and nutrients. The reservoir, located about a 0.5 miles southeast of the town of Elk River, is 0.12 square miles (75.4 acres) in size, and has a perimeter of 2.3 miles. Numerous campgrounds, fishing docks, boat ramps, and a swimming area make it a popular recreational destination. In the winter, ice fishing and snowmobiling are popular activities. The reservoir was originally constructed as a log holding pond by Potlatch Corporation. The dam washed out in 1937 and was reconstructed in 1950; IDFG reconstructed the dam and spillway again in 1987.

IDFG manages the reservoir as “mixed fisheries” meaning it provides habitat for both warm and cold water fisheries. It is believed that brook trout were introduced to the reservoir in the early 1900s, bullheads in the 1930s, and bass (both smallmouth and largemouth) were stocked in 1984-1985. IDFG has been stocking rainbow trout consistently since 1968 and currently maintains the reservoir so that the average catch rate is 0.5 fish/hour. IDFG has documented that no salmonid spawning occurs in the reservoir (Hand 2002). As a result of the formation of the reservoir and of these exotic introductions, it is believed that sculpin are the only native fish in the reservoir.

The following fish are found in Elk Creek Reservoir:

Black Crappie
Bluegill
Largemouth Bass
Pumkinseed
Brook Trout
Redside Shiner
Black Bullhead
Smallmouth Bass
Rainbow Trout
Sculpin – (not species specific)

IDFG has an approved operating plan for the dam/reservoir with Idaho Department of Water Resources (IDWR) Division of Dam Safety being responsible for approving that plan. Under the plan, IDFG is required to lower the reservoir elevation to its winter spillway crest by October 1 of each year, and they can't raise the dam by putting in dam boards until after June 20. This is to reduce flooding and dam integrity risks. Annual waivers for these dates can be requested based on extenuating circumstances. For example, when climate data indicate that the overwhelming majority of the snow pack in the Elk Creek watershed is gone prior to June 20, IDWR will allow IDFG to install the dam boards early.

IDFG has been addressing the algae growth situation in the shallow northern portion of the reservoir. This part of the reservoir is more like a wetland area with water levels being less than a meter, and cattails and other wetland plant species prevalent. In 2001 IDFG applied approximately two tons barley straw, experimentally to control algae. As opposed to many types of chemical treatments, it is non-toxic to humans and wildlife and it does not require governmental approval or an applicator's license. During the decomposition of barley straw algae growth is prevented. Barley straw decomposes slowly so its oxygen demand is not a problem unless it is used excessively. It takes six to eight weeks for the straw to become active after being placed in the water, and the treatment lasts about six months. The cost for the barley straw is about $300 a year, which is much less than the cost of chemical treatments and will not create an imbalance in water chemistry or add toxins to the water column, which could lead to a water quality impairment and fish toxicity problems. In past years the algae was physically removed from the reservoir. Based on visual observations the barley straw appeared to successfully limit algae growth and IDFG plans to apply two tons of barley straw on a yearly basis.

Status of beneficial uses

A majority of data used to assess the streams is not applicable to assess the condition of water quality in Elk Creek Reservoir. For instance the MBI and HI scores, data on a watershed scale including CWE and WATBAL, and the different stream hydrological information are all not applicable for Elk Creek Reservoir. The DEQ state office collected the following data on August 28, 1997, as a one-time collection effort as part of the agency lake program: chlorophyll a, ammonia, nitrate and nitrite, ortho-phosphate, total kjeldahl nitrogen, and total phosphorus. Temperature and DO profiles were taken that day as well. Other data included macroinvertebrate data, fish data, secchi disk depth, pH, and conductivity and a depth contours. *E. coli* data was collected on August 10, 1999. In the 2001 monitoring season, *E. coli*, TSS, total phosphorus, nitrate and nitrite, ammonia, air and surface water temperatures were taken every two weeks from June through October for a total of eight different sampling events. These samples were taken just below the surface of the reservoir. Locations ER5 and ER6; those sites were added in August because the other sites were not detecting significant levels of phosphorus in the reservoir. However, as shown in Figure 22, high levels of phosphorus were not detected at ER5 or ER6 either. Whole lake phosphorus levels based from the different years data is below 0.50 mg/l. It also noted that the minimum detection limit for the lab analysis for phosphorus in 2001 was 0.50 mg/l. A phosphorus level profile is shown in Figure 23 indicating there is not a nutrient problem within the reservoir. Nitrogen and ammonia levels are very low (Figures 34-35) indicating there is not a nitrogen or ammonia problem within the reservoir. Based on the nutrient data and visually observations DEQ concludes that a nutrient TMDL is not needed and recommends Elk Creek Reservoir be removed for the 303(d) list for nutrients.

Conclusions drawn from the data in Figure 24 show that there is not a problem with bacteria as levels are below the state numeric standard. Sediment does not appear to be a problem either as total suspend solids levels were very low and the aquatic life in the lake is not impaired (Figure 25). Depth integrated temperature and DO sample profiles were taken along three different transects on August 9, 2001 (Map 19). The results are displayed in Figures 26-33. From these profiles it appears that the lake is somewhat stratified; however, there are levels within the reservoir where the temperature and DO levels are within state standards for cold water biota - brook trout and rainbow trout. Since the reservoir also has warm water fisheries, there is as much or more habitat for those species as well.

Isabella Creek Watershed Drainage

The Isabella Creek watershed encompasses two separate stream 303(d) listed segments, Isabella Creek and Dog Creek, both of which are listed for sediment as a pollutant. Map 15 displays the entire basin. The Isabella Creek Watershed is 30.46 square miles (19,491.34 acres) in size. Isabella Creek is a fourth order tributary at the mouth where it flows into the North Fork Clearwater River approximately 2 miles downstream from Aquarius campground. The CNF manages all lands within this drainage primarily for timber harvesting and recreational activities. The dominant landform of this drainage is mountainous. Isabella Creek flows from the north-northeast to south-southwest, and the basic drainage pattern is dendritic. Elevations range from 1,660 feet at the mouth to over 7,077 feet on Black Mountain. The Isabella Creek watershed is just north of the Idaho Batholith and is located within the contact zone between the Idaho Batholith and metasedimentary rocks as the geology of the watershed is dominated by schist and gneiss with some areas of granitics of the Idaho Batholith. Schist and gneiss to tend be unstable and weather fairly rapidly; evidence of these erosional processes can be seen in several places in this watershed.

The streams within this drainage typically start out as high energy streams with very high stream gradients and are classified as steep Aa channels. The gradient lowers as the streams continue downstream and changes from steep Aa channels to steep A channels. Near the mouth, Isabella Creek is a steep B channel, while Dog Creek and the other creeks remain steep Aa or A channels as they flow into Isabella Creek. Because of the high energy condition of these streams and the unstable geology higher occurrences of unstable banks and mass failures will occur naturally. A significant portion of this drainage has no roads and has not been commercially harvested for timber. Our GIS coverage shows a road density of 1.4 miles per square mile for the entire drainage. Portions of the Mallard Larkins Wilderness/Pioneer area are within this basin; therefore, Isabella Creek is a popular hiking destination.

The water quality in the Isabella Creek watershed is generally in an excellent condition. This drainage has a very low density of roads, and a lot of the basin has never been altered by human activities, aside from hiking into the backcountry. In fact, Goat Creek (see Map 15) is used by DEQ as a reference stream for this area. A recommendation to pull some of the culverts and fill slopes on the trail on the eastside of Isabella Creek that goes into the Mallard Larkins was made during a field review with the CNF hydrologist and biologist. This improvement could help reduce some sediment input to creek (Jones and Murphy 2001). The major water quality-limiting factor in this drainage could be low nutrient levels. With the completion of Dworshak Dam, all anadromous fish were prevented from entering the streams on the North Fork Clearwater River, and some studies have suggested that the loss of decomposing anadromous fish has reduced nutrient levels anywhere from 25 to 60% of the natural condition (Stockner et al. 2000). Land locked Kokanee planted in Dworshak spawn in some of the streams in the LNFCRS including Isabella, Beaver, Long Meadow, and Elk Creeks.

Isabella Creek

Isabella Creek is 303(d)-listed for sediment and the boundaries are defined as headwaters to the North Fork of the Clearwater River. Isabella Creek is a 4th order stream at its confluence with the North Fork of the Clearwater River and the headwaters originate from within the Mallard Larkins Pioneer Area. In 1990 the Clearwater Biostudies surveyed the lower portion of Isabella Creek. Results indicated that Isabella is a steep stream with an average gradient of 4.4%, cobble embeddedness averaged 37.7%, stable banks (5.0), and the streambed was dominated by rubble-boulder substrate (Clearwater Biostudies 1991[b]). In 1995 Isabella Wildlife Works extensively surveyed the upper portion of Isabella Creek. Results indicated that Isabella Creek is a steep stream with an average gradient of 8.9%, cobble embeddedness of 19%, has stable banks (4.9), and the streambed was dominated by boulders, large and small rubble, and has 14 primary pools per mile (Isabella Wildlife Works 1995).

Status of beneficial uses

DEQ recommends Isabella Creek be removed from the 303(d) list for sediment as conclusions drawn the data indicate that beneficial uses are being met, and Isabella Creek is not water quality impaired by sediment. Biological data indicate a self-propagation salmonid population, a diverse and thriving stream macroinvertebrate population, and the presence of other aquatic lifeforms. The SMI and SHI raw scores are excellent and were some of the highest out of any streams in the entire LNFCRS. GIS analysis supports the delisting for sediment as the road density is very low; there are a limited number of stream crossings; and an extremely low number of miles of roads in the SPZ, and in high mass failure and high surface erosion areas. Bank stability index rated a 5.0 for Isabella Creek in 1990, and 4.9 in 1995. WATBAL scores support the delisting for sediment and indicate that current sediment levels above natural are below the water quality objectives and that current cobble embeddedness values are very close to being within the desired range. Additional fish data collect by the IDFG and DEQ BURP surveys indicated that a self-propagating salmonid population exists throughout the watershed, as well as other aquatic life. Even with minute increases of fine sediment from roads and mass failures macroinvertebrates, fish, and other aquatic life populations appear to be thriving; therefore, sediment levels are within state standards and are not impairing the beneficial uses of Isabella Creek.

Large cedar stands dominate the riparian area; therefore, the potential for future recruitment debris is excellent. During several field reviews during the 2001 season, several large cedars were windblown into the stream. Two continuous temperature data loggers placed by DEQ-LRO in the summer of 2001 indicated stream temperatures were out of compliance. The upper temperature probe was placed above just downstream of Elmer Creek (elevation 3,034 feet), which is a few miles upstream of Black Creek. The data in Figure 36 show a temperature exceedance; however, no roads have been constructed nor has any logging activity occurred above Black Creek, so what is shown in Figure 36 is a natural temperature exceedance. Figure 37, which is a temperature profile of Goat Creek (see Map 15) shows another natural temperature exceedance as the Goat Creek Watershed is un-roaded and has never been logged. Figure 38 is the data from a temperature probe that was placed near the mouth of Fern Creek in Isabella Creek (elevation 2,296 feet) which shows another temperature exceedance. The temperature increases about 1.5^{o} C from the upper site to the lower site (738 feet drop in elevation). Based on this data, Isabella Creek is limited by temperature and DEQ recommends that the managed portion Isabella Creek (confluence with Black Creek to mouth) be listed for temperature during the next 303(d) listing cycle.

Dog Creek

Dog Creek is 303(d)-listed for sediment and its boundaries are defined as headwaters to Isabella Creek. Dog Creek is a 2nd order stream at the mouth and the headwaters originate off of Smith Ridge, which is within the southwestern portion of the Mallard Larkins Pioneer Area. Results from the 1990 Clearwater Biostudies report showed that Dog Creek is a very steep stream with an average gradient of 13.9%, cobble embeddedness averaged 32%, has moderately stable banks 3.7, and the streambed was dominated by boulders, rubble, and cobble substrate (Clearwater Biostudies 1991[b]).

Status of Beneficial Uses

DEQ recommends Dog Creek be removed from the 303(d) list for sediment as conclusions drawn from the data indicate that beneficial uses are being met, and Dog Creek is not water quality impaired by sediment. Biological data indicate a self-propagation salmonid population, a diverse and thriving stream macroinvertebrate population, and the presence of other aquatic lifeforms. The SMI and SHI raw scores are excellent and were some of the highest out of any streams in the entire LNFCRS. GIS analysis supports the de-listing for sediment as the road density is very low; there are a limited number of stream crossings; and an extremely low number of miles of roads within a 100 meters of a stream, and few roads high mass failure and high surface erosion areas. WATBAL supports the delisting for sediment as well. WATBAL scores indicate that current sediment levels above natural are below the water quality objective and that current cobble embeddedness value is very close to being within the desired range. An instantaneous temperature reading of 13 ºC is displayed in Table 9. Even with increases of fine sediment from roads and mass failures macroinvertebrate, fish, and other aquatic life populations appear to be thriving; therefore, sediment levels are within state standards and are not impairing the beneficial uses of Dog Creek.

Long Meadow Creek

Long Meadow Creek is 303(d)-listed for sediment, temperature, nutrients, and bacteria with the boundaries being defined as headwaters to Dworshak Reservoir. Long Meadow Creek is a 4th order tributary at the mouth generally flowing from the northwest to the southeast (Map 16). Elevations in the watershed range from 1,600 feet where Long Meadow Creek empties into Dworshak Reservoir, to 4,457 feet on McGary Butte. Ownership is divided between IDL, Potlatch Corporation, and the CNF. IDL and Potlatch intensively manage the land for timber production. Grazing and recreational activities are the other two major land uses in the watershed.

The terrain in most of the Long Meadow Creek Watershed is quite gentle by north Idaho standards, with the exception of the lower sidewall canyon where Long Meadow Creek cuts down through basalt formations to Dworshak Reservoir. The emplacement of the Miocene-aged Columbia River basalts halted normal erosional processes as such that landforms above about 3,000 feet are well rounded and deeply weathered. Within the watershed at elevations ranging from about 2,800 feet to just over 3,000 feet are significant areas of gently rolling terrain associated with the top of the basalt plateau and the Tertiary sediments (IDL 2001[g]). Highly weathered schist and gneiss predominantly underlie the upper portion of Long Meadow drainage. In the lower end of the drainage the Elk River embayment of Columbia River basalt is found while in the very northeast corner of the watershed is highly metamorphosed granitics. Significant areas of Tertiary continental sediments in layered formations lie on top of and around the edges of the Columbia River basalts. On top of all of these are varying thicknesses of Palouse loess and Mazama volcanic ash forming the soils (IDL 2001[g]).

Status of Beneficial Uses

Results from the 2001 field season indicate that there is not a problem with nutrients (Figures 39-41) in the Long Meadow Creek Watershed. Nuisance algae was not a problem as indicated by field verification and biweekly DO levels were well within state standards. Therefore, a TMDL will not be completed for nutrients and DEQ recommends that Long Meadow Creek be removed from the 303(d) list for nutrients.

Bacteria levels in Long Meadow Creek are not within state standards. Stations LM2 and LM4 were both above state standards for secondary contact recreation. Station LM2 is located on Three-Bear Creek, and station LM4 is stationed on Long Meadow Creek about a 0.5 miles above the confluence with Three-Bear Creek. Based on the data in Figure 42, a bacteria TMDL will be completed for the entire Long Meadow Creek Watershed including Three-Bear Creek. Continuous temperature data, displayed in Figures 43-45, indicate stream temperatures are above state standards for salmonid spawning and cold water biota; therefore, a temperature TMDL will be completed.

Based on CWE sediment scores, BURP data, GIS analysis, and aerial and ground surveys, sediment levels are impairing water quality to a degree that beneficial uses are not being met;

therefore, DEQ will complete a sediment TMDL for Long Meadow Creek. Biological data demonstrated very low macroinvertebrate scores within the WBAG II process. However BURP data indicated the presence of other aquatic species and a self-propagating salmonid population. The SHI score was very low in the lower reach consequently because of the low SMI and SHI scores both BURP sites failed the WBAG II beneficial use status calls process. Additional data of GIS analysis revealed a high number of road crossings, and a high density of roads in the watershed. CWE reports identified an adverse condition for sediment in the Long Meadow Creek Watershed. Mass failure density was also high in the watershed. Field reviews indicate the sediment sources may not be only from roads or mass failures but from bank erosion as well. Therefore, the bank erosion field estimate procedure (NRCS, 1983) was conducted in the watershed and substantial sediment inputs from the bank erosion were noted and calculated. These sediment sources, combined with the biological and habitat data made it apparent that sediment levels are impairing the beneficial uses in Long Meadow Creek; therefore, a sediment TMDL will be written. In conclusion, DEQ completed TMDLs for sediment, bacteria and temperature for Long Meadow Creek and recommends that Long Meadow Creek be removed from the 303(d) list for nutrients.

Reeds Creek

Reeds Creek is 303(d)-listed for sediment with the boundaries being defined as headwaters to Dworshak Reservoir. Reeds Creek is a 5th order stream at the mouth with Dworshak Reservoir. The watershed is 79.36 square miles, which makes it the second largest watershed of the 303(d)-listed waterbodies (Map 17). Potlatch Corporation and IDL manage the lands within Reeds Creek with the primary land uses are timber production and recreational activities. Reeds Creek generally flows from the east to west and the basic drainage pattern is dendritic. Elevations range from 1,600 feet at the mouth to 5,054 feet on Bald Mountain, which is located in the southeastern portion of the watershed. The headwaters originate off of the Scofield Divide area. The geology of the basin is mixed; the upper part of the watershed is primarily underlain by highly weathered granitics; while the rest of the watershed is a mixture of highly weathered schist and gneiss, alluvium and basalt. The highly weathered material typically is found in the floodplains of the lower reaches while weakly weathered material occupies the uplands and ridgelines (IDL 2001[k]).

This drainage has been subject to extensive timber harvesting and road building activities. Most of the basin has been logged at least once, but is well-stocked and regenerating with natural or artificial regeneration. Portions of the riparian areas in this basin have been altered by historic timber harvest operations. Most of the streams in this drainage are Rosgen B or C channels with some A channels near the headwaters of most perennial streams.

Status of beneficial uses

Based on CWE sediment scores, BURP data, GIS analysis, and aerial and ground surveys, sediment levels are impairing water quality to a degree that beneficial uses are not being met; therefore, DEQ will complete a sediment TMDL for Reeds Creek. Biological data demonstrated very low macroinvertebrate scores within the WBAG II process in both BURP reaches. Habitat scores were also somewhat lower in both reaches. Although the lower site passed and the upper site failed according to the WBAG II process other sites in the watershed (Deer and Alder Creeks) failed as well. Additional data revealed a high number of road crossings, a high density of roads in the watershed and a high number of miles of roads on high mass failure and high surface erosion areas. CWE reports demonstrated an adverse condition for sediment in the Reeds Creek watershed. BURP data, WBAG II ratings, high sediment levels from roads and mass failures, CWE results, and a poor macroinvertebrate community lead DEQ to conclude that sediment levels are impairing the beneficial uses in Reeds Creek; therefore, a sediment TMDL will be written.

Continuous temperature measurements recorded a temperature violation of the state standards for salmonid spawning (Figure 46). Based on instantaneous stream temperature data, cover over the streams, CWE adverse condition for temperature, and field verification, Reeds Creek is limited by temperature and DEQ recommends that Reeds Creek be listed for temperature during the next 303(d)-listed cycle.

Swamp Creek

Swamp Creek is 303(d)-listed for sediment, temperature, nutrients, and bacteria with the boundaries being defined as headwaters to Dworshak Reservoir. Swamp Creek is a 3rd order tributary at the mouth and is oriented in a southeasterly direction with the Swamp Creek mainstem generally flowing from northwest to southeast. Elevation in the watershed ranges from 1,600 feet where Swamp Creek empties into Dworshak Reservoir to 4,740 feet on Little Green Mountain. Potlatch Corporation and IDL intensively manage the land in Swamp Creek for timber production. Some recreational activities occur in the watershed as well. Map 18 shows the geographic location of Swamp Creek as well as the different sampling locations. Highly weathered metamorphosed rock composed of schist and gneiss and basalts predominantly underlie the Swamp Creek watershed. Tertiary and more recent sediments, including loess cover the basalts. The geologic structure results in three distinct geomorphic zones in the watershed: the steeply rolling northern ridge of metamorphic rocks, the central undulating basalt plateau, and the southeastern strongly dissected areas where the channel is cutting down to the level of the Dworshak Reservoir (IDL 2001[m]). A natural anadromous upstream fish barrier was discovered in Swamp Creek during the summer of 2002.

Status of beneficial uses

Results from the 2001 field season indicate that there is not a problem with nutrients or bacteria in Swamp Creek (see Figures 47-50). Nuisance algae was not a problem as indicated by field verification and biweekly DO levels were well within state standards. Bacteria levels were below the numeric state standard. Therefore, a TMDL will not be completed for nutrients or bacteria and DEQ recommends that Swamp Creek be removed from the 303(d) list for bacteria and nutrients. Continuous temperature data displayed in Figure 51-52 demonstrates that stream temperatures are above state standards; therefore, a temperature TMDL will be completed for Swamp Creek.

Based on sediment inputs, BURP data, GIS analysis, and aerial and ground surveys, sediment levels are impairing water quality to a degree that beneficial uses are not being met; therefore, DEQ will complete a sediment TMDL for Swamp Creek. Biological data demonstrated very low macroinvertebrate scores within the WBAG II process in both reaches. The habitat score was low in the upper reach. The upper reach has no fish present but that is due to an upstream fish barrier located downstream from the reach. The fish barrier found in June 2002 is more like a series of large falls impassable to all species of fish. With the low SMI and SHI scores additional data was needed. GIS analysis indicates there are a high number of road crossings, and a high density of roads in the watershed. Although the CWE sediment delivery scores are low and there are a relatively low number of mass failures, field reviews indicate the sediment sources may not be limited to just roads or mass failures. Field reviews indicated that some erosional processes were from bank erosion and riparian areas. Therefore, the bank erosion field estimate procedure (NRCS 1983) was conducted in the watershed and erosion from bank and riparian area erosion was excessive. These sediment sources combined with the biological data made it apparent that sediment levels are impairing the beneficial uses in Swamp Creek; therefore, a sediment TMDL will be written. In conclusion, DEQ completed TMDLs for sediment and temperature for Swamp Creek and recommends that Swamp Creek be removed from the 303(d) list for bacteria and nutrients.

3. Subbasin Assessment – Pollutant Source Inventory

3.1 Sources of Pollutants of Concern

The sources of the pollutants cited as causing water quality standards exceedances for the 303(d)-listed waterbodies are identified and discussed in detail in this section. Pollutant sources may occur as point sources, which are regulated by the National Pollutant Discharge Elimination System (NPDES) program or as nonpoint sources of pollutants, which are not subject to NPDES or any other permitting programs. Point sources have a discrete conveyance, such as a pipe, ditch, or other identifiable "point" of discharge into a receiving water while nonpoint sources are pollutants coming off the landscape having no one exact point of discharge. Common point sources of pollution are industrial and municipal wastewater facilities. Examples of nonpoint sources include logging activities, roads, grazing activities, and mass failures. There is only one point source discharge in the basin; therefore, nearly all of the pollutant sources discussed in this section are from nonpoint sources. All of the 303(d)-listed waterbodies have sediment listed as a possible pollutant. Nonpoint source sediment sources excluding natural background in the basin are a result of three primary activities: roadbuilding, logging, and grazing. Other pollutants such as nutrients, bacteria, DO, and temperature, and the potential sources and causes of these pollutants will be discussed in this section.

Point Sources

The only point source in the basin is the wastewater treatment plant (WWTP) for the town of Elk River, which discharges into Elk Creek about 200 meters above the slackwater of Elk Creek Reservoir. The plant was built in 1967 and an NPDES permit was issued in 1974. The Elk River WWTP uses facultative lagoons for biological oxygen demand (BOD) reduction; chlorine is applied for disinfection prior to discharge. There are two unlined lagoons, which are typically operated in series, although parallel operation is possible. Chlorine solution is applied to the lagoon effluent and a contact basin is used to provide sufficient contact time prior to discharge to Elk Creek. The discharge is intermittent, as the plant is very lightly loaded and there are some losses due to evaporation and seepage (Moore 2001). Under the permit, the plant is only allowed a seasonal discharge between November 1 and June 30. When the facility discharges the following parameters are monitored: flow, fecal coliform counts, BOD, pH, TSS and Cl. Discharge from the plant is rare, in fact for the year 2000 and 2001 the WWTP did not discharge, and for the year 1999 they only discharged in the months of November and December. There is a high water table in the valley and it is suspected that the lagoon leaks into the ground.

A recent drinking water pilot study for the town indicated that shallow ground water is moving from the lagoons toward Elk Creek and Elk Creek Reservoir. Map 19 is an outlay of the town of Elk River and its location relative to Elk Creek and Elk Creek Reservoir. The study also indicated the water quality of the shallow ground water between the lagoon and Elk Creek was of lower value than the water in Elk Creek. No samples were collected from the ground water but visual observations described the ground water from a well as brownish with an oily sheen. The shallow ground water was turbid with a putrid odor, a deep brown color, and a lower qualitative value than the water from the creek (Moore, 2001). Based on this information, it is reasonable to assume that the shallow ground water is somewhat impaired and a probable cause could be unlined lagoons at the WWTP. When the mill was operating, the area also used to be a pole yard; therefore, it is safe to assume that various chemicals were used to treat logs. Additional monitoring would be important regarding this situation and is discussed in further detail in Section 3.2 data gaps.

Nonpoint Sources

The primary reason that streams in the LNFCRS were 303(d)-listed was because of nonpoint source pollutants. One way to classify nonpoint sources would be to divide them into two categories: anthropogenic (human caused) and non-anthropogenic (non-human caused). Athropogenic sources include road building, logging activities, construction activities, grazing, recreational activities, and fire. Non-anthropogenic causes include natural mass failures and erosional processes, wildlife impacts and fire. Fire can be both anthropogenic and non-anthropogenic. In the following section sediment, heat, nutrients, DO, and bacteria loading sources will be discussed. Included in these sections will be the transport mechanisms for these pollutants.

Sediment

All 19 listed waterbodies in the LNFCRS are listed with sediment as a pollutant. Nonpoint sources of sediment in the LNFCRS include forest management activities, roads and trails construction and maintenance, grazing activities, landslides, in-stream erosion, fires, other past and present land management activities, and air deposition. The precise amounts of pollutant contributions from each of these nonpoint sources to the subbasin are unknown, as it is nearly impossible to determine the exact amounts from each source. The forest management activities conducted in the basin include road construction, reconstruction, maintenance, and obliteration; timber harvesting; thinning; fertilization; and fire suppression. These activities may result in increased erosion and sedimentation. At the same time, some activities like road obliteration and road re-construction will reduce the amount of sediment to waterbodies.

Sediment is transported by numerous methods. The majority of sediment transport occurs during precipitation events when bare soil is eroded and water moves sediment off the landscape into and through natural and man-made ephemeral areas and into intermediate and perennial streams. Mass failures tend to occur during or after storm events as supersaturated soil becomes mobile. Roads can be the primary paths for transporting exposed sediments into waterbodies. Maintaining best management practices (BMPs) is critical to minimizing excess sedimentation into waterbodies.

Based on DEQ-LRO's GIS coverage, the LNFCRS has 5,800.3 miles of roads, virtually all of which are unpaved, and most of which are of native surface. Map 6 shows the distribution of these roads in the subbasin. Within timber management areas, road erosion is known to be the primary source of sediment to waterbodies. Roads directly affect natural sediment and hydrologic regimes by changing the landscape. For example, fill slopes have the potential to alter stream flow by confining the channel, reducing the floodplain storage, increasing sediment input to the stream, removing riparian vegetation, changing channel morphology, decreasing channel stability, and altering substrate composition. Culverts also impact the landscape as they tend to confine the stream channel, and without proper maintenance or if improperly installed or improperly sized, can fail during high flows and deliver large amounts of sediment to the stream. These failures, along with road-related surface erosion and mass failures, can continue for decades after the roads are constructed. Road-stream crossings can also be major sources of sediment to streams resulting from channel fill around culverts, road surface drainage to crossing areas, and crossing failures. Road construction techniques have improved tremendously over the past few decades and will continue to improve. Roads engineered and constructed properly with these new techniques have significantly decreased sedimentation inputs to waterbodies from roads, and older roads are typically obliterated.

Within the LNFCRS, most road-related sediment is being delivered into waterways from a few situations: roads that are parallel to and within approximately 100 feet of a stream, mass failures from road cuts and fill slopes that move all the way down a slope into a stream channel, and stream crossings where road drainage and the associated sediment is dumped directly into the channel. Road density can be used as an indicator of the impact of roads. The USFS identifies greater than 4.7 miles of road per square mile of watershed as a high road density (USFS 1996). Of the 19 waterbodies on the 303(d) list, 11 watersheds have greater than 4.7 miles of roads per square mile of watershed. Another indicator of road hazard to water quality is the percentage of roads in land types identified as having a high risk for mass failures. Approximately 12.9% of the roads in the LNFCRS are on high mass failure land types. Still another indicator is the percentage of roads within 100 feet of a stream. These parameters were examined in detail for each of the 303(d)-listed streams in Section two.

Mass failures are the other major sediment source in the subbasin. The geology and topography in this region lead naturally to a high number of mass failures. These highly weathered, metamorphosed, and steep slopes have had substantial road building, fire-and logging-reduced vegetative covers, and rain-on-snow events which have resulted in a significant increase in the number of mass failures and landslides in portions of the LNFCRS. Our GIS coverage identified 751 landslides in the LNFCRS for a density of 0.67 per square mile. This coverage at the subbasin level is not nearly complete and is probably very low as the LNFCRS is a very large area and an extensive landslide coverage would be extremely time consuming and expensive. However, CWE field surveys conducted by the IDL, Potlatch Corporation, and DEQ have provided a fairly extensive coverage for landslides in GPS format for the 303(d)-listed watersheds.

Field observations conclude that grazing activities do contribute to riparian area denudation and possibly to the overall sediment load within the LNFCRS. Potlatch Corporation and IDL have grazing leases throughout the LNFCRS. The following 303(d)-listed waterbodies have some grazing impacts to the riparian areas: Long Meadow Creek drainage, Cranberry Creek and Swamp Creek. Elk Creek, Reeds Creek and Breakfast Creek also have some grazing within those watersheds, but to a much lesser extent.

Gravel is mined for road construction and surfacing at several sites within the subbasin. Most of these sites are away from riparian areas and streams; however, there are some sites that could use some improvement. There are no current permitted mining activities in the subbasin, but there are recreational dredge mining operations in the subbasin that may be contributing to some sediment transportation from one point in a stream to another. A recent study by DEQ-LRO indicated that the NTU State standard was never in violation from recreation dredge mining operations (Stewart 2002). Most sediment from mining activities resulted from placer mines in the last half of the 19^{th} century. The result is cobble-sized material along the banks of some streams as stream channels reestablish their normal meander patterns.

Recreational activities like hiking, camping, hunting, horseback riding, bicycling, off-road vehicle use, fishing, kayaking, canoeing, rafting, swimming, cross country skiing, snowmobiling, and scenery and wildlife viewing may contribute to erosion and sedimentation. These activities do not produce significant amounts of sediment in the LNFCRS. However, observations in the Partridge Creek and Elk Creek watersheds indicate that off-road vehicle use is contributing to in-stream erosion and increased levels of sediment to these creeks. It is noted that litter from recreational activities can be significant at times especially in the Christiansen Meadow area of Partridge Creek.

Some sediment comes from air deposition in the form of fine particle dust from fires, roads, and administrative activities in the subbasin. Some of these contributors, such as large fires, produce significant amounts of airfall at times, but for sediment assessment purposes in this document, DEQ concluded sedimentation from air deposition is insignificant.

Geologic and geomorphic evidence indicates that most of the LNFCR subbasin is actively downcutting geologically, and as such, should be expected to exhibit some natural background erosion as well a certain amount of in-stream erosion. A natural background erosion rate of 25 tons per square mile is used in this report for TMDL loading allocation. This natural background rate was determined from work that occurred in the CNF (Wilson et al 1982). Recent work by (Kirchner et al 2001) which uses cosmic radiation to determine sediment yield measurements indicate that conventional background measurements may be 17 times lower than what is actually happening on the landscape on a geological time scale (periods of at least 10,000 years). Incremental erosion prevails most of the time, but accounts for very little of the overall sediment yield. Catastrophic erosion events, although extremely rare, dominate the long-term sediment yield. In fact 70% to 97% of sediment delivery must occur during these episodes. Conventional sediment yield measurements are ineffective at measuring these catastrophic events due to the enormous size and infrequency of these events. With these recent discoveries it would appear that human activities have contributed very little to the long-term sediment yield, but can still alter the frequency or size of these catastrophic events (Kirchner et al 2001).

In conclusion, the major sources of sediment in the LNFCRS considered significant for this assessment are natural background, roads, mass failures, in-stream channel erosion, and grazing activities. The effects of increased sedimentation to waterbodies from mining, recreation, administrative activities, and air deposition are observable at times, but many orders of magnitude less significant; therefore, would not be given a loading amount if it is determined a TMDL is necessary.

Heat Sources

Cranberry Creek, Elk Creek, Elk Creek Reservoir, Long Meadow Creek, and Swamp Creek are the water bodies 303(d)-listed for temperature. The heat source is solar radiation from the sun. This is a natural condition; the question in point is what amount of additional solar radiation is occurring due to anthropogenic activities. Additional heat being absorbed by a water body beyond background in forested environments is usually a function of shade reduction. The waterbodies that are listed for temperature are being actively logged and have had historical impacts from logging. A reasonable conclusion would be that an additional heat load to these streams has resulted from decreased stream shading by removing the canopy cover from these waterbodies.

Research has suggested that another possible contributor to increased stream temperature is altered flow regimes as a result of watershed canopy removal. Some evidence exists that canopy removal over broad sections of a watershed may increase flows in the early part of the season and result in lower flows in the latter part of the season when air temperatures are highest. Other evidence exists in watersheds with deep, permeable vadose zones and vegetative covers with large evapotranspiration potentials, that canopy removal may result in increased flows throughout the year. If flows are lower in the summer following the removal of the watershed canopy, higher stream temperatures could be the one of the results. Flow modification is not a pollutant under the CWA; therefore, lower flows and possible flow modifications are not fully addressed. A recommendation for land managers to possibly reduce stream temperatures would be to include methods to increase late season flows thereby reducing temperatures.

Higher early season flows could possibly result in channel widening and subsequent increased heat loading. This results in an increase of the surface area of the water to receive solar radiation. In most cases within the LNFCRS, where higher width to depth ratios are thought to have developed as a result of human activity, the altered ratios are primarily the result of road construction, mining alteration, or the removal of streamside vegetation that kept the channel narrow and sinuous.

Temperature data from streams that are not 303(d)-listed for temperature in LNFCRS indicates that water temperature exceedances are very common in the summer months. A recent report about water temperatures in the Lochsa watershed concluded that restoration strategies to generate full potential canopy cover in riparian areas throughout the Lochsa River Watershed would decrease average and maximum water temperatures, but not enough to satisfy Idaho Cold Water Biota temperature criteria (HDR, 2001). This is likely the same case in the LNFCRS, as the Lochsa Subbasin and the LNFCRS have similar characteristics. Based on the temperature data collected, DEQ is proposing that the following streams go through the formal listing procedure for temperature as a pollutant during the upcoming 303(d) listing cycle: Beaver Creek, Bingo Creek, Breakfast Creek, Floodwood Creek, Isabella Creek, Reeds Creek and Stony Creek. Preliminary temperature data from the CNF indicates that nearly all streams on the CNF are in exceedance of the numeric temperature criteria. For future TMDL work the task will be to determine if these temperature violations are human caused and if they are, to what degree.

Nutrients

Cranberry Creek, Elk Creek, Elk Creek Reservoir, Long Meadow Creek, and Swamp Creek are the waterbodies 303(d)-listed for nutrients. Nutrient sources for these waterbodies include the WWTP in Elk River, fertilization from forest management activities, grazing activities and natural sources. The Idaho general surface water quality criteria states that, "Surface waters must be free of excess nutrients that cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses." Results from the data collected during the 2001 field season indicate that excessive nutrient levels are not a problem in any of the above waterbodies; therefore, DEQ recommends that all the above waterbodies listed for nutrients as a pollutant be removed from the 303(d) list for nutrients. Data and a discussion of the data are presented in section two.

Dissolved Oxygen (DO)

Elk Creek Reservoir, Breakfast Creek, Floodwood Creek and Stony Creek are the waterbodies 303(d)-listed for DO. Dissolved oxygen is not a pollutant per say. It is a measurable result caused from excess nutrients or from other oxygen demanding and deleterious materials. Dissolved oxygen readings were collected in the water column for the above waterbodies during the 2001 field-monitoring season. Twenty-four hour DO readings were taken during the summer for Breakfast, Floodwood, and Stony Creeks (see Figures 2, 4, and 6) which clearly illustrate that DO concentrations are far above the state standard. Temperature and DO profiles were also performed in Elk Creek Reservoir and indicate a two-to-three meter wide layer where both temperature and DO were within state standards (Figures 26-33). Therefore, DEQ proposes that the all waterbodies listed for DO as a pollutant be removed from the 303(d) list.

Bacteria

Cranberry Creek, Elk Creek, Elk Creek Reservoir, Long Meadow Creek, and Swamp Creek are the water bodies 303(d)-listed for bacteria. Bacteria are a type of microorganism, which are found in certain bacteria, virus and protozoa, and when ingested into body can cause sickness or even death. Other bacteria are able to cause illness by entering the body through abrasions in the skin; therefore, state standards are set at a level to protect human health. In the state standards, DEQ uses *E-coli* bacterium as an indicator of the pathogen levels in a waterbody. All humans and most warm-blooded animals carry *E-coli* in the intestinal tract making *E-coli* a good indicator of the more harmful types of bacteria to humans.

Sources for bacteria include cattle, wildlife, humans, and other domesticated warm-blooded animals. The 303(d)-listed waterbodies for bacteria were sampled during the 2001 field-monitoring season for *E-coli* organisms. Results from the data indicate that the most of the waterbodies were within state standards. Elevated bacteria levels were present in the

Cranberry Creek and Long Meadow Creek drainages. At the time of the high levels of *E-coli*, field reports indicated a concentration of cattle in the drainage near the sample site during the summer months. Once the cattle left the area, *E-coli* levels dropped. Based on the available data, a bacteria TMDL will be completed for a portion of the Long Meadow Creek drainage and is discussed in detail in Section 5. DEQ proposes to remove the remaining waterbodies listed for bacteria as a pollutant from the 303(d) list.

3.2 Data Gaps

This section discusses where additional monitoring to gather data could help clarify questions about water quality impairment. At the beginning of this subbasin assessment, a large data gap loomed in the forefront. Little or no data existed for nutrients, bacteria, and DO. Sediment and temperature data were fairly abundant with CWE reports, temperature loggers, Clearwater Biostudies reports, and other flow and sediment data from the Forest Service. Therefore, a monitoring plan to gather baseline data for nutrients, bacteria and DO was created, and data was collected from June through October 2001.

Collecting data during the 2001 monitoring season was extremely challenging, as access to the sites was limited due to the steep terrain and a very limited road system. Getting samples to the laboratory was challenging as well as the bacteria samples had to be at a laboratory within 24 hours of sampling. After October, sampling is nearly impossible in most areas of the LNFCR due to snowfall. Budget constraints also limited the extent and frequency of the sampling. In spite of these limitations, DEQ believes a credible database was established to adequately assess the condition of the 303(d)-listed waterbodies with a reasonable degree of certainty.

Point Sources

Additional data regarding the Elk Creek WWTP would be extremely useful. A ground water study to determine the loading from the settlement ponds via ground water to Elk Creek and Elk Creek Reservoir would provide valuable information. Although no significant level of any pollutants from the WWTP were discovered, additional data for the WWTP and for Elk Creek reservoir would also be useful to determine long-term trends. DEQ encourages one long term monitoring site at the deepest spot in the reservoir to gather DO/temp profiles, chlorophyll-a, total nitrogen, total phosphorus, ortho-phosphorus and *E-coli* samples year round. This kind of data would be helpful to determine if the reservoir is becoming more or less polluted with time.

Nonpoint Sources

New techniques regarding bacteria sampling have been performed by using DNA tracers to establish the sources of species, i.e. tracing the fecal material to the source. Establishing this kind of analysis to develop a "bank of species" could be an asset to this region. Positively identifying the species responsible for elevated *E-coli* levels in the Long Meadow and Cranberry Creek drainages would be extremely helpful.

There is a lack of long term flow data for most of the streams in LNFCRS as it is a remote and rugged area and some permanent flow stations have been washed out during large flooding events. Establishing permanent stations to collect this data would be a very expensive and labor intensive process, but should be considered at selected locations. Long term sediment information, which originated from historic fires and mass failures would be helpful. Gathering this data would be challenging, but understanding overall effects and specifically how these events affected the life histories of major fish species could provide key information regarding sedimentation levels and fish conditions prior to European settlement. For example, there is very little data on the sediment condition of streams before the early 20th century fires or the large 1975-76 rain-on-snow event. A natural background erosion rate of 25 tons per square mile is used in this report for TMDL loading allocation; however, recent work using cosmic radiation to measure natural background erosion rates indicate that conventional measurements may be 17 times lower than what is actually happening on the landscape. Incremental erosion prevails most of the time, but accounts for very little of the overall sediment yield. Catastrophic erosion events, although extremely rare, dominate the long-term sediment yield. It is possible that aquatic habitats subject to such catastrophic sediment loads will be episodically disrupted and these episodic catastrophic sediment delivery disturbances may be essential for maintaining their diversity and productivity (Kirchner et al 2001). With these recent discoveries it would appear that human activities have very little contribution to the long-term sediment yield, but still have the potential to significantly disrupt aquatic ecosystems that have evolved to cope with episodic sediment deliveries rather than persistent low-level disturbances (Kirchner et al 2001).

There is no reliable data on the extent and cause of bull trout declines in this subbasin. It is unknown how much of the decline is due to habitat factors or food chain factors, and what part might be the result of heat or sediment pollution.

There is a data gap regarding the effects of nutrients. Anadromous fish have been absent from this subbasin since the completion of Dworshak dam; therefore, it is possible that there could be a nutrient deficiency in these watersheds. Some research indicates that anadromous fish spawning and dying used to contribute between 25-50% of the annual phosphorous loading to streams (Stockner et al. 2000). The North Fork of the Clearwater River has some of the best and most abundant habitat for anadromous fish in the Columbia River Basin.

One of the biggest questions regarding water quality in the LNFCRS has to do with heat as a pollutant and the degree to which water temperature might be limiting the beneficial uses of a given water body. It is known at this point that summer stream temperatures for many streams in the LNFCRS exceed the state water quality standards for salmonid spawning. A question beyond the scope of the LNFCRS problem assessment is whether the state temperature standards (including the methods for measuring stream temperature) are correct for the designated beneficial uses. What is known is that stream temperature data collected using the standard methodology indicate a violation of the state and federal temperature standards, yet we also have what appear to be healthy, reproducing populations of sensitive salmonids such as westslope cutthroat trout. Additional data could help rectify this discrepancy. The extent to which riparian timber harvest has altered streamside shading and channel morphology is not known. There are no historic records that show how much shading existed before logging began, or what the channels looked like. A complete picture of what really is human-caused heat loading and what is natural would be difficult to determine, but would very useful information. The same can be said for the effects of mining on sediment inputs, riparian habitat conditions, and additional heat loading. It is also unclear what long-term effects the large fires during the first half of the 20th century had on salmonids and shading.

In conclusion, the temperature standards issue and the discrepancy between the background natural erosion rates are the most critical pieces of information that need to be addressed. Additional temperature data could help prove that the current temperature standards are unrealistic. Currently, EPA and the states in Region 10 are working toward new temperature standards. DEQ is also working toward collecting existing temperature data into one database to better address the temperature issue for the state. Other important data that DEQ recommends collecting are ground water information near the Elk River WWTP and a long-term data set for Elk Creek Reservoir.

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

This section describes some past and present water pollution control efforts in the subbasin. Since 1992, various data have been collected and harvest conditions, especially in the CNF have changed. The federal Pacific Anadromous Fish Strategy (PACFISH) and the federal Inland Native Fish Strategy (INFISH) standards were adopted in1995 and have been implemented on all federal forest lands, which occupy 35.7% of the LNFCRS. PACFISH and INFISH standards increased streamside buffer widths, improved trail and road construction practices, and required land managers to review grazing situations. The total number of timber sales and the millions of board feet production on the CNF have dropped significantly since the 1960s and 1970s, as shown in Table 14.

Table 14. Timber harvest on Clearwater National Forest lands.

Decade	Millions of Board Feet Harvested
1930s	40
1940s	51
1950s	173
1960s	726
1970s	694
1980s	318
1990s	228

Perhaps the most important pollution control activities on forested land in the state of Idaho, including the LNFCRS, are those derived from the FPA. The FPA is state policy and is legislatively mandated. A Forest Practices Advisory Committee composed of various interest groups has been established with the specific responsibility to review and improve forestry BMPs such that forest practices will be conducted using the latest economically sound information and practices to protect water quality. The committee conducts research into forest practice questions and gathers information from various sources, effectively providing a feedback loop for continuous improvement of forest practices. Many of the activities now being implemented in the LNFCRS subbasin to improve water quality are the direct result of improved practices and BMPs put in place by the FPA (Dechert et al. 2001).

The Idaho Forest Practices Act (FPA) was codified during the mid-1970s to comply with Section 208 of the federal CWA. The FPA established mandatory rules and regulations leading to BMPs to be used during forest practices to protect surface water quality (IDL 1998). Espinosa et al. (1997) described estimated sediment delivery above USFS management plan goals from the 1950s through the 1970s, and noted that the awareness of watershed and habitat degradation problems helped to initiate a moderation of timber and road construction impacts in the early 1980s. On-site audits of FPA compliance were conducted in 1978, 1984, 1988, 1992, 1996, and 2000. Because of these audits, BMPs have been revised to promote better water quality protection (Dechert et al. 2001).

Under the FPA, the forest industry and the state of Idaho have developed and are implementing a CWE process for forest lands in the state. The goal of this methodology is to systematically examine forested watersheds and identify on-the-ground cases where management may be contributing to water quality problems as defined by the CWA and state standards. When problems are identified, the process leads directly to corrective management prescriptions where the problem is occurring. CWE assessments have been completed on a significant portion of the state and private managed land in the LNFCRS (Dechert et al. 2001). CWE reports define corrective management actions for each watershed where actual on-the-ground-conditions have been documented. These actions include BMPs based on FPA guidelines to ensure that forestry activities are not impairing water quality conditions. DEQ has been working closely with the FPA committee, IDL, and private industry to ensure BMPs are implemented, and will continue to do so.

On the CNF, 380.9 miles of roads were obliterated between the years 1993 and 1999, while only 18.5 miles of roads were constructed. The majority of the roads obliterated were roads that were high sediment producers and had a high potential for mass failures. From 1990 through 2000, audits were performed as required by the FPA. Over 3000 BMP checks were conducted, with 97.8% of those BMPs being effective on CNF lands; since 1996 the BMP effectiveness has risen to 99%.

The CNF has had an active water temperature monitoring program in the subbasin since 1990. As of 2000, the CNF reported stream temperature data from over 90 sites in the subbasin, many in water bodies on the 303(d) list (Murphy et al. 2000). Newly proposed language in the state water quality standards states that pollutants such as temperature shall not vary from the standard due to *human activities*. This seems to provide a realistic approach to address the numeric temperature criteria issue.

Erosion and sedimentation control has been the objective of many recent and ongoing efforts in the subbasin. The IDL, Potlatch Corporation, and the CNF all have programs to control pollution associated with forest practices. Fire prevention and suppression, and other management activities are conducted in ways developed to minimize water pollution. Logged or burned forest stands are planted and monitored to insure that a full forest canopy and the associated water quality is attained as quickly as possible after the disturbance (Dechert et al. 2001).

In the Beaver Creek drainage, Potlatch Corporation has obliterated 5.6 miles of road and abandoned 3.29 miles of road. Currently, Potlatch Corporation is working on a long-term transportation plan. This involves looking at all of the existing roads and roads that will need to be built in the future. Potlatch will then determine which roads need to maintained for future use, obliterated, or abandoned, and where new roads will need to be built. Many of the new roads are temporary spur roads for harvest and silverculture activities and will be obliterated after these activities are complete. On all newly constructed roads the cut and fill slopes are grass-seeded and mulched with straw. Most of the secondary dirt roads are gated and only open to ATVs and non-motorized traffic. In 2000, Potlatch Corporation was 97.9% in compliance with FPA harvest evaluations; 99.4% in 2001. Potlatch identifies and manages class I riparian stands that at least meet and often exceed FPA BMP standards. Potlatch is also developing a new environmental management system to assist with the management of their timberlands.

5. Total Maximum Daily Loads

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 waste load allocation (WLA); and nonpoint sources, which receive a load allocation (LA). Natural background (NB), when present, is considered part of the load allocation, 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 (40 CFR § 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the MOS 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 LC is determined. Then the LC is broken down into its components: the necessary MOS is determined and subtracted; then NB, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation is completed we have a TMDL, which must equal the LC.

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, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. Also a required part of the loading analysis is that the LC 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 LC 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. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

5.1 Breakfast Creek Sediment TMDL

Breakfast Creek is water quality limited by sediment as determined by the various data in section two of this document. Therefore, a sediment TMDL will be completed with the goal to restore full support of existing and designated beneficial uses. The three main sources of sediment to Breakfast Creek are natural background erosion, roads and mass failures. A numeric and narrative sediment target will be applied for this TMDL.

Seasonal Variation

Seasonal variation was considered for this sediment TMDL. The TMDL is broken into sources; natural background, roads, and mass failures. The sediment load amounts from natural background and roads are based on a yearly cycle with the majority of the erosion occurring during the high precipitation events, typically the spring (Table B-3). The sediment load from mass failures is based on a fifteen-year cycle and converted to a yearly amount.

Water Quality Targets

The numeric sediment target was based on the CWE road score methodology and correlations developed by Western Watershed Analysts (Western Watershed Analysts 2000). CWE is the appropriate management tool to determine the impacts from logging activities. Logging activities fall under the FPA, and FPA is state policy and legislatively mandated with mandatory rules and regulations leading to best management practices (BMPs). These BMPs are implemented and maintained on forest lands to protect surface water quality and are enforced by IDL. Therefore, the numeric sediment target is related to FPA BMPs and the CWE assessment. The narrative target is based on the state water quality standards for sediment and on desirable physical and biological conditions found in similar watersheds.

Estimating Existing Pollutant Loads

A natural background rate of 25 tons per square mile per year was calculated for most of the CNF (Wilson et al. 1982). This background rate seems reasonable as other research produced similar results (USFS 1981). This background rate is based on year to year erosion rates, which in a forested environment are generally small except when the ground surface is disturbed. Over a 10,000 or 1,000,000-year time scale, erosion rates are somewhat larger and are dominated by catastrophic events that tend to change the landscape significantly (Kirchner et al. 2001). However, for this TMDL a natural background rate of 25 tons per square mile per year was used. There are 13.67 square miles in Breakfast Creek, so the background rate is approximately 342 tons per year for the watershed (Table 15).

Road erosion was calculated based on the CWE methodology based on field conditions during the 1999 summer season. Table B-2 in Appendix B is the sediment delivery and erosion source evaluation (IDL 2000[b]). For the road portion, observations of each physical parameter (cut bank, road surface, etc.) were made in the field and assigned a value. Roads were divided into as many segments as needed to accurately interpret the situation on the ground. The value was then multiplied by the condition of each physical parameter to get a weighted score. For example, a road surface not graveled with ruts received a higher multiplier than a gravel road with no rutting. The weighted scores were then added and assigned an overall delivery multiplier. Once that was determined, the two were multiplied to arrive at the total score for roads. This procedure was done for each road segment. The segment scores are then converted to tons per year using a conversion developed by McGreer when he conducted both the Washington State watershed analysis and the CWE analysis on different watersheds with different geological types, and correlated the results (Western Watershed Analysts 2000). The current load from roads was calculated at approximately 831 tons per year and is shown in Table 15.

Seventy-seven mass failures were identified and assigned an estimated volume and delivery percentage to a stream based on visual observations outlined in the CWE manual or by aerial photography by the CNF. The total volume delivered to the streams was calculated at 5,600 tons of sediment from mass failures. The amount delivered does not occur on a yearly basis, but rather on the average of every 15 years (McCelland et al. 1997). This is based on the frequency of the rain-on-snow events in north Idaho (McCelland et al. 1997). Therefore, the total delivery amount of 5,600 tons was divided by 15 to convert it to a yearly number to arrive at the figure of 373 tons of sediment per year from mass failures. The current load from mass failures is shown in Table 15.

Table 15. Existing nonpoint source loads in Breakfast Creek.

Waste Load Type	Source	Load (tons/yr)	Method Referenced
Sediment	Natural Background	342	Wilson et al. 1982
Sediment	Roads	831	CWE Methodology/ WWA 2000
Sediment	Road Related Mass Failures	373	Mass Failure Database/GIS Analysis

Breakfast Creek Load Capacity and Allocation

The load capacity for Breakfast Creek must be at a level so that water quality standards are met while ensuring the beneficial uses of salmonid spawning and cold water biota are fully supported. Load allocations will be assigned to roads and mass failures. Potlatch Corporation and IDL are the primary entities responsible for meeting these allocations, as they are the primary land managers in the Breakfast Creek watershed.

Desired conditions in the Floodwood Creek and Stony Creek watersheds were used to determine the sediment targets in Breakfast Creek. All three watersheds have similar geology, land types, relief ratios, stream classifications, mean elevations, climate, hydrology and dominant slopes. They are managed by the same offices, the St. Maries IDL office and the Bovill Potlatch Corporation office, and have very similar management regimes. The other reason Floodwood Creek and Stony Creek were used is due to the robust and healthy salmonid and macroinvertebrate populations in each watershed. The SMI scores in Floodwood Creek and Stony Creek were significantly higher than Breakfast Creek. For example, the IDFG starting tagging and tracking bull trout in the year 2000. Bull trout entered and remained in Floodwood and Stony Creeks, but did not enter Breakfast Creek above Stony Creek in 2001. Fish populations in Floodwood and Stony Creek are excellent while in Breakfast Creek they are not as numerous. Although an upstream resident fish barrier was found in Breakfast Creek, fish populations below the barrier do not appear to be as numerous as Stony and Floodwood Creeks. Table 16 shows the similar physical watershed characteristics and the dissimilar biological characteristics.

Table 16. Breakfast Creek, Floodwood Creek and Stony Creek watershed comparisons.

Characteristics	Breakfast	Floodwood	Stony
Area (mi^2)	13.67	13.19[1]	23.13
Road Density (mi/mi^2)	9.21	3.15[1]	8.70
Total Road Miles (mi)	125.9	35.5[1]	201.2
Mass Failure Density (#/mi^2)	5.6	1.5[1]	1.0
CWE Road Erosion (tons/yr)	831	157[1]	493
Sediment Yield per mile of road (tons/mi)	6.6	4.4[1]	2.5
SMI (Average)	49.8	71.0	68.2
SFI (Average)	52.06	65.5	61.2
SHI (Average)	73	82	67
Geology	Schists and Gneiss	Schists and Gneiss	Schists and Gneiss
Relief Ratio	0.083	0.084	0.078
Stream Type	A,B,C	A,B,C,D	A,B,C
Mean Elevation (feet)	3698	4270	3820

[1]WF Floodwood only-entire watershed does not have full CWE analysis (entire watershed size 51.74)

To determine the load allocation from roads for Breakfast Creek, the sediment load per mile of road per year from Stony and Floodwood Creeks was calculated and then averaged at 3.4 tons per mile of road per year. This number was applied to the total miles of road in Breakfast Creek to get 434 tons per year for the load capacity. By subtracting the current load from roads (831) by the load capacity (434), a load reduction of 396 tons per year was calculated for sediment from roads. To determine the load allocation for mass failures for Breakfast Creek, the Stony Creek and Floodwood Creek watersheds mass failure densities were used as a desirable condition for Breakfast Creek watershed. The mass failure density of Stony and Floodwood Creeks is about 1.0 mass failures per square mile while the mass failure density in Breakfast Creek is nearly five times that amount. Therefore, an 80% reduction in the mass failure volume in Breakfast Creek is necessary. Multiplying the 80% to the current load of 373 tons per year, a load allocation of 75 tons per year and a load reduction of 298 tons per year were calculated (Table 17). The narrative target of sediment not impairing the beneficial uses of Breakfast Creek will be met when additional BURP data is collected and macroinvertebrate, fish and habitat conditions improve to the point where Breakfast Creek passes WBAG II, and is more comparable to Floodwood and Stony Creeks.

Table 17. Nonpoint source load allocations and reductions for Breakfast Creek.

Source	Pollutant	Existing Load	Load Allocation	Load Reduction	Time Frame
Roads	Sediment	831 tons/yr	434.5 tons/yr	396.5 tons/yr	5 years
Mass Failures	Sediment	373 tons/yr	75 tons/yr	298 tons/yr	5 years

Margin of Safety

A margin of safety was included when the current load amounts from roads and mass failures were calculated. These current load calculations were very conservative figures as CWE tends to overestimate the total sediment input to a stream when compared to other models. The CWE model and the WATBAL model were compared and results have shown that CWE sediment loading to surface waters are higher than WATBAL. For example DEQ calculated the total sediment input from watersheds where CWE could be compared to WATBAL. In the French Creek watershed, CWE total sediment input results were over three times higher than WATBAL. Results were similar in the Isabella Creek and Beaver Creek watersheds. Therefore, a margin of safety is part of the current road load allocation. For mass failures, the 15-year cycle included in this calculation was based on all of north Idaho not just the LNFCRS. Therefore, by using the 15-year cycle DEQ was conservative at determining the current load allocation from mass failures. The possibility of major rain-on-snow events happening every 15 years in LNFCRS is not very likely. Therefore, the current load from mass failures has a margin of safety built into the calculation.

Future Monitoring Points and Parameters

Physical monitoring parameters for sediment in Table B-2, Appendix B will be the information collected during the CWE assessment process. These include the total sediment score for roads and trails, and the mass failure size and delivery calculations. After the parameters in CWE are gathered the total sediment input to Breakfast Creek will be calculated. Monitoring sites will include the existing BURP sites and possible others to gather more biological information. If other biological, physical or chemical parameters, data or monitoring points are determined pertinent during implementation they will be included as well.

In conclusion, new road construction should be limited as much as possible in this drainage to ensure the goals of the TMDL are met. If new roads are constructed they should be kept out of high hazard land types, and all road related BMPs should be in effect per the Idaho Forest Protection Act. When load allocations are met and the biological data can fully support the beneficial uses in Breakfast Creek the goals of the TMDL will be met. If the load reductions mentioned in Table 17 do not allow the narrative targets to be achieved, further sediment reductions may be necessary. CWE should be conducted in this watershed again within five years to determine BMP effectiveness and ensure the sediment load allocations are met. At a minimum BURP monitoring and additional fish collection efforts should also be conducted within five years.

5.2 Cranberry Creek Sediment, Bacteria and Temperature TMDLs

Cranberry Creek is water quality limited by sediment, temperature, and bacteria as determined by the various data in Section 2 of this document. Therefore, TMDLs will be completed with the goal to restore full support of existing and designated beneficial uses. The sediment and temperature TMDLs will have numeric and narrative targets, while the bacteria TMDL will only have a numeric target.

Seasonal Variation

Seasonal variation was considered for all the TMDLs. The sediment TMDL is broken into sources; natural background, roads, mass failures and in-stream erosion. The sediment load amounts from natural background and roads are based on a yearly cycle with the majority of the erosion occurring during the high precipitation events, typically the spring (Table B-3). The sediment load from mass failures is based on a fifteen-year cycle and converted to a yearly amount. The sediment load from in-stream erosion is calculated to a yearly rate, which accounts for seasonal variation activities like grazing and ATV usage. The critical time frame for the temperature TMDL is mid May and June, as this is when the temperature exceeds the Idaho Salmonid Spawning (ISS) numeric criteria (Figure 12). The salmonid species present is rainbow trout, which are spring and early summer spawners. The critical time frame for the bacteria TMDL is May through November, as this is when the secondary contact recreation beneficial use is applicable, and the time frame that cattle are grazing in the Cranberry Creek watershed.

Water Quality Targets

The four main sources of sediment to Cranberry Creek are natural background erosion, roads, mass failures, and streambank and riparian area erosion. The existing beneficial uses protected by the sediment TMDL are salmonid spawning and cold water. CWE is the appropriate management tool to determine the impacts from logging activities. Logging activities fall under the FPA, and FPA is state policy and legislatively mandated with mandatory rules and regulations leading to best management practices (BMPs). These BMPs are implemented and maintained on forest lands to protect surface water quality and are enforced by IDL. Therefore, the numeric sediment target is related to FPA BMPs and the CWE assessment. The numeric sediment target for bank erosion is based on the NRCS field estimate procedure. The narrative target is based on the state water quality standards for sediment and on desirable physical and biological conditions in similar watersheds.

The three main sources of bacteria to Cranberry Creek are cattle and other livestock, wildlife, and humans. The existing beneficial use protected by the bacteria TMDL is secondary contact recreation (SCR). The target will be the state standard of 126 *E. coli* organisms per

100 ml. To achieve this, the sources of bacteria to Cranberry Creek must be reduced or eliminated.

Heat is transferred to Cranberry Creek via six different ways: solar radiation (shortwave), radiation between the stream and the adjacent vegetation and sky (longwave), evaporation from the stream, convection between the stream and the air, conduction between the stream and the streambed, and ground water and tributary input to the stream (Adams and Sullivan 1990). Stream temperature analysis at this level of detail is very costly, time consuming and complex. The complexity includes the fact that there are cool areas in the stream due to ground water discharges, tributary inputs, canopy cover, deep water, and topographic orientation. There are also warm spots caused by shallow areas, a lack of canopy cover, and slower/stagnant water. To gather this kind of information on this large scale is impracticable and extremely costly. Stream temperatures are directly related to air temperature, and in a forested environment air temperatures and stream shading are the major environmental factors influencing 90% of the variability in stream temperature (Brown 1971, IDL 2000[b]). Numeric load allocations and percent reductions are shown in Table D-1, Appendix D. The target will be the salmonid spawning numeric criteria, but when the temperature of the stream exceeds the natural background conditions the temperature in the stream will become the standard. However, significant changes will have to occur to reach natural conditions in the stream riparian areas of Cranberry Creek.

Estimating Existing Pollutant loads

A natural background rate of 25 tons per square mile per year was calculated for most of the CNF (Wilson et al. 1982). This background rate seems reasonable as other research produced similar results (USFS 1981). This background rate is based on year to year erosion rates, which in a forested environment are generally small except when the ground surface is disturbed. Over a 10,000 or 1,000,000-year time scale, erosion rates are somewhat larger and are dominated by catastrophic events that tend to change the landscape significantly (Kirchner et al 2001). However, for this TMDL a natural background rate of 25 tons per square mile per year was used. There are 14.63 square miles in Cranberry Creek, so the background rate is approximately 366 tons per year for the watershed (Table 18).

Road erosion was calculated based on the CWE methodology based on field conditions during the 1999 summer season. Table B-2 in Appendix B is the sediment delivery and erosion source evaluation (IDL 2000[b]). For the road portion, observations of each physical parameter (cut bank, road surface, etc.) were made in the field and assigned a value. Roads were divided into as many segments as needed to accurately interpret the situation on the ground. The value was then multiplied by the condition of each physical parameter to get a weighted score. For example, a road surface not graveled with ruts received a higher multiplier than a gravel road with no rutting. The weighted scores were then added and assigned an overall delivery multiplier. Once that was determined, the two were multiplied to arrive at the total score for roads. This procedure was done for each road segment. The segment scores are then converted to tons per year using a conversion developed by McGreer when he conducted both the Washington State watershed analysis and the CWE analysis on different watersheds with different geological types, and correlated the results (Western

Watershed Analysts 2000). The current load from roads was calculated at approximately 218 tons per year and is shown in Table 18.

Eight mass failures were identified and assigned an estimated volume and delivery percentage to a stream based on visual observations outlined in the CWE manual or by aerial photography by the CNF. The total volume delivered to the streams was calculated at 80 tons of sediment from mass failures. The amount delivered does not occur on a yearly base, but rather on an average of every 15 years (McCelland et al. 1997). This is based on the frequency of the rain-on-snow events in North Idaho (McCelland et al. 1997). Therefore, the total delivery amount of 80 tons was divided by 15 to convert it to a yearly number to arrive at the figure of 5 tons of sediment per year from mass failures. The current load from mass failures is shown in Table 18.

Stream bank erosion was estimated using a methodology used in the Lemhi River TMDL which originated from the NRCS. (NRCS 1983). Field notes indicate the causes of the bank erosion in Cranberry Creek are from cattle, wildlife, ATVs, and other human-related trampling along the banks. A significant amount of streambank erosion is occurring along approximately 5 miles (20%) of the total linear distance of the Cranberry Creek. Streambank erosion was estimated at 10 tons per mile of stream. Therefore, the total current load from bank erosion is 50 tons per year. The current loading from bank erosion is shown in Table 18.

Samples collected during the 2001 monitoring season revealed an exceedance in the state standard for bacteria. The average *E.coli* result was 183.25 *E. coli* organisms per 100 ml at CR2. Based on the flow collected at CR2 the following mass per unit volume for the current load was calculated at 7.4×10^{10} *E.coli* organisms per 100ml per day and is shown in Table 18.

The temperature load capacities are shown for each segment of Cranberry Creek in watts per square meter in Table D-1, Appendix D.

Table 18. Existing nonpoint source loads in Cranberry Creek.

Waste Load Type	Source	Load	Method Referenced
Sediment	Natural Background	366 tons/yr	Wilson et al. 1982
Sediment	Mass Failures	5 tons/yr	Mass Failure Data/GIS Analysis
Sediment	Roads	218 tons/yr	CWE Methodology/ WWA 2000
Sediment	Bank Erosion	50 tons/yr	NRCS 1983
Bacteria (*E. coli*)	Cattle, Wildlife, Humans	7.4×10^{10} *E.coli*	Sampling Site CR2
Temperature[1]			

[1] See table D-1 in Appendix D

Cranberry Creek Load Capacities and Allocations

The load capacities for Cranberry Creek must be at level so that water quality standards are met while ensuring the beneficial uses of salmonid spawning, cold water biota, and secondary contact recreation are fully supported. Load allocations will be assigned to roads, mass failures and erosion from banks and riparian areas for sediment. For bacteria, load allocations will be assigned to cattle and humans since wildlife is primarily an uncontrollable factor. The load allocations for temperature will in watts per square meter and as a shade percentage over the creek. Potlatch Corporation and IDL are the primary entities responsible for meeting these allocations, as they are the primary land managers in the Cranberry Creek Watershed.

Sediment

Desirable conditions in other watersheds were used to determine the sediment load allocations for Cranberry Creek. The road and mass failure conditions in Elk Creek-lower were considered desirable and were therefore used to determine the load allocations in Cranberry Creek. Elk Creek-lower has similar geology, landform types, stream classifications, climate, mean elevation, dominant slopes, and land management regimes as Cranberry Creek. Table 19 displays the similar characteristics, mass failure densities, area, road densities, and road erosion rates. The sediment yield per mile per year amount is almost 1.5 times more in Cranberry Creek than Elk Creek-lower. The bank and riparian area erosion condition in Elk Creek-upper was used as a desirable condition for Cranberry Creek. The bank erosion field estimate procedure was conducted in Elk Creek-upper and erosion levels were very minimal or zero. In fact in places it appears the Elk Creek-upper is aggrading not degrading.

Table 19. Cranberry Creek and Elk Creek-lower watershed comparisons.

Characteristics	Cranberry Creek	Elk Creek-lower
Area (mi^2)	14.63	59.44
Road Density (mi/mi^2)	5.94	6.38
Mass Failure Density (#/mi^2)	0.41	0.12
CWE Road Erosion (tons/yr)	218.04	704.34
Sediment Yield per Mile of Road (tons/mi)	2.51	1.86
Geology	Basalts, Alluvium, Schists and Gneiss	Basalts, Alluvium, Schists and Gneiss
Relief Ratio	0.059	0.100
Stream Type	A,C	Aa,B,C
Dominant Slope (average)	30%	30%
Mean Elevation (feet)	2,966	3140

The sediment load per mile of road and the mass failure density from Elk Creek-lower were used as desirable conditions. The sediment yield of 1.86 tons per mile of road from Elk Creek-lower was multiplied by the total miles of roads in Cranberry Creek to arrive at a load capacity of 161.5 tons per year sediment input from roads. By subtracting the current load from roads (218) from the load capacity (161.5) a load reduction of 56.5 tons per year is needed for the sediment reduction from the roads. The mass failure density is about 3.5 times higher in Cranberry Creek; therefore, the current loading amount was reduced by that amount. A load allocation of 1.5 tons per year and a load reduction of 3.5 tons per year were calculated (Table 20). Bank erosion occurs naturally, especially in meandering channels which are found in the upper part of Cranberry Creek, but based on field observations and calculations some additional bank and riparian area erosion is occurring unnaturally. Based on field conditions in Elk Creek-upper, which has a grazing allotment, a comparable bank erosion reduction for Cranberry Creek is 50%. Reducing bank erosion by 50% in Cranberry Creek should mimic field conditions in Elk Creek-upper. Multiplying the current load of 50 tons per year by 50%, a load allocation of 25 tons per year and a load reduction of 25 tons per year were calculated. (Table 20).

The narrative target of sediment not impairing the beneficial uses of Cranberry Creek will be met when additional data is collected and macroinvertebrate, fish and habitat conditions improve to the point where Cranberry Creek passes WBAG II. If the load reductions mentioned in Table 20 do not allow the narrative targets to be achieved, further sediment reductions may be necessary.

Table 20. Sediment nonpoint source load allocations for Cranberry Creek.

Source	Pollutant	Load Allocation	Load Reduction	Time Frame
Roads	Sediment	161.5 tons/yr	56.5 tons/yr	5 years
Mass Failures	Sediment	1.5 tons/yr	3.5 tons/yr	5 years
Bank Erosion	Sediment	25 tons/yr	25 tons/yr	5 years

Margin of Safety

A margin of safety was included when the current load amounts from road, mass failures, and bank erosion were calculated. These current load calculations were very conservative figures. The CWE model tends to overestimate the total sediment input to a stream. For the roads calculation a comparison between the CWE process and the CNF WATBAL process was used. When comparing the two models results have shown that CWE results are higher than results drawn from WATBAL. For example DEQ calculated the total sediment input from watersheds where we could compare CWE with WATBAL. In the French Creek watershed (UNFCRS) CWE total sediment input results were over three times higher than WATBAL. Results were similar in the Isabella Creek and Beaver Creek watersheds. Therefore, a margin of safety is part of the current road load allocation. For mass failures the 15-year cycle included in this calculation was based on all of north Idaho not just the LNFCRS. North Idaho is a much larger area. Therefore, by using the 15-year cycle DEQ was conservative at determining the current load allocation from mass failures. The possibility of these major rain-on-snow events happening every 15 years in LNFCRS is not very likely. Therefore, the current load from mass failures has a margin of safety built into the calculation. The bank erosion calculation has a margin of safety built into it as well. An estimate of 20% of the entire length of the stream was determined to have significant amounts of bank erosion. This estimate was very conservative, as the entire length of the stream was not walked. With this conservative estimate and with the recommendation of not allowing additional AUMs in this drainage DEQ believes that an MOS is already built into the current load allocation.

Future Monitoring Points and Parameters

Physical monitoring parameters for sediment (Table B-2, Appendix B) will be the information collected during the CWE sediment process. These include the total sediment score for roads and trails, and the mass failure size and delivery calculations. Other physical monitoring parameters will be along the banks of the creek, measuring bank erosion levels. Monitoring sites for sediment will include the existing BURP sites and possible others to gather more biological information. Once all the data is collected the total sediment input to Cranberry Creek will be calculated. If other biological, physical or chemical parameters, data or monitoring points are determined pertinent during implementation they will be included as well.

In conclusion, new road construction should be limited as much as possible in this drainage to ensure the goals of the TMDL are met. If new roads are constructed they should be kept out of high hazard land types, and all road related BMPs should be in effect per the Idaho Forest Protection Act. DEQ is also recommending that no additional AUMs over the current allotment amount enter the watershed. The goals of the TMDL will be met when the biological data demonstrates that the beneficial uses in Cranberry Creek are fully supported. If the load reductions mentioned in Table 20 do not allow the narrative targets to be achieved, further sediment reductions may be necessary. CWE should be conducted in this watershed again within five years to determine BMP effectiveness and ensure the sediment load allocations are met. At a minimum BURP and additional fish collect efforts should also be conducted within five years.

Bacteria

The bacteria load capacity for Cranberry Creek must be at a level so that the water quality standards are met to ensure the beneficial use of secondary contact recreation is supported. Samples collected from the 2001 monitoring season revealed an exceedance in the state standard for bacteria. The average *E.coli* result was 183.25 *E. coli* organisms per 100 ml at CR2. Based on the flow collected at CR2 the following mass per unit volumes for the current load, load capacity, load reduction amount and percentages were calculated. A margin of safety of 10% was applied to the total load reduction to ensure the goals of the bacteria TMDL are fully met. Until bacteria levels are within state standards, DEQ is recommending any AUMs above the current allotment amount not be allowed in the watershed. Table 21 displays the bacteria load allocations and reductions for Cranberry Creek. Monitoring points for bacteria should be the established monitoring sites of CR1, and CR2

Geometric Mean Concentration	183.25 *E.coli* organisms/100 ml
Average Flow (June-October)	0.164 cfs (ft^3/sec) or 4.0 x 10^8 ml/day
Average Current Load	7.4 x 10^{10} *E.coli* oranisms/day
Load Allocation/Capacity	5.1 x 10^{10} *E.coli* organisms/day
Margin Of Safety (MOS)	10%
Load Reduction	2.5 x 10^{10} *E.coli* organisms/day

Table 21. Bacteria nonpoint source load allocations for Cranberry Creek.

Source	Pollutant	Current Load (*E.coli* organisms/day)	Load Allocation (*E.coli* organisms/ day)	MOS (10%)	Load Reduction (*E.coli* organisms/ day)
Cattle, Wildlife, Humans	Bacteria - *E.coli*	7.4 x 10^{10}	5.1 x 10^{10}	2.3 x 10^9	2.5 x 10^{10}

Temperature

The temperature load capacity for Cranberry Creek must be at the numeric standard or the habitat must be at a natural condition so that the water quality standards are met to ensure the beneficial uses of aquatic life and salmonid spawning are met. Based on the CWE methodology, the canopy cover for the entire Cranberry Creek watershed is 100% cover or the maximum canopy achievable. There are some rock bluffs in the drainage where 100% canopy cover is not possible. During implementation land managers can document the locations where specific natural conditions prevent 100% canopy cover. The percent canopy increases required are shown on Map 20. The data calculation charts can be found in Table D-1 in Appendix D. Monitoring points for temperature should be the established monitoring sites of CRT1, and CRT2. Other monitoring points for temperature should be done via aerial photos to determine the shade progression and effectiveness over the stream

5.3 Elk Creek-lower Temperature TMDL

Elk Creek-lower is water quality limited by temperature as determined by the various data in Section 2 of this document. Therefore, a temperature TMDL will be completed with the goal to restore full support of existing and designated beneficial uses. The temperature TMDL will have a numeric and narrative target.

Seasonal Variation

Seasonal variation was considered for this temperature TMDL. The critical time frame for the temperature TMDL is May through September, as this is when the temperature exceeds the Idaho Salmonid Spawning (ISS) numeric criteria, and the Idaho Cold Water Aquatic Life (ICWB) numeric criteria (Figures 18 and 19). The salmonid species present include spring and early summer spawners (rainbow trout), summer spawners (cutthroat trout) and fall spawners (brook trout and kokanee).

Water Quality Targets

Heat is transferred to Elk Creek-lower via six different ways: solar radiation (shortwave), radiation between the stream and the adjacent vegetation and sky (longwave), evaporation from the stream, convection between the stream and the air, conduction between the stream and the streambed, and ground water and tributary input to the stream (Adams and Sullivan 1990). Stream temperature analysis at this level of detail is very costly, time consuming and complex. The complexity includes the fact that there are cool areas in the stream due to ground water discharges, tributary inputs, canopy cover, deep water, and topographic orientation. There are also warm spots cause by shallow areas, a lack of canopy cover, and slower/stagnant water. To gather this kind of information at this large scale is impracticable and extremely costly. Stream temperatures are directly related to air temperature, and in a forested environment air temperatures and stream shading are the major environmental factors influencing 90% of the variability in stream temperature (Brown 1971, IDL 2000[b]). For TMDL loading purposes a numeric load allocation and percent reductions are shown in Table D-2, Appendix D. The target is the salmonid spawning numeric criteria but it has a narrative component to it. The narrative component to the numeric temperature TMDL states that when the temperature of the stream exceeds the natural background conditions the temperature in the stream will become the state standard. Significant changes will have to occur to reach natural conditions in the stream riparian areas of Elk Creek. For natural conditions in Elk Creek-lower to ever be achieved, a low discharge line will have to be installed in the Elk Creek Reservoir Spillway. Water comes off of the surface of Elk Creek Reservoir as it flows into Elk Creek-lower. The high surface water temperatures of the reservoir will make achieving the numeric standards in Elk Creek-lower probably impossible during the summer. The difference in temperature during the summer from the inflow and the outflow of the reservoir is about 5ºC, with the outflow being 5ºC warmer.

Estimating Existing Pollutant loads

The current heat loading for each segment of Elk Creek-lower in watts per square meter is displayed in Table D-2, Appendix D. An approximate daily peak load allocation of 5°C for the months of May through September has been allocated to Elk Creek Reservoir. The surface temperature of the water is raised by this amount as it moves through the reservoir. Although an allocation has been applied, there are several reasons why it may never be achieved. The reservoir is managed for mixed fisheries, meaning both cool and warm water fish are present. There is a limited supply of cold water in the reservoir which is needed for survival of the cool water fish species. The average flow leaving the reservoir between May and September is about 15 cfs. If cool water were used during the summer months to augment the temperature for Elk Creek-lower, the reservoir would be drained of all cool water in a matter of days and the cool water fisheries would be eliminated from the reservoir. In addition, dredging or removing the reservoir would most likely cause more environmental harm than the current situation and removing the reservoir would definitely negatively impact the town of Elk River. Elk Creek Reservoir is a popular recreational and fishing destination, and the economy of the town of Elk River relies heavily on the fishing and boating associated with the reservoir. Elk Creek-lower is a modified system and should be treated as such. One possible solution would be to apply for a variation under the Idaho State Code. Further analysis and documentation will most likely be necessary to track progress during implementation.

Load Capacity and Allocation

The temperature load capacity for Elk Creek-lower must be at a level so that water quality standards are met while ensuring the beneficial uses of aquatic life and salmonid spawning are fully supported. The load allocation for temperature will be described as a shaded percentage over the creek as, land managers can relate to this for implementation. However, a thermal loading amount in watts per square meter is shown in Table D-2, Appendix D. Based on the CWE methodology the necessary canopy cover for the most of Elk Creek-lower is 100% cover or the maximum canopy achievable for the entire length of perennial streams. Elk Creek lower is a fourth and fifth order stream and there are places where 100% canopy cover is not possible due to width of the stream and rock bluffs. During implementation land managers can document the locations where specific natural conditions prevent 100% canopy cover. Potlatch Corporation, IDL, and the CNF are the primary entities responsible for meeting these allocations, as they are the primary land managers in the Elk Creek-lower Watershed. The percent canopy increases required are shown on Map 21. The load capacity and allocation information is displayed in Table D-2 in Appendix D.

Future Monitoring Points and Parameters

The monitoring points for temperature should be the established monitoring sites of ECT1 and ECT2. Other monitoring for temperature will be done via aerial photos to measure the shade progression and effectiveness over the stream. If other monitoring points are determined pertinent during implementation they will be included as well.

5.4 Long Meadow Creek Sediment, Bacteria, and Temperature TMDLs

Long Meadow Creek is water quality limited by sediment, bacteria, and temperature as determined by the various data in section two of this document. Therefore, TMDLs will be completed with the goal to restore full support of existing and designated beneficial uses. The sediment and temperature TMDLs have numeric and narrative targets, while the bacteria TMDL will only have a numeric target.

Seasonal Variation

Seasonal variation was considered for all the TMDLs. The sediment TMDL is broken into sources; natural background, roads, mass failures and in-stream erosion. The sediment load amounts from natural background and roads are based on a yearly cycle with the majority of the erosion occurring during the high precipitation events, typically the spring (Table B-3). The sediment load from mass failures is based on a fifteen-year cycle and converted to a yearly amount. The sediment load from in-stream erosion is calculated to a yearly rate, which accounts for seasonal variation activities like grazing and ATV usage. The critical time frame for the temperature TMDL is mid May through September as this is when the temperature exceeds the Idaho Salmonid Spawning (ISS) numeric criteria (Figure 43). The salmonid species present include spring and early summer spawners (rainbow trout), summer spawners (cutthroat trout) and fall spawners (brook trout and kokanee). The critical time frame for the bacteria TMDL is May through November, as this is when the secondary contact recreation beneficial is applicable and the time frame where cattle are grazing in the Long Meadow Creek watershed.

Water Quality Targets

The four main sources of sediment to Long Meadow Creek are natural background erosion, roads, mass failures, and streambank and riparian area erosion. The existing beneficial uses being protected by this sediment TMDL will be salmonid spawning and cold water. CWE is the appropriate management tool to determine the impacts from logging activities. Logging activities fall under the FPA, and FPA is state policy and legislatively mandated with mandatory rules and regulations leading to best management practices (BMPs). These BMPs are implemented and maintained on forest lands to protect surface water quality and are enforced by IDL. Therefore, the numeric sediment target is related to FPA BMPs and the

CWE assessment. The numeric sediment target for bank erosion is based on the NRCS field estimate procedure. The narrative target is based on the state water quality standards for sediment and on desirable physical and biological conditions in similar watersheds.

The three main sources of bacteria to Long Meadow Creek are cattle and other livestock, wildlife, and humans. The existing beneficial use being protected by this bacteria TMDL is secondary contact recreation. The target will be the state standard of 126 *E. coli* organisms per 100 ml, but to achieve this TMDL the sources of bacteria to Long Meadow Creek must be reduced or eliminated.

Heat is transferred to Long Meadow Creek via six different ways: solar radiation (shortwave), radiation between the stream and the adjacent vegetation and sky (longwave), evaporation from the stream, convection between the stream and the air, conduction between the stream and the streambed, and ground water and tributary input to the stream (Adams and Sullivan 1990). Stream temperature analysis at this level of detail is very costly, time consuming, and complex. The complexity includes the fact that there are cool areas in the stream due to ground water discharges, tributary inputs, canopy cover, deep water, and topographic orientation. There are also warm spots caused by shallow areas, a lack of canopy cover, and slower/stagnant water. To gather this kind of information on this large scale is impracticable and extremely costly. Stream temperatures are directly related to air temperature, and in a forested environment air temperatures and stream shading are the major environmental factors influencing 90% of the variability in stream temperature (Brown 1971, IDL 2000[b]). Numeric load allocations and percent reductions are shown in Table D-3, Appendix D. The target will be the salmonid spawning numeric criteria, but when the temperature of the stream exceeds the natural background conditions the temperature in the steam will become the state standard. However, significant changes will have to occur to reach natural conditions in the stream riparian areas of Long Meadow Creek.

Estimating Existing Pollutant Loads

A natural background rate of 25 tons per square mile per year was calculated for most of the CNF (Wilson et al. 1982). This background rate seems reasonable as other research produced similar results (USFS 1981). This background rate is based on year to year erosion rates, which in a forested environment are generally small except when the ground surface is disturbed. Over a 10,000 or 1,000,000-year time scale, erosion rates are somewhat larger and are dominated by catastrophic events that tend to change the landscape significantly (Kirchner et al 2001). However, for this TMDL a natural background rate of 25 tons per square mile per year was used. There are 56.09 square miles in Long Meadow Creek, so the background rate is approximately 1,402 tons per year for the watershed.

Road erosion was calculated based on the CWE methodology based on field conditions during the 1999 summer season. Table B-2 in Appendix B is the sediment delivery and erosion source evaluation (IDL 2000[b]). For the road portion, observations of each physical parameter (cut bank, road surface, etc.) were made in the field and assigned a value. Roads were divided into as many segments as needed to accurately interpret the situation on the ground. The value was then multiplied by the condition of each physical parameter to get a weighted score. For example, a road surface not graveled with ruts received a higher multiplier than a gravel road with no rutting. The weighted scores were then added and assigned an overall delivery multiplier. Once that was determined, the two were multiplied to arrive at the total score for roads. This procedure was done for each road segment. The segment scores are then converted to tons per year using a conversion developed by McGreer when he conducted both the Washington State watershed analysis and the CWE analysis on different watersheds with different geological types, and correlated the results (Western Watershed Analysts 2000). The current sediment load from roads was calculated at approximately 2,366 tons per year and is shown in Table 22.

Sixty-eight mass failures were identified and were assigned an estimated volume and delivery percentage to a stream based on visual observations outlined in CWE manual or by aerial photography by the CNF. The total volume delivered to the stream was calculated at 4,022 tons of sediment from mass failures. The amount delivered does not occur on a yearly basis, but rather on an average of every 15 years (McCelland et al. 1997). This is based on the frequency of rain-on-snow events in North Idaho (McCelland et al. 1997). Therefore, the total delivery amount of 4,022 tons was divided by 15 to convert it to a yearly number to arrive at the figure of 268 tons of sediment per year from mass failures. The current load from mass failures is shown in Table 22.

Estimating streambank erosion was performed by a methodology used in the Lemhi River TMDL which originated from the NRCS (NRCS 1983). Field notes indicate the causes of the bank erosion in Long Meadow Creek are from cattle, wildlife, ATVs, and other human related trampling along the banks. A significant measurable amount of streambank erosion is occurring along approximately 37 miles (20%) of the total linear distance of the Long Meadow Creek. Streambank erosion was estimated at 10 tons per mile of stream. Therefore, the total current load from bank erosion is 370 tons per year. The current loading from bank erosion is shown in Table 22.

Samples collected during the 2001 monitoring season revealed an exceedance in the state standard for bacteria. The average *E.coli* results were calculated at 578.63 *E. coli* organisms per 100 ml at LM2, and 335.09 *E. coli* organisms per 100 ml at LM4. Based on the flow collected at LM2 and LM4 the following mass per unit volumes for the current load was calculated at 2.5×10^{12} *E.coli* organisms per 100ml per day at LM2, and 3.2×10^{11} *E.coli* organisms per 100ml per day at LM4 are shown below in Table 22.

The temperature load capacities are shown for each segment of Long Meadow Creek in watt per square meter in Table D-3, Appendix D.

Table 22. Nonpoint source loads in Long Meadow Creek.

Waste Load Type	Source	Load	Method Referenced
Sediment	Natural Background	1,402 tons/yr	Wilson et al. 1982
Sediment	Mass Failures	268 tons/yr	Mass Failure Data/GIS Analysis
Sediment	Roads	2,366 tons/yr	CWE Methodology/ WWA 2000
Sediment	Bank Erosion	370 tons/yr	NRCS 1983
Bacteria (*E. coli*)	Cattle, Wildlife, Humans	2.5×10^{12} *E.coli*	Sampling Site LM2
Bacteria (*E. coli*)	Cattle, Wildlife, Humans	3.2×10^{11} *E.coli*	Sampling Site LM4
Temperature[1]			

[1] See table D-3 in Appendix D

Long Meadow Creek Load Capacity and Allocation

The load capacities for Long Meadow Creek must be at levels where water quality standards are met while ensuring the beneficial uses of salmonid spawning, cold water, and secondary contact recreation are fully supported. Load allocations will be assigned to roads, road related mass failures and erosion from banks and riparian areas for sediment. For bacteria, the load allocation will be assigned to cattle and humans since wildlife is primarily an uncontrollable factor. The load allocation for temperature will be described as a shaded percentage over the creek as this is manageable. Potlatch Corporation, IDL, and the CNF are the primary entities responsible for meeting these allocations, as they are the primary land managers in the Long Meadow Creek Watershed.

Sediment

Desirable conditions in other watersheds were used to determine the sediment load allocations for Long Meadow Creek. The road and mass failure conditions in Elk Creek-lower were considered desirable and were therefore used to determine the load allocations in Long Meadow Creek. Elk Creek-lower has similar geology, landform types, stream classifications, climate, mean elevation, dominant slopes, and land management regimes. Table 23 displays the similar characteristics, mass failure densities, area, road densities and road erosion in both watersheds. The sediment yield per mile amount is about 3.5 times more in Long Meadow Creek than Elk Creek-lower. Elk Creek-upper was used as the reference watershed for bank and riparian area erosion as grazing occurs in Elk Creek-upper. The bank erosion field estimate procedure was conducted in Elk Creek-upper and erosion levels were very minimal. In fact, in places it appears the Elk Creek-upper is aggrading not degrading.

Table 23. Long Meadow Creek and Elk Creek-lower watershed comparisons.

Characteristics	Long Meadow Creek	Elk Creek-lower
Area (mi^2)	56.09	59.44
Road Density (mi/mi^2)	6.46	6.38
Mass Failure Density (#/mi^2)	0.41	0.12
CWE Road Erosion (tons/yr)	2365.6	704.34
Sediment Yield per mile of Road (tons/mi)	6.53	1.86
Geology	Basalts, Alluvium, Schists and Gneiss	Basalts, Alluvium, Schists and Gneiss
Relief Ratio	0.059	0.100
Stream Type	A, B ,C ,E	Aa, B ,C
Dominant Slope (average)	60%	30%
Mean Elevation (ft)	3,133	3,140

The sediment load per mile of road and the mass failure density from Elk Creek-lower were used as reference sediment conditions for Long Meadow Creek. The sediment yield of 1.86 tons per mile of road per year from Elk Creek-lower was multiplied to the total miles of roads in Long Meadow Creek to arrive at a load capacity of 674 tons per year of sediment input from roads. By subtracting the current load from roads (2,365) from the load capacity (674) a load reduction of 1,691 tons per year is needed for the sediment reduction from the roads. The mass failure density in Long Meadow Creek is about 10 times the density in Elk Creek-lower. A load allocation of 27 tons per year and a load reduction of 241 tons per year from mass failures were calculated (Table 24).

Based on field conditions in Elk Creek-upper, which has a grazing allotment, a comparable bank erosion reduction for Long Meadow Creek is 50%. Reducing bank erosion by 50% in Long Meadow Creek should mimic field conditions in Elk Creek-upper. Multiplying 50% to the current load of 370 tons per year a load allocation of 185 tons per year and a load reduction of 185 tons per year were calculated (Table 24).

The narrative target of sediment not impairing the beneficial uses of Long Meadow Creek will be met when additional BURP data is collected and macroinvertebrate, fish and habitat conditions improve to the point where Long Meadow Creek passes WBAG II. If the load reductions mentioned in Table 24 do not allow the narrative targets to be achieved further sediment reductions may be necessary.

Table 24. Sediment nonpoint source load allocations for Long Meadow Creek.

Source	Pollutant	Load Allocation	Load Reduction	Time Frame for Meeting Allocations
Roads	Sediment	674 tons/yr	1,691 tons/yr	5 years
Mass Failures	Sediment	27 tons/yr	241 tons/yr	5 years
Bank Erosion	Sediment	185 tons/yr	185 tons/yr	5 years

Margin of Safety

A margin of safety was included when the current load amounts from road, mass failures, and bank erosion were calculated. These current load calculations were very conservative figures. The CWE model tends to overestimate the total sediment input to a stream. For the roads calculation a comparison between the CWE process and the CNF WATBAL process was used. When comparing the two models results have shown that CWE results are higher than results drawn from WATBAL. For example DEQ calculated the total sediment input from watersheds that we could compare CWE with WATBAL. In the French Creek watershed (UNFCRS) CWE total sediment input results were over three times higher than WATBAL. Results were similar in the Isabella Creek and Beaver Creek watersheds. Therefore, a margin of safety is part of the current road load allocation. For mass failures the 15-year cycle included in this calculation was based on all of north Idaho not just the LNFCRS. North Idaho is a much larger area. Therefore, by using the 15-year cycle DEQ was conservative at determining the current load allocation from mass failures. The possibility of these major rain-on-snow events happening every 15 years in LNFCRS is not very likely. Therefore, the current load from mass failures has a margin of safety built into the calculation. The bank erosion calculation has a margin of safety built into it as well. An estimate of 20% of the entire length of the stream was determined to have significant amounts of bank erosion. This estimate was very conservative, as the entire length of the stream was not walked. With this conservative estimate, and with the recommendation of not allowing additional AUMs in this drainage, DEQ believes that an MOS is already built into the current load allocation.

Future Monitoring Points and Parameters

Physical monitoring parameters for sediment displayed in Table B-2 (Appendix B) will be the information collected during the CWE sediment process. These include the total sediment score for roads and trails, and the mass failure size and delivery calculations. After the parameters in CWE are gathered the total sediment input to Long Meadow Creek will be calculated. Other physical monitoring parameters will be along the banks of the creek measuring bank erosion levels. Monitoring sites for sediment will include the existing BURP sites and possible others to gather more biological information. If other biological, physical or chemical parameters, data or monitoring points are determined pertinent during implementation they will be included as well

In conclusion, new road construction should be limited as much as possible in this drainage to ensure the goals of the TMDL are met. If new roads are constructed they should be kept out of high hazard land types, and all road related BMPs should be in effect per the Idaho Forest Protection Act. DEQ is also recommending that no additional AUMs enter the watershed over the current amount. When the load allocations are met and when the biological data can fully support the beneficial uses in Long Meadow Creek the goals of the TMDL will be met. CWE should be conducted in this watershed again within five years to determine BMP effectiveness and ensure the sediment load allocations are met. At a minimum BURP and some additional fish collect efforts should be conducted within five years as well.

Bacteria

The bacteria load capacity for Long Meadow Creek must be at a level so that the water quality standards are met to ensure the beneficial use of secondary contact recreation is met. Samples collected from the 2001 monitoring season revealed an exceedance in the state standard for bacteria. The average *E.coli* result was 578.63 *E. coli* organisms per 100 ml at LM2 and 335.09 *E. coli* organisms per 100 ml at LM4. Based on the flows collected at LM2 and LM4, the mass per unit volumes for the current load, load capacity, load reduction amount and percentages were calculated. An MOS of 10% will be applied to the total load reduction to ensure the goals of the bacteria TMDL are fully met. Until bacteria levels are within state standards DEQ is recommending any AUMs above the current allotment amount not be allowed in the watershed. Table 25 displays the bacteria load allocations and reductions for Long Meadow Creek. Monitoring points for bacteria and should be the established monitoring sites of LM1, LM2, LM3, and LM4.

Site LM2

Geometric Mean Concentration	578.63 *E.coli* organisms/100 ml
Average Flow (June-October)	1.78 cfs (ft^3/sec) or 4.4 x 10^9 ml/day
Average Current Load	2.5 x 10^{12} *E.coli* organisms/day
Load Allocation/Capacity	5.5 x 10^{11} *E.coli* organisms/day
Margin of Safety (MOS)	10%
Load Reduction	2.1 x 10^{12} *E.coli* organisms/day

Site LM4

Geometric Mean Concentration	335.09 *E.coli* organisms/100 ml
Average Flow (June-October)	0.394 cfs (ft^3/sec) or 9.6 x 10^8 ml/day
Average Current Load	3.2 x 10^{11} *E.coli* organisms/day
Load Allocation/Capacity	1.2 x 10^{11} *E.coli* organisms/day
Margin of Safety (MOS)	10%
Load Reduction	2.2 x 10^{11} *E.coli* organisms/day

Table 25. Bacteria nonpoint sources load allocations for Long Meadow Creek.

Source	Pollutant	Current Load (*E.coli* organisms/day)	Load Allocation (*E.coli* organisms/day)	MOS (10%)	Load Reduction (*E.coli* organisms/day)
Cattle, Wildlife, Humans (LM2)	Bacteria - *E.coli*	2.5×10^{12}	5.5×10^{11}	2.0×10^{10}	2.1×10^{12}
Cattle, Wildlife, Humans (LM4)	Bacteria - *E.coli*	3.2×10^{11}	1.2×10^{11}	2.3×10^{10}	2.2×10^{11}

Temperature

The temperature load capacity for Long Meadow Creek must be at the numeric standards or the habitat must be at a natural condition so that the water quality standards are met to ensure the beneficial uses of aquatic life and salmonid spawning are met. Based on the CWE methodology the canopy cover for the entire Long Meadow Creek watershed is 100% cover or the maximum canopy achievable for the entire length of perennial streams. There are some rock bluffs in the drainage where 100% canopy cover is not possible, and Long Meadow Creek is a fourth order stream at the mouth so 100% cover may be impossible to achieve because of the width of the creek. During implementation land managers can document the locations where specific natural conditions prevent 100% canopy cover. The percent canopy increases required are shown on Map 22. The data calculation charts can be found in Table D-3 in Appendix D. Monitoring points for temperature should be the established monitoring sites of LMT1, LMT2, and LMT3. Other monitoring points should be done via aerial photos to determine the shade progression and effectiveness over the stream.

5.5 Partridge Creek Sediment TMDL

Partridge Creek is water quality limited by sediment as determined by the various data in section two of this document. Therefore, a sediment TMDL will be completed with the goal to restore full support of existing and designated beneficial uses. This sediment TMDL will have a numeric and a narrative target.

Seasonal Variation

Seasonal variation was considered for this sediment TMDLs. The sediment TMDL is broken into sources; natural background, roads, mass failures and in-stream erosion. The sediment load amounts from natural background and roads are based on a yearly cycle with the majority of the erosion occurring during the high precipitation events, typically the spring (Table B-3). The sediment load from mass failures is based on a fifteen-year cycle and converted to a yearly amount. The sediment load from in-stream erosion is calculated to a yearly rate, which accounts for seasonal variation activities like grazing and ATV usage.

Water Quality Targets

The three main sources of sediment to Partridge Creek are natural background erosion, streambank and riparian area erosion, and roads. The existing beneficial uses protected by the sediment TMDL are salmonid spawning and cold water biota. CWE is the appropriate management tool to determine the impacts from logging activities. Logging activities fall under the FPA, and FPA is state policy and legislatively mandated with mandatory rules and regulations leading to best management practices (BMPs). These BMPs are implemented and maintained on forest lands to protect surface water quality and are enforced by IDL. Therefore, the numeric sediment target is related to FPA BMPs and the CWE assessment. The numeric sediment target for bank erosion is based on the NRCS field estimate procedure. The narrative target is based on the state water quality standards for sediment and on desirable physical and biological conditions in similar watersheds.

Estimating Existing Pollutant Loads

A natural background rate of 25 tons per square mile per year was calculated for most of the CNF (Wilson et al. 1982). This background rate seems reasonable as other research produced similar results (USFS 1981). This background rate is based on year to year erosion rates, which in a forested environment are generally small except when the ground surface is disturbed. Over a 10,000 or 1,000,000-year time scale, erosion rates are somewhat larger and are dominated by catastrophic events that tend to change the landscape significantly (Kirchner et al 2001). However, for this TMDL a natural background rate of 25 tons per square mile per year was used. There are 4.62 square miles in Partridge Creek, so the background rate is approximately 115.5 tons per year for the watershed (Table 26.)

Estimating streambank erosion was performed by a methodology used in the Lemhi River TMDL which originated from the Natural Resource Conservation Service (NRCS, 1983). Field notes indicate the causes of the bank erosion in Partridge Creek were from cattle, wildlife, ATVs, and other human related trampling along the banks. A significant measurable amount of streambank erosion is occurring along approximately 6.4 miles (20%) of the total linear distance of the Partridge Creek, mostly in or around Christiansen Meadows. Streambank erosion was estimated at 30.60 tons per mile of stream. Therefore, the total current load from bank erosion is 195 tons per year. The current loading from bank erosion is shown in Table 26.

Road erosion was calculated based on the CWE methodology based on field conditions during the 2001 summer season. Table B-2 in Appendix B is the sediment delivery and erosion source evaluation (IDL 2000[b]). For the road portion, observations of each physical parameter (cut bank, road surface, etc.) were made in the field and assigned a value. Roads were divided into as many segments as needed to accurately interpret the situation on the ground. The value was then multiplied by the condition of each physical parameter to get a weighted score. For example, a road surface not graveled with ruts received a higher multiplier than a gravel road with no rutting. The weighted scores were then added and assigned an overall delivery multiplier. Once that was determined, the two were multiplied to arrive at the total score for roads. This procedure was done for each road segment. The segment scores are then converted to tons per year using a conversion developed by McGreer when he conducted both the Washington State watershed analysis and the CWE analysis on different watersheds with different geological types, and correlated the results (Western Watershed Analysts 2000). The current load from roads was calculated at approximately 13.8 tons per year and is shown in Table 26. No mass failures were found.

Table 26. Nonpoint source loads in Partridge Creek.

Waste Load Type	Source	Load (tons/yr)	Method Referenced
Sediment	Natural Background	115.5	Wilson et al. 1982
Sediment	Bank Erosion	195.0	NRCS 1983
Sediment	Roads	13.8	CWE Methodology/ WWA 2000

Partridge Creek Load Capacity and Allocation

The load capacities for Partridge Creek must be at levels where water quality standards are met while ensuring the beneficial uses of salmonid spawning, and cold water biota are fully supported. Load allocations will be assigned to roads and erosion from banks and riparian areas for sediment. The CNF, Potlatch Corporation and IDL are the primary entities responsible for meeting these allocations, as they are the primary land managers in the Partridge Creek watershed.

Bank erosion is the major source of sediment in Partridge Creek. Roads are somewhat a minor source and no mass failures were found to deliver sediment in this watershed. The road average for Elk Creek-lower was used to determine the load allocation and reduction for Partridge Creek. Since the condition of the roads in Partridge Creek and Elk Creek-lower was nearly identical, and in general very good condition, the road reduction for Partridge Creek is fairly minimal; however, the reference condition for roads was used. The bank erosion field estimate procedure was conducted in Elk Creek-upper and erosion levels were very minimal or zero. In fact in places it appears the Elk Creek-upper is aggrading not degrading.

Bank erosion occurs naturally, especially in meandering channels, which are found in the lower portions of Partridge Creek, but based on field observations and calculations additional bank and riparian area erosion is occurring unnaturally. Based on field conditions in Elk Creek-upper, which has a grazing allotment, a comparable bank erosion reduction for Partridge Creek is 50%. Reducing bank erosion by 50% in Partridge Creek should mimic field conditions in Elk Creek-upper. Multiplying 50% to the current load of 195 tons per year, a load allocation of 97.5 tons per year and a load reduction of 97.5 tons per year are calculated (Table 27). The sediment load per mile of road from Elk Creek-lower was used as a reference sediment condition for roads for Partridge Creek. The sediment yield of 1.86 tons per mile of road from Elk Creek-lower was multiplied to the total miles of roads in Partridge Creek to arrive at a load capacity of 13.5-tons per year sediment input from roads.

By subtracting the current load from roads (13.8) from the load capacity (13.5) a load reduction of 0.3 tons per year is needed for the sediment reduction from the roads.

The narrative target of sediment not impairing the beneficial uses of Partridge Creek will be met when additional BURP data is collected and macroinvertebrate, fish and habitat conditions improve to the point where Partridge Creek passes WBAG II. If the load reductions mentioned in Table 27 do not allow the narrative targets to be achieved further sediment reductions may be necessary.

Table 27. Sediment nonpoint source load allocations for Partridge Creek.

Source	Pollutant	Load Allocation	Load Reduction	Time Frame for Meeting Allocations
Bank Erosion	Sediment	97.5 tons/yr	97.5 tons/yr	5 years
Roads	Sediment	13.5 tons/yr	0.3 tons/yr	5 years

Margin of Safety

A margin of safety was included when the current load amounts from road, mass failures, and bank erosion were calculated. These current load calculations were very conservative figures. The CWE model tends to overestimate the total sediment input to a stream. For the roads calculation a comparison between the CWE process and the CNF WATBAL process was used. When comparing the two models results have shown that CWE results are higher than results drawn from WATBAL. For example DEQ calculated the total sediment input from watersheds that we could compare CWE with WATBAL. In the French Creek watershed (UNFCRS) CWE total sediment input results were over three times higher than WATBAL. Results were similar in the Isabella Creek and Beaver Creek watersheds. Therefore, a margin of safety is part of the current road load allocation. The bank erosion calculation has a margin of safety built into it as well. An estimate of 20% of the entire length of the stream was determined to have significant amounts of bank erosion. This estimate was very conservative, as the entire length of the stream was not walked. With this conservative estimate and with the recommendation of not allowing additional AUMs in this drainage DEQ believes that an MOS is already built into the current load allocation.

Future Monitoring Points and Parameters

Physical parameters for sediment from roads are displayed in Table B-2 Appendix B and will be the information collected during the CWE road process. These include the total sediment score for roads and trails. After the parameters in CWE are gathered the total sediment input to Partridge Creek will be calculated. Other physical monitoring parameters will be along the banks of the creek measuring bank erosion levels. Monitoring sites for sediment will include the existing BURP sites and possible others to gather more biological information. If other biological, physical or chemical parameters, data or monitoring points are determined pertinent during implementation they will be included as well.

In conclusion, new road construction should be limited as much as possible in this drainage to ensure the goals of the TMDL are met. If new roads are constructed they should be kept out of high hazard land types, and all road-related BMPs should be in effect per the Idaho Forest Protection Act. DEQ is also recommending that no additional AUMs enter the watershed over the current allotment amount. When the load allocations are met and when the biological data can fully support the beneficial uses in Partridge Creek the goals of the TMDL will be met. CWE should be conducted in this watershed again within the five years to determine BMP effectiveness and ensure the sediment load allocations are met. The bank erosion field estimate procedure should also be conducted. At a minimum BURP monitoring and some additional fish collection efforts should also be conducted within five years.

5.6 Reeds Creek Sediment TMDL

Reeds Creek is water quality limited by sediment as determined by the various data in Section 2 of this document. Therefore, a TMDL will be completed with the goal of restoring full support of existing and designated beneficial uses. The three main sources of sediment to Reeds Creek are natural background erosion, roads, and mass failures. Numeric and narrative sediment targets will be applied to this TMDL.

Seasonal Variation

Seasonal variation was considered for this sediment TMDL. The TMDL is broken into sources; natural background, roads, and mass failures. The sediment load amounts from natural background and roads are based on a yearly cycle with the majority of the erosion occurring during the high precipitation events, typically the spring (Table B-3). The sediment load from mass failures is based on a fifteen-year cycle and converted to a yearly amount.

Water Quality Targets

The numeric sediment target is based on the CWE road score methodology and the correlations developed by Western Watershed Analysts (Western Watershed Analysts 2000). CWE is the appropriate management tool to determine the impacts from logging activities. Logging activities fall under the FPA, and FPA is state policy and legislatively mandated with mandatory rules and regulations leading to best management practices (BMPs). These BMPs are implemented and maintained on forest lands to protect surface water quality and are enforced by IDL. Therefore, the numeric sediment target is related to FPA BMPs and the CWE assessment. The narrative target is based on the state water quality standards for sediment and on desirable physical and biological conditions in similar watersheds.

Estimating Existing Pollutant Loads

A natural background rate of 25 tons per square mile per year was calculated for most of the CNF (Wilson et al. 1982). This background rate seems reasonable as other research produced similar results (USFS 1981). This background rate is based on year to year erosion rates, which in a forested environment are generally small except when the ground surface is disturbed. Over a 10,000 or 1,000,000-year time scale, erosion rates are somewhat larger and are dominated by catastrophic events that tend to change the landscape significantly (Kirchner et al. 2001). However, for this TMDL a natural background rate of 25 tons per square mile per year was used. Due to the large size and different geology types in Reeds Creek, the watershed will be split into five subwatersheds: Reeds Creek-sidewalls, Reeds Creek-headwaters, Reeds Creek north fork, Alder Creek, and Gold and Snake Creeks. Each of these five subwatersheds will have an existing load calculated, along with a load allocation and load reduction for each watershed. Table 28 below displays the background rates for each subwatershed.

Road erosion was calculated based on the CWE methodology based on field conditions during the 1999 summer season. Table B-2 in Appendix B is the sediment delivery and erosion source evaluation (IDL 2000[b]). For the road portion, observations of each physical parameter (cut bank, road surface, etc.) were made in the field and assigned a value. Roads were divided into as many segments as needed to accurately interpret the situation on the ground. The value was then multiplied by the condition of each physical parameter to get a weighted score. For example, a road surface not graveled with ruts received a higher multiplier than a gravel road with no rutting. The weighted scores were then added and assigned an overall delivery multiplier. Once that was determined, the two were multiplied to arrive at the total score for roads. This procedure was done for each road segment. The segment scores are then converted to tons per year using a conversion developed by McGreer when he conducted both the Washington State watershed analysis and the CWE analysis on different watersheds with different geological types, and correlated the results (Western Watershed Analysts 2000). The current load from roads was calculated for each subwatershed and is shown in Table 28.

Fifty-seven mass failures were identified and were assigned an estimated volume and delivery percentage to a stream based on visual observations outlined in the CWE manual or by aerial photography by the CNF. The amount delivered does not occur on a yearly basis, but rather on the average of every 15 years. The total volume delivered in each subwatershed was calculated and then divided by 15 to get a yearly loading amount. The current load from mass for each subwatershed is shown in Table 28.

Reeds Creek Load Capacity and Allocation

The load capacity for Reeds Creek must be at a level where water quality standards are met and the beneficial uses of salmonid spawning and cold water biota are fully supported. Load allocations will be assigned to roads and mass failures. Potlatch Corporation and IDL are the primary entities responsible for meeting these allocations, as they are the primary land managers in the Reeds Creek watershed.

The road conditions in the South Fork of Beaver Creek (SFBC) were used as desired conditions for all the sub watershed of Reeds Creek except for Reeds Creek sidewalls. The roads and mass failures in Elk Creek-lower were used as desired conditions for Reeds Creek sidewalls. The geology of Reeds Creek sidewalls is dominated by basalts, similar to Elk Creek-lower, and the stream order of the lower section of Reeds Creek-sidewalls is fourth and fifth, similar to Elk Creek-lower. The geology of the rest of Reeds Creek is dominated by schist and gneiss, and granitics, and most of these streams are first and second order streams, both similar to SFBC.

Table 28. Nonpoint source loads in Reeds Creek.

Waste Load	Size (mile^2)	Sub-watershed	Source	Load (tons/yr)	Method Referenced
Sediment	10.11	Reeds-SW[a]	Natural Background	253	Wilson et al. 1982
Sediment	10.11	Reeds-SW	Roads	328	CWE Methodology/ WWA 2000
Sediment	10.11	Reeds-SW	Mass Failures	58	Mass Failure Database/GIS Analysis
Sediment	19.47	Reeds-HW[b]	Natural Background	487	Wilson et al. 1982
Sediment	19.47	Reeds-HW	Roads	506	CWE Methodology/ WWA 2000
Sediment	19.47	Reeds-HW	Mass Failures	327	Mass Failure Database/GIS Analysis
Sediment	6.91	Reeds-NF[c]	Natural Background	173	Wilson et al. 1982
Sediment	6.91	Reeds-NF	Roads	205	CWE Methodology/ WWA 2000
Sediment	6.91	Reeds-NF	Mass Failures	1	Mass Failure Database/GIS Analysis
Sediment	24.09	Reeds-Alder[d]	Natural Background	602	Wilson et al. 1982
Sediment	24.09	Reeds-Alder	Roads	727	CWE Methodology/ WWA 2000
Sediment	24.09	Reeds-Alder	Mass Failures	75	Mass Failure Database/GIS Analysis
Sediment	18.77	Reeds-GS[e]	Natural Background	469	Wilson et al. 1982
Sediment	18.77	Reeds-GS	Roads	807	CWE Methodology/ WWA 2000
Sediment	18.77	Reeds-GS	Mass Failures	3	Mass Failure Database/GIS Analysis

a= SW= Sidewalls (near the mouth)
b=HW=Headwaters
c= NF=North Fork of Reeds Creek
d=Alder=Alder Creek Watershed within Reeds Creek Watershed
e=GS=Gold and Snake Creek Watersheds within Reeds Creek Watershed

To determine the load allocation from roads for Reeds Creek-sidewalls the sediment load of 1.86 tons per mile per year of road from Elk Creek-lower was used. This number was multiplied by the total miles of road in Reeds Creek-sidewalls to get 109 tons per year for the load allocation. By subtracting the current load from road (328) by the load allocation (109) a load reduction of 219 tons per year is calculated for sediment from roads. To determine the load allocation for mass failures for Reeds Creek-sidewalls again Elk Creek-lower was as the reference watershed. The mass failure density in Reeds Creek-sidewalls is over ten times (92%) greater than that in Elk Creek-lower. Therefore, a 92% reduction in the mass failure volume in Reeds Creek-sidewalls is necessary. Multiplying the 92% to the current load of 58 tons per year, a load allocation of 5 tons per year and a load reduction of 53 tons per year are calculated and shown in Table 29. The sediment yield per mile of road in SFBC was used as a reference condition. In the Reeds Creek-north fork and Reeds Creek-headwaters subwatersheds the sediment yield per mile of road was slightly lower than SFBC. In these two cases a 10% reduction will be applied to the current load. No mass failures were discovered in SFBC; therefore, a general 50% reduction to mass failures will be applied to the remaining subwatersheds of Reeds Creek. The load allocations and load reductions for all of the subwatersheds in Reeds Creek are shown in Table 29.

Table 29. Nonpoint source load allocations and reductions for Reeds Creek.

Source	Subwatershed	Pollutant	Load Allocation	Load Reduction	Time Frame
Roads	Reeds-SW[a]	Sediment	109 tons per yr.	219 tons per yr.	5 years
Mass Failures	Reeds-SW	Sediment	5 tons per yr.	53 tons per yr.	5 years
Roads	Reeds-HW[b]	Sediment	455 tons per yr.	51 tons per yr.	5 years
Mass Failures	Reeds-HW	Sediment	163.5 tons per yr.	163.5 tons per yr.	5 years
Roads	Reeds-NF[c]	Sediment	184 tons per yr.	21 tons per yr.	5 years
Mass Failures	Reeds-NF	Sediment	0.5 tons per yr.	0.5 tons per yr.	5 years
Roads	Reeds-Alder[d]	Sediment	567 tons per yr.	160 tons per yr.	5 years
Mass Failures	Reeds-Alder	Sediment	37.5 tons per yr.	37.5 tons per yr.	5 years
Roads	Reeds-GS[e]	Sediment	484 tons per yr.	323 tons per yr.	5 years
Mass Failures	Reeds-GS	Sediment	1.5 tons per yr.	1.5 tons per yr.	5 years

[a] SW= Sidewalls (near the mouth)
[b] HW=Headwaters
[c] NF=North Fork of Reeds Creek
[d] Alder=Alder Creek Watershed within Reeds Creek Watershed
[e] GS=Gold and Snake Creek Watersheds within Reeds Creek Watershed

Margin of Safety

A margin of safety was included when the current load amounts from roads and mass failures were calculated. These current load calculations were very conservative figures as CWE tends to overestimate the total sediment input to a stream when compared to other models. The CWE model and the WATBAL model were compared and results have shown that CWE sediment loading to surface waters are higher than WATBAL. For example DEQ calculated the total sediment input from watersheds where CWE could be compared to WATBAL. In the French Creek watershed, CWE total sediment input results were over three times higher than WATBAL. Results were similar in the Isabella Creek and Beaver Creek watersheds. Therefore, a margin of safety is part of the current road load allocation. For mass failures, the 15-year cycle included in this calculation was based on all of north Idaho not just the LNFCRS. Therefore, by using the 15-year cycle DEQ was conservative at determining the current load allocation from mass failures. The possibility of major rain-on-snow events happening every 15 years in LNFCRS is not very likely. Therefore, the current load from mass failures has a margin of safety built into the calculation.

Future Monitoring Points and Parameters

Physical monitoring parameters displayed in Table B-2 for sediment will be the information collected during the CWE sediment process. These include the total sediment score for roads and trails, and the mass failure size and delivery calculations. After the parameters in CWE are gathered the total sediment input to Reeds Creek will be calculated. Monitoring sites will include the existing BURP sites and possible others to gather more biological information. If other biological, physical or chemical parameters, data or monitoring points are determined pertinent during implementation they will be included as well.

In conclusion, new road construction should be limited as much as possible in this drainage to ensure the goals of the TMDL are met. If new roads are constructed they should be kept out of high hazard land types, and all road related BMPs should be in effect per the Idaho Forest Protection Act. The narrative target of sediment not impairing the beneficial uses of Reeds Creek will be met when additional BURP data is collected and macroinvertebrate, fish and habitat conditions improve to the point where Reeds Creek passes WBAG II. If the load reductions mentioned in Table 29 do not allow the narrative targets to be achieved further sediment reductions may be necessary. CWE should be conducted in this watershed again within five years to determine BMP effectiveness and ensure the sediment load allocations are met. At a minimum BURP and some additional fish collect efforts should also be conducted within five years.

5.7 Swamp Creek Sediment and Temperature TMDLs

Swamp Creek is water quality limited by sediment and temperature as determined by the various data in section two of this document. Therefore, a sediment and temperature TMDL will be completed with the goal to restore full support of existing and designated beneficial uses. These TMDLs will have a numeric and narrative targets.

Seasonal Variation

Seasonal variation was considered for both TMDLs. The sediment TMDL is broken into sources; natural background, roads, mass failures and in-stream erosion. The sediment load amounts from natural background and roads are based on a yearly cycle with the majority of the erosion occurring during the high precipitation events, typically the spring (Table B-3). The sediment load from mass failures is based on a fifteen-year cycle and converted to a yearly amount. The sediment load from in-stream erosion is calculated to a yearly rate, which accounts for seasonal variation activities like grazing and ATV usage. The critical time frame for the temperature TMDL is May and June as this is when the temperature exceeds the Idaho Salmonid Spawning (ISS) numeric criteria (Figure 43). The salmonid species present is rainbow trout, which are a spring and early summer spawners.

Water Quality Targets

The four main sources of sediment to Swamp Creek are natural background erosion, roads, mass failures, and streambank and riparian area erosion. The existing beneficial uses protected by the sediment TMDL are salmonid spawning and cold water. CWE is the appropriate management tool to determine the impacts from logging activities. Logging activities fall under the FPA, and FPA is state policy and legislatively mandated with mandatory rules and regulations leading to best management practices (BMPs). These BMPs are implemented and maintained on forest lands to protect surface water quality and are enforced by IDL. Therefore, the numeric sediment target is related to FPA BMPs and the CWE assessment. The numeric sediment target for bank erosion is based on the NRCS field estimate procedure. The narrative target is based on the state water quality standards for sediment and on desirable physical and biological conditions in similar watersheds.

Heat is transferred to Swamp Creek via six different ways: solar radiation (shortwave), radiation between the stream and the adjacent vegetation and sky (longwave), evaporation from the stream, convection between the stream and the air, conduction between the stream and the streambed, and ground water and tributary input to the stream (Adams and Sullivan 1990). Stream temperature analysis at this level of detail is very costly, time consuming and complex. The complexity includes the fact that there are cool areas in the stream due to ground water discharges, tributary inputs, canopy cover, deep water and topographic orientation. There are also warm spots caused by shallow areas, a lack of canopy cover, and slower/stagnant water. To gather this kind of information on this large scale is impracticable and extremely costly. Stream temperatures are directly related to air temperature, and in a forested environment air temperatures and stream shading are the major environmental factors influencing 90% of the variability in stream temperature (Brown 1971, IDL 2000[b]). For TMDL loading purposes a numeric load allocation and percent reductions are shown in Table D-4, Appendix D. The target will be the salmonid spawning numeric criteria but when the temperature of the stream exceeds the natural background conditions the temperature in the stream will become the state standard. However, significant changes will have to occur to reach natural conditions in the stream riparian areas of Swamp Creek.

Estimating Existing Pollutant Loads

A natural background rate of 25 tons per square mile per year was calculated for most of the CNF (Wilson et al. 1982). This background rate seems reasonable as other research produced similar results (USFS 1981). This background rate is based on year to year erosion rates, which in a forested environment are generally small except when the ground surface is disturbed. Over a 10,000 or 1,000,000-year time scale, erosion rates are somewhat larger and are dominated by catastrophic events that tend to change the landscape significantly (Kirchner et al 2001). However, for this TMDL a natural background rate of 25 tons per square mile per year was used. There are 12.17 square miles in Swamp Creek, so the background rate is approximately 304 tons per year for the watershed.

Road erosion was calculated based on the CWE methodology based on field conditions during the 1999 summer season. Table B-2 in Appendix B is the sediment delivery and erosion source evaluation (IDL 2000[b]). For the road portion, observations of each physical parameter (cut bank, road surface, etc.) were made in the field and assigned a value. Roads were divided into as many segments as needed to accurately interpret the situation on the ground. The value was then multiplied by the condition of each physical parameter to get a weighted score. For example a road surface not graveled with ruts received a higher multiplier than a gravel road with no rutting. The weighted scores were then added and assigned an overall delivery multiplier. Once that was determined the two were multiplied to arrive at the total score for roads. This procedure was done for each road segment. The segment scores are then converted to tons per year using a conversion developed by McGreer when he conducted both the Washington State watershed analysis and the CWE analysis on different watersheds with different geological types, and correlated the results (Western Watershed Analysts 2000). The current load from roads was calculated at approximately 417 tons per year and is shown in Table30.

Eleven mass failures were identified and were assigned an estimated volume and delivery percentage to a stream based on visual observations outlined in the CWE manual or by aerial photography by the CNF. The total volume delivered to the streams was calculated at 260 tons of sediment from mass failures. The amount delivered does not occur on a yearly basis, but rather on the average of every 15 years (McCelland et al. 1997). This is based on the frequency of the rain-on-snow events in North Idaho (McCelland et al. 1997). Therefore, the total delivery amount of 260 tons was divided by 15 to convert it to a yearly number to arrive at the figure of 17 tons of sediment per year from mass failures. The current load from mass failures is shown in Table 30.

Estimating streambank erosion was performed by a methodology used in the Lemhi River TMDL which originated from the Natural Resource Conservation Service (NRCS, 1983). Field notes indicate the causes of the bank erosion in Swamp Creek were from cattle, wildlife, ATVs, and other human related trampling along the banks. A significant measurable amount of streambank erosion is occurring along approximately 6.5 miles (20%) of the total linear distance of the Swamp Creek. streambank erosion was estimated at 10 tons per mile of stream. Therefore, the total current load from bank erosion is 65 tons per year. The current loading from bank erosion is shown in Table30.

The temperature load capacities are shown for each segment of Swamp Creek in watts per square meter in Table D-4, Appendix D.

Table 30. Existing nonpoint source loads in Swamp Creek.

Waste Load Type	Source	Load	Method Referenced
Sediment	Natural Background	304 tons/yr	Wilson et al. 1982
Sediment	Roads	417 tons/yr	CWE Methodology/ WWA 2000
Sediment	Mass Failures	17 tons/yr	Mass Failure Data/GIS Analysis
Sediment	Bank Erosion	65 tons/yr	NRCS 1983
Temperature[1]			

[1] See Table D-4, Appendix D

Swamp Creek Load Capacity and Allocation

The load capacities for Swamp Creek must be at levels where water quality standards are met and the beneficial uses of salmonid spawning and cold water biota are fully supported. Load allocations will be assigned to roads, mass failures, and erosion from banks and riparian areas for sediment. The load allocation for temperature will be described as a shaded percentage over the creek as this is manageable. Potlatch Corporation and IDL are the primary entities responsible for meeting these allocations, as they are the primary land managers in the Swamp Creek Watershed.

Sediment

Desirable conditions in other watersheds were used to determine the sediment load allocations for Swamp Creek. The road and mass failure conditions in Elk Creek-lower were considered desirable and were therefore used to determine the load allocations in Swamp Creek. Elk Creek-lower has similar geology, landform types, stream classifications, climate, mean elevation, dominant slopes, and land management regimes. Table 31 displays the similar characteristics, mass failure densities, area, road densities and road erosion. The sediment yield per mile amount is almost 1.5 times more in Swamp Creek than Elk Creek-lower. The bank and riparian area erosion condition in Elk Creek-upper was used as a desirable condition for Swamp Creek. The bank erosion field estimate procedure was conducted in Elk Creek-upper and erosion levels were very minimal or zero. In fact in places it appears the Elk Creek-upper is aggrading not degrading.

Table 31. Swamp Creek and Elk Creek-lower watershed comparisons.

Characteristics	Swamp Creek	Elk Creek-lower
Area (mi^2)	12.17	59.44
Road Density (mi/mi^2)	6.98	6.38
Mass Failure Density ($\#/mi^2$)	0.9	0.12
CWE Road Erosion (tons/yr)	417.35	704.34
Sediment Yield per mile of Road (tons/mi)	4.83	1.86
Geology	Basalts, Alluvium, Schists and Gneiss	Basalts, Alluvium, Schists and Gneiss
Relief Ratio	0.083	0.100
Stream Type	A,C	Aa,B,C
Dominant Slope (average)	30%	30%
Mean Elevation (feet)	3104	3140

The sediment load per mile of road and the mass failure density from Elk Creek-lower were used as a desirable sediment condition for roads and mass failures for Swamp Creek. The sediment yield of 1.86 tons per mile of road from Elk Creek-lower was multiplied to the total miles of roads in Swamp Creek to arrive at a load capacity of 161.0-tons per year sediment input from roads. By subtracting the current load from roads (417) from the load capacity (161.0) a load reduction of 256 tons per year is needed for the sediment reduction from the roads. The mass failure density was about eight times higher in Swamp Creek; therefore, the total delivery of 17 tons per year was reduced by about 87%. Multiplying 87% to the current load of 17 tons per year, a load allocation of 2.3 tons per year and a load reduction of 14.7 tons per year are calculated (Table 32). Bank erosion occurs naturally, especially in meandering channels, which are found in the upper part of Swamp Creek, but based on field observations and calculations additional bank erosion is occurring that is unnatural. Based on field conditions in Elk Creek-upper, which has a grazing allotment, a comparable bank erosion reduction for Swamp Creek is 50%. Reducing bank erosion by 50% in Swamp Creek should mimic field conditions in Elk Creek-upper. Multiplying the 50% to the current load of 65 tons per year a load allocation of 32.5 tons per year and a load reduction of 32.5 tons per year are calculated (Table 32).

The narrative target of sediment not impairing the beneficial uses of Swamp Creek will be met when additional BURP data is collected and macroinvertebrate, fish and habitat conditions improve to the point where Cranberry Creek passes WBAG II. If the load reductions mentioned in Table 32 do not allow the narrative targets to be achieved further sediment reductions may be necessary.

Table 32. Sediment nonpoint source load allocations for Swamp Creek.

Source	Pollutant	Load Allocation	Load Reduction	Time Frame for Meeting Allocations
Roads	Sediment	161.0 tons/yr	256.5 tons/yr	5 years
Mass Failures	Sediment	2.3 tons/yr	14.7 tons/yr	5 years
Bank Erosion	Sediment	32.5 tons/yr	32.5 tons/yr	5 years

Margin of Safety

A margin of safety was included when the current load amounts from road, mass failures, and bank erosion were calculated. These current load calculations were very conservative figures. The CWE model tends to overestimate the total sediment input to a stream. For the roads calculation a comparison between the CWE process and the CNF WATBAL process was used. When comparing the two models results have shown that CWE results are higher than results drawn from WATBAL. For example DEQ calculated the total sediment input from watersheds that we could compare CWE with WATBAL. In the French Creek watershed (UNFCRS) CWE total sediment input results were over three times higher than WATBAL. Results were similar in the Isabella Creek and Beaver Creek watersheds. Therefore, a margin of safety is part of the current road load allocation. For mass failures the 15-year cycle included in this calculation was based on all of north Idaho not just the LNFCRS. North Idaho is a much larger area. Therefore, by using the 15-year cycle DEQ was conservative at determining the current load allocation from mass failures. The possibility of these major rain-on-snow events happening every 15 years in LNFCRS is not very likely. Therefore, the current load from mass failures has a margin of safety built into the calculation. The bank erosion calculation has a margin of safety built into it as well. An estimate of 20% of the entire length of the stream was determined to have significant amounts of bank erosion. This estimate was very conservative, as the entire length of the stream was not walked. With this conservative estimate and with the recommendation of not allowing additional AUMs in this drainage DEQ believes that an MOS is already built into the current load allocation.

Temperature

The temperature load capacity for Swamp Creek must be at the numeric standards or the habitat must be at a natural condition so that the beneficial uses of aquatic life and salmonid spawning are met. Based on the CWE methodology the canopy cover for the entire Swamp Creek watershed should be 100% cover or maximum canopy achievable for the entire length of perennial streams. There are some rock bluffs in the drainage where 100% canopy cover is not possible; during implementation land managers can document the locations where specific natural conditions prevent 100% canopy cover. The percent canopy increases required are shown on Map 23. The data calculation charts can be found in Table D-4 in Appendix D.

Future Monitoring Points and Parameters

Physical monitoring parameters displayed in Table B-2 for sediment will be the information collected during the CWE sediment process. These include the total sediment score for roads and trails, and the mass failure size and delivery calculations. After the parameters in CWE are gathered the total sediment input to Swamp Creek will be calculated. Other physical monitoring parameters will be along the banks of the creek measuring bank erosion levels. Monitoring sites for sediment will include the existing BURP sites and possible others to gather more biological information. Monitoring points for temperature should be the established monitoring sites of SWT1 and SWT2. Other monitoring points for temperature will be done via aerial photos to determine the shade progression and effectiveness over the stream. If other biological, physical or chemical parameters, data or monitoring points are determined pertinent during implementation they will be included as well.

In conclusion, new road construction should be limited as much as possible in this drainage to ensure the goals of the TMDL are met. If new roads are constructed they should be kept out of high hazard land types, and all road related BMPs should be in effect per the Idaho Forest Protection Act. DEQ is also recommending that no additional AUMs enter the watershed beyond the current amount. The goals of the TMDL will be met when the biological data demonstrates that the beneficial uses in Swamp Creek are fully supported. If the load reductions mentioned in Table 32 do not allow the narrative targets to be achieved further sediment reductions may be necessary. CWE should be conducted in this watershed again within the five years to determine BMP effectiveness and ensure the sediment load allocations are met. At a minimum BURP and additional fish collect efforts should also be conducted within five years.

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Glossary

305(b) Refers to section 305 subsection "b" of the Clean Water Act. 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.

Acre-Foot A volume of water that would cover an acre to a depth of one foot. Often used to quantify reservoir storage and the annual discharge of large rivers.

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

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.

Adfluvial Describes fish whose life history involves seasonal migration from lakes to streams for spawning.

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. 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 (Armantrout 1998, EPA 1996).

Anadromous Fish, such as salmon and sea-run trout, that live part or the majority of their lives in the salt water but return to fresh water to spawn.

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

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 58.01.02.003.56).

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).

Autotrophic An organism is considered autotrophic if it uses carbon dioxide as its main source of carbon. This most commonly happens through photosynthesis.

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 biota, 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.
Benthos	Organisms living in and on the bottom sediments of lakes and streams. Originally, the term meant the lake bottom, but it is now applied almost uniformly to the animals associated with the lake and stream bottoms.
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.
Biologial 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).

Biota	The animal and plant life of a given region.
Biotic	A term applied to the living components of an area.
Clean Water Act (CWA)	The Federal Water Pollution Control Act (Public Law 92-50, commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987 (Public Law 100-4), 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).
Colluvium	Material transported to a site by gravity.
Community	A group of interacting organisms living together in a given place.
Conductivity	The ability of an aqueous solution to carry electric current, expressed in micro (μ) mhos/cm at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.
Cretaceous	The final period of the Mesozoic era (after the Jurassic and before the Tertiary period of the Cenozoic era), thought to have covered the span of time between 135 and 65 million years ago.
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. EPA 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).

Culturally Induced Erosion Erosion caused by increased runoff or wind action due to the work of humans in deforestation, cultivation of the land, overgrazing, and disturbance of natural drainages; the excess of erosion over the normal for an area (also see Erosion).

Debris Torrent The sudden down slope movement of soil, rock, and vegetation on steep slopes, often caused by saturation from heavy rains.

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 mm depending on the observer and methodology used. The depth sampled varies but is typically about one foot (30 cm).

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. Their presence is often indicative of fecal contamination.

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.
Eocene	An epoch of the early Tertiary period, after the Paleocene and before the Oligocene.
Eolian	Windblown, referring to the process of erosion, transport, and deposition of material by the wind.
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 Geologic 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 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).
Exotic Species	A species that is not native (indigenous) to a region.
Extrapolation	Estimation of unknown values by extending or projecting from known values.
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 bacteria (also see Coliform Bacteria).
Fecal Streptococci	A species of spherical bacteria including pathogenic strains found in the intestines of warm-blooded animals.
Feedback Loop	In the context of watershed management planning, a feedback loop is a process that provides for tracking progress toward goals and revising actions according to that progress.
Fixed-Location Monitoring	Sampling or measuring environmental conditions continuously or repeatedly at the same location.
Flow	See Discharge.
Fluvial	In fisheries, this describes fish whose life history takes place entirely in streams but migrate to smaller streams for spawning.
Focal	Critical areas supporting a mosaic of high quality habitats that sustain a diverse or unusually productive complement of native species.

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. 2000).

Fully Supporting Cold Water Reliable data indicate functioning, sustainable cold water biological assemblages (e.g., fish, macroinvertebrates, or algae), none of which have been modified significantly beyond the natural range of reference conditions (EPA 1997).

Fully Supporting but Threatened An intermediate assessment category describing water bodies that fully support beneficial uses, but have a declining trend in water quality conditions, which if not addressed, will lead to a “not fully supporting” status.

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.

Grab Sample A single sample collected at a particular time and place. It may represent the composition of the water in that water column.

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.

Growth Rate A measure of how quickly something living will develop and grow, such as the amount of new plant or animal tissue produced per a given unit of time, or number of individuals added to a population.

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. A 1^{st} field HUC is larger in size than a 2^{nd} order HUC and so on.
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.

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.

Loading 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.

Loam Refers to a soil with a texture resulting from a relative balance of sand, silt, and clay. This balance imparts many desirable characteristics for agricultural use.

Loess A uniform wind-blown deposit of silty material. Silty soils are among the most highly erodible.

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; and 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, essentially equivalent to parts per million (ppm).
Miocene	Of, relating to, or being an epoch of, the Tertiary between the Pliocene and the Oligocene periods, or the corresponding system of rocks.
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	A condition indistinguishable from that without human-caused disruptions.
Nitrogen	An element essential to plant growth, and thus is considered a nutrient.
Nodal	Areas that are separated from focal and adjunct habitats, but serve critical life history functions for individual native fish.
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 silverculture; 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 Attainable	A concept and an assessment category describing water bodies that demonstrate characteristics that make it unlikely that a beneficial use can be attained (e.g., a stream that is dry but designated for salmonid spawning).
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. 2000).
Not Fully Supporting Cold Water	At least one biological assemblage has been significantly modified beyond the natural range of its reference condition (EPA 1997).
Nuisance	Anything which 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.

Organisms per 100ml The total number of colonies or colony forming units of *E-coli* bacteria per 100 milliliters of solution.

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 which consume oxygen during decomposition.

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

Partitioning The sharing of limited resources by different races or species; use of different parts of the habitat, or the same habitat at different times. Also the separation of a chemical into two or more phases, such as partitioning of phosphorus between the water column and sediment.

Bacteria Disease-producing organisms (e.g., bacteria, viruses, parasites).

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.
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.
Pretreatment	The reduction in the amount of pollutants, elimination of certain pollutants, or alteration of the nature of pollutant properties in wastewater prior to, or in lieu of, discharging or otherwise introducing such wastewater into a publicly owned wastewater treatment plant.
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.
Quality Assurance (QA)	A program organized and designed to provide accurate and precise results. Included are the selection of proper technical methods, tests, or laboratory procedures; sample collection and preservation; the selection of limits; data evaluation; quality control; and personnel qualifications and training. The goal of QA is to assure the data provided are of the quality needed and claimed (Rand 1995, EPA 1996).
Quality Control (QC)	Routine application of specific actions required to provide information for the quality assurance program. Included are standardization, calibration, and replicate samples. QC is implemented at the field or bench level (Rand 1995, EPA 1996).
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.

Resident	A term that describes fish that do not migrate.
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.
River	A large, natural, or human-modified stream that flows in a defined course or channel, or a series of diverging and converging channels.
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.
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.
Spring	Ground water seeping out of the earth where the water table intersects the ground surface.
Stagnation	The absence of mixing in a water body.
Stratification	An Idaho Department of Environmental Quality classification method used to characterize comparable units (also called classes or strata).
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.
Stream Protection Zone	Under the Idaho Forest Practice Act this is a mandated 75-foot minimum distance from a Class I stream, lake or other water body that is protected, includes the riparian areas.
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 mm 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).
Tertiary	An interval of geologic time lasting from 66.4 to 1.6 million years ago. It constitutes the first of two periods of the Cenozoic Era, the second being the Quaternary. The Tertiary has five subdivisions, which from oldest to youngest are the Paleocene, Eocene, Oligocene, Miocene, and Pliocene epochs.
Thalweg	The center of a stream's current, where most of the water flows.
Threatened Species	Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.
Total Maximum Daily Load (TMDL)	A TMDL is a water body's loading 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. TMDL = Loading Capacity = Load Allocation + Waste Load Allocation + Margin of Safety. 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 (Greenborg, Clescevi, and Eaton 1995) call for using a filter of 2.0 micron 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.

Trophic State The level of growth or productivity of a lake as measured by phosphorus content, chlorophyll *a* concentrations, amount (biomass) of aquatic vegetation, algal abundance, and water clarity.

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.

Waste Load Allocation (WLA) The portion of receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. Waste load 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.

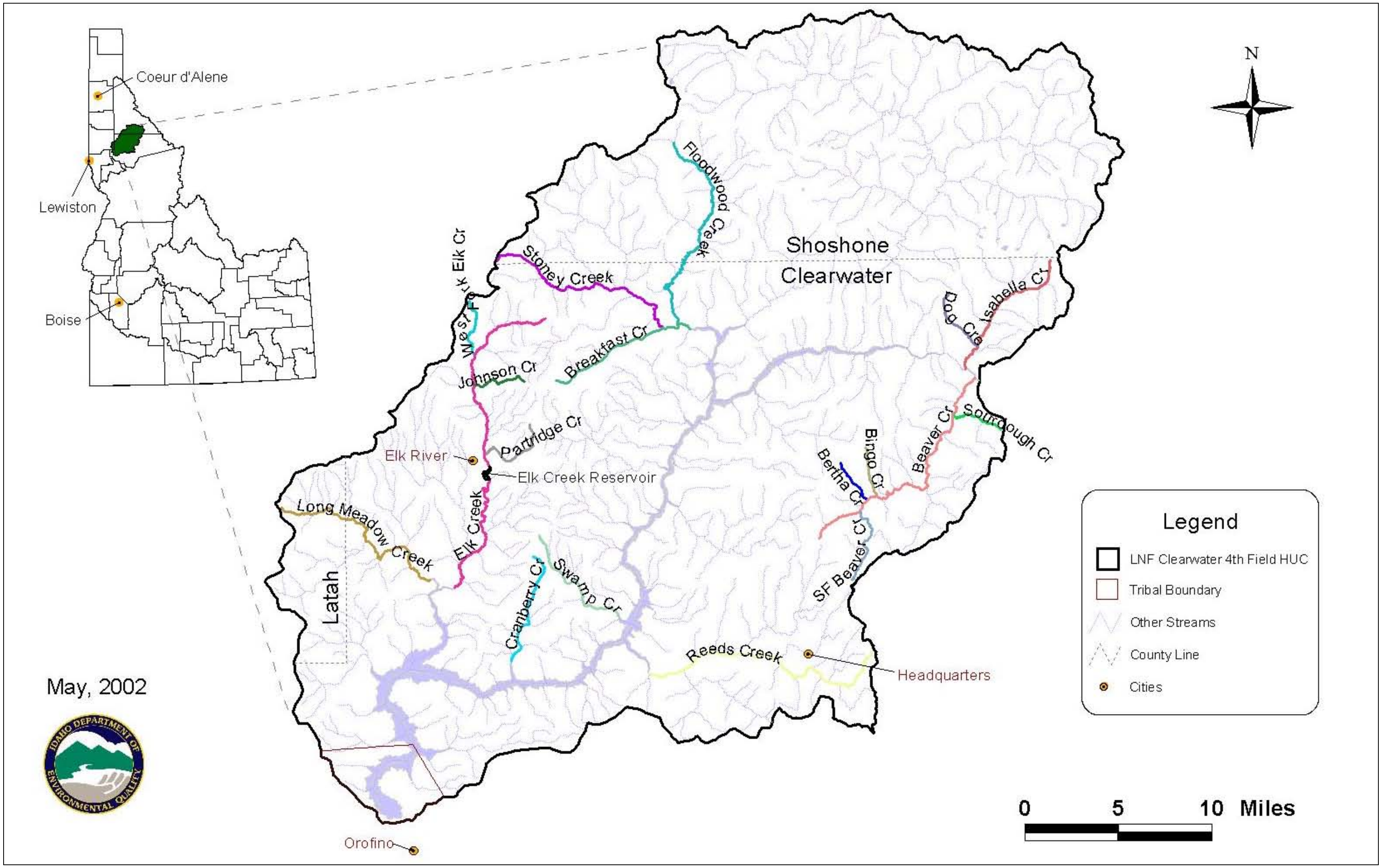
Water Quality	A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.
Water Quality Criteria	Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific 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 limited segments may or may not be on a 303(d) list.
Water Quality Limited Segment (WQLS)	Any segment placed on a state's 303(d) list for failure to meet applicable water quality standards, and/or is not expected to meet applicable water quality standards in the period prior to the next list. These segments are also referred to as "303(d)-listed."
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 EPA-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.
Water Table	The upper surface of ground water; below this point, the soil is saturated with water.
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.
Water Body Identification Number (WBID)	A number that uniquely identifies a water body in Idaho ties in to the Idaho Water Quality Standards and GIS information.

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.

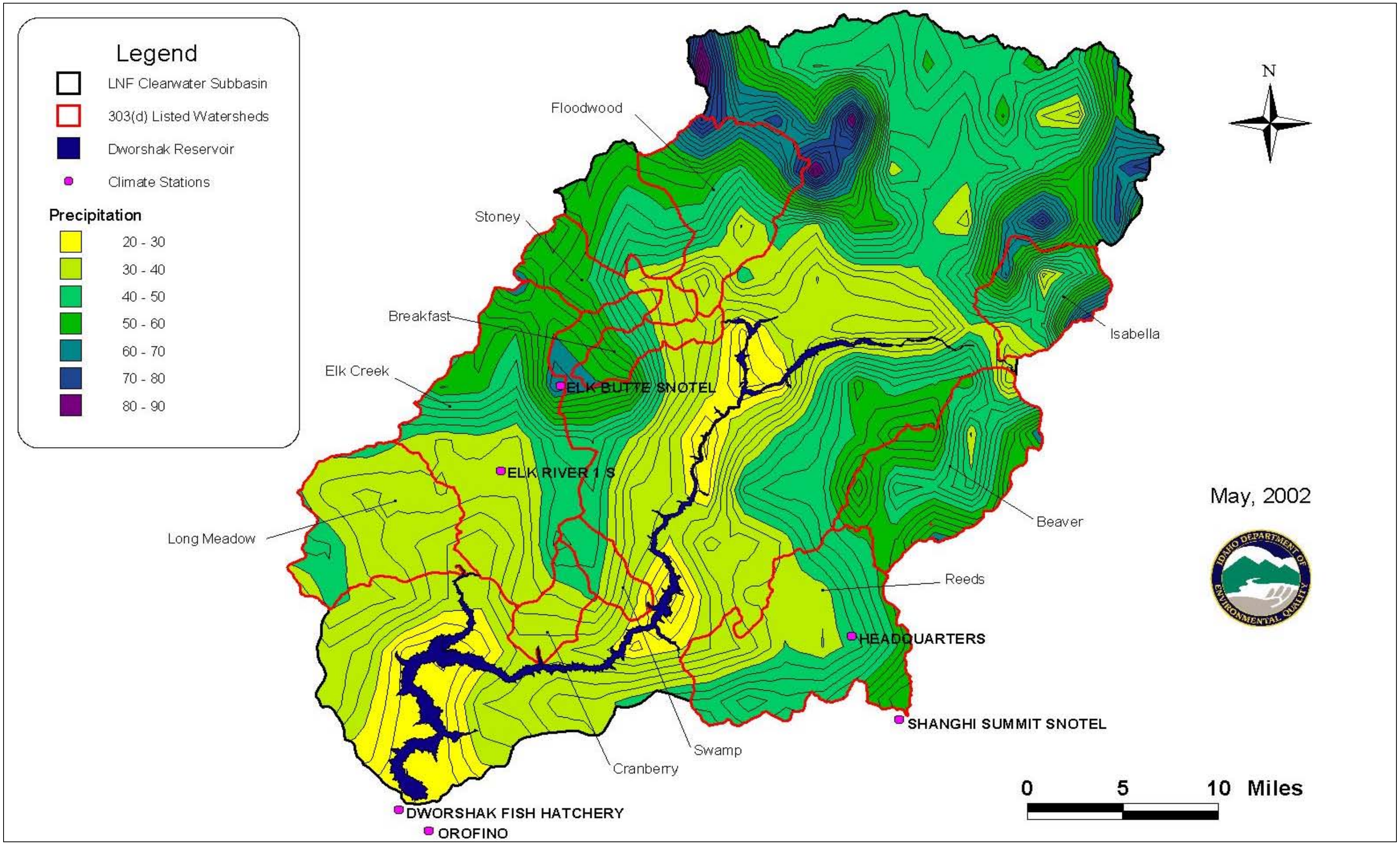
Young of the Year Young fish born the year captured, evidence of spawning activity.

Appendix A. Maps

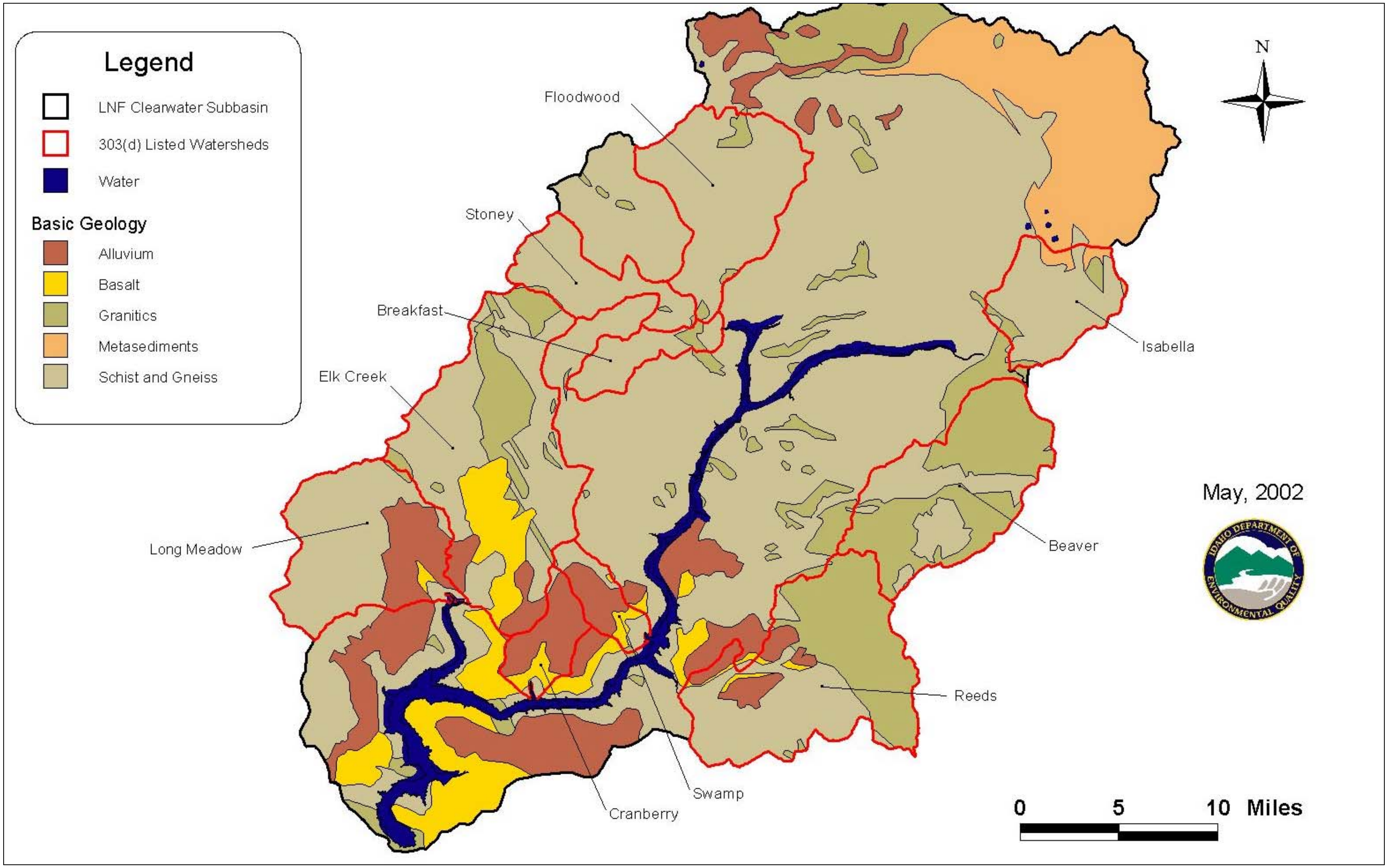
Map 1. Location of the Lower North Fork Clearwater River, Hydrological Unit 17060308, and 303(d) listed streams.



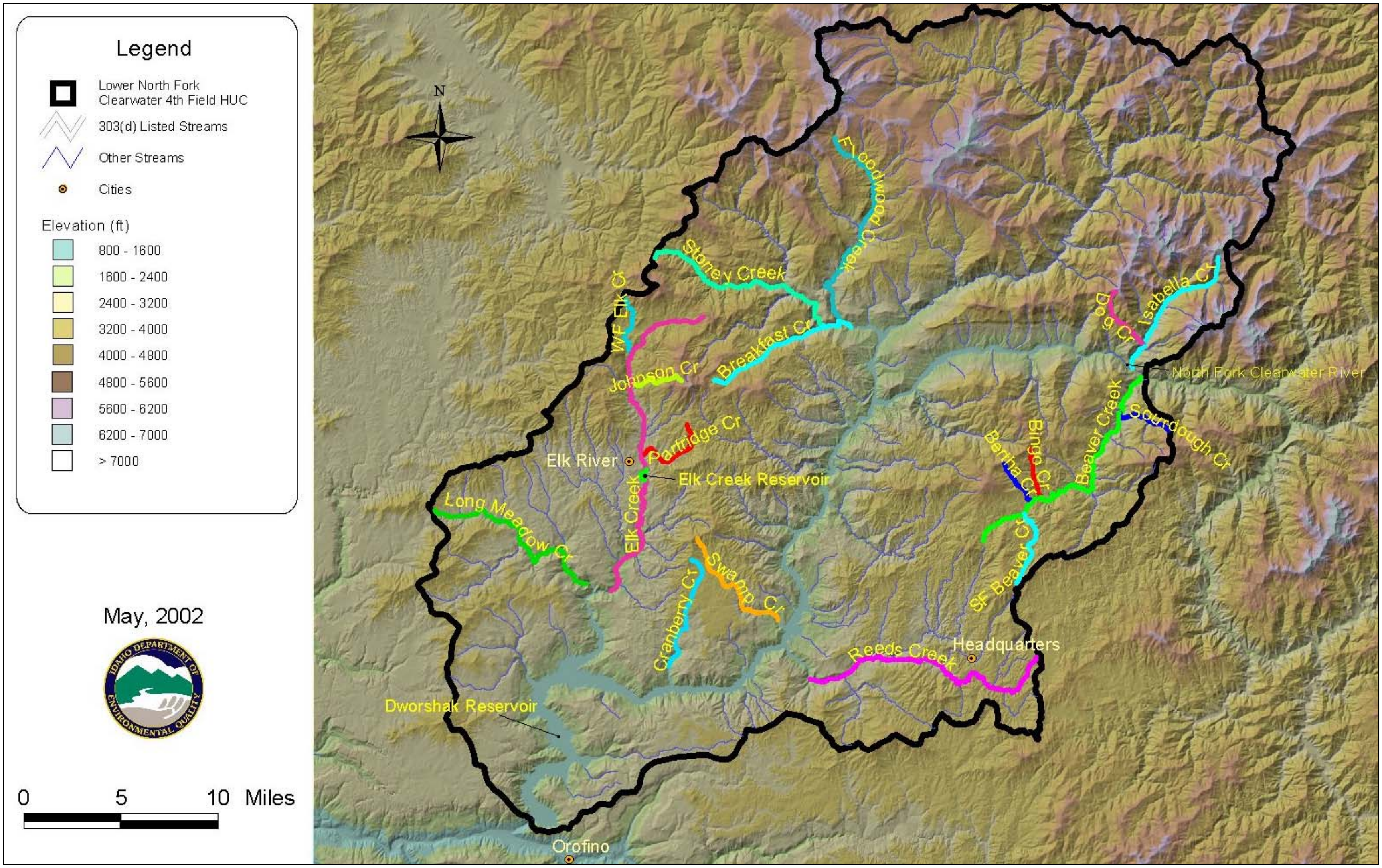
Map 2. Precipitation and Climate Stations for the Lower North Fork Clearwater River Subbasin.



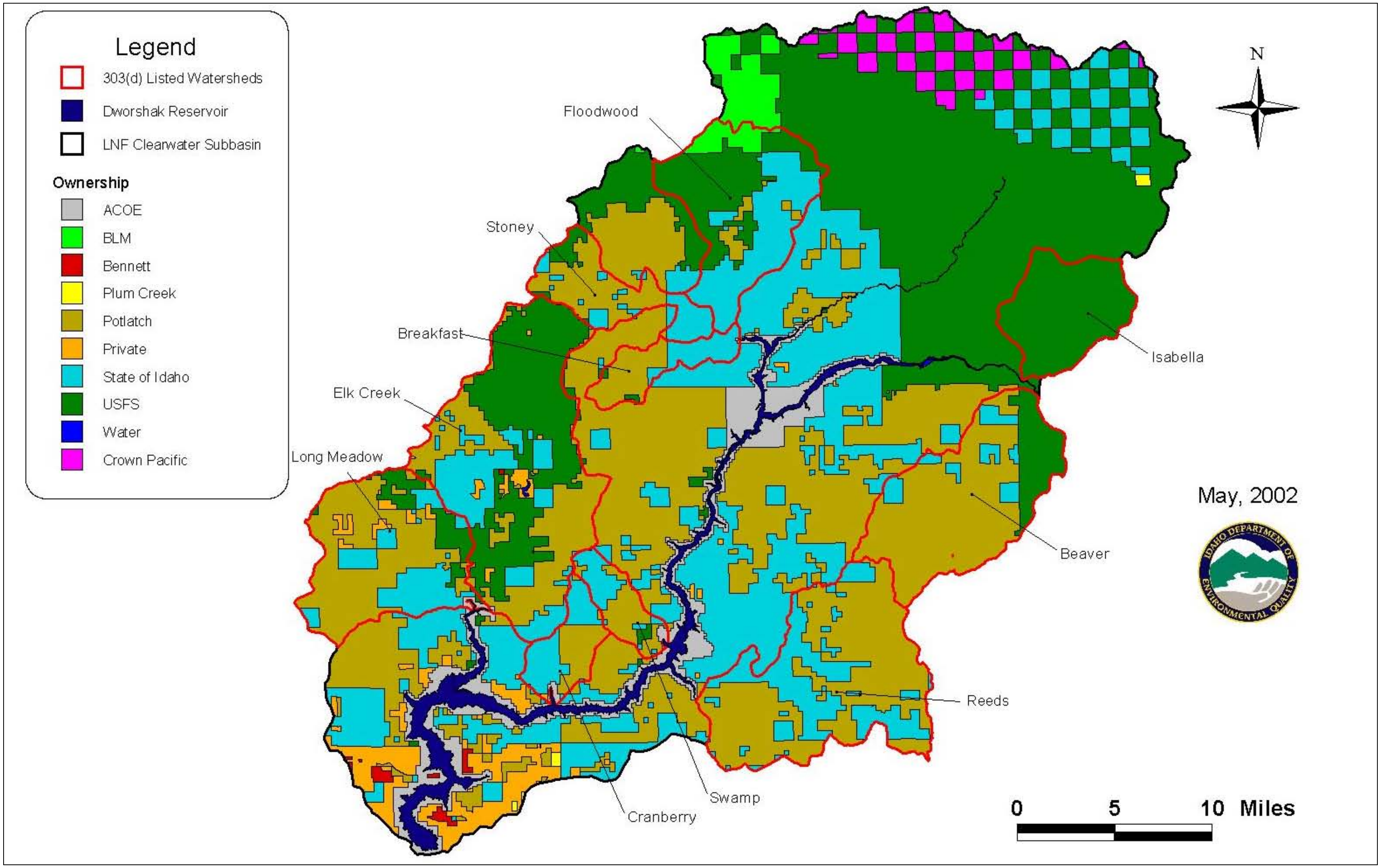
Map 3. Basic Geology for the Lower North Fork Clearwater River Subbasin.



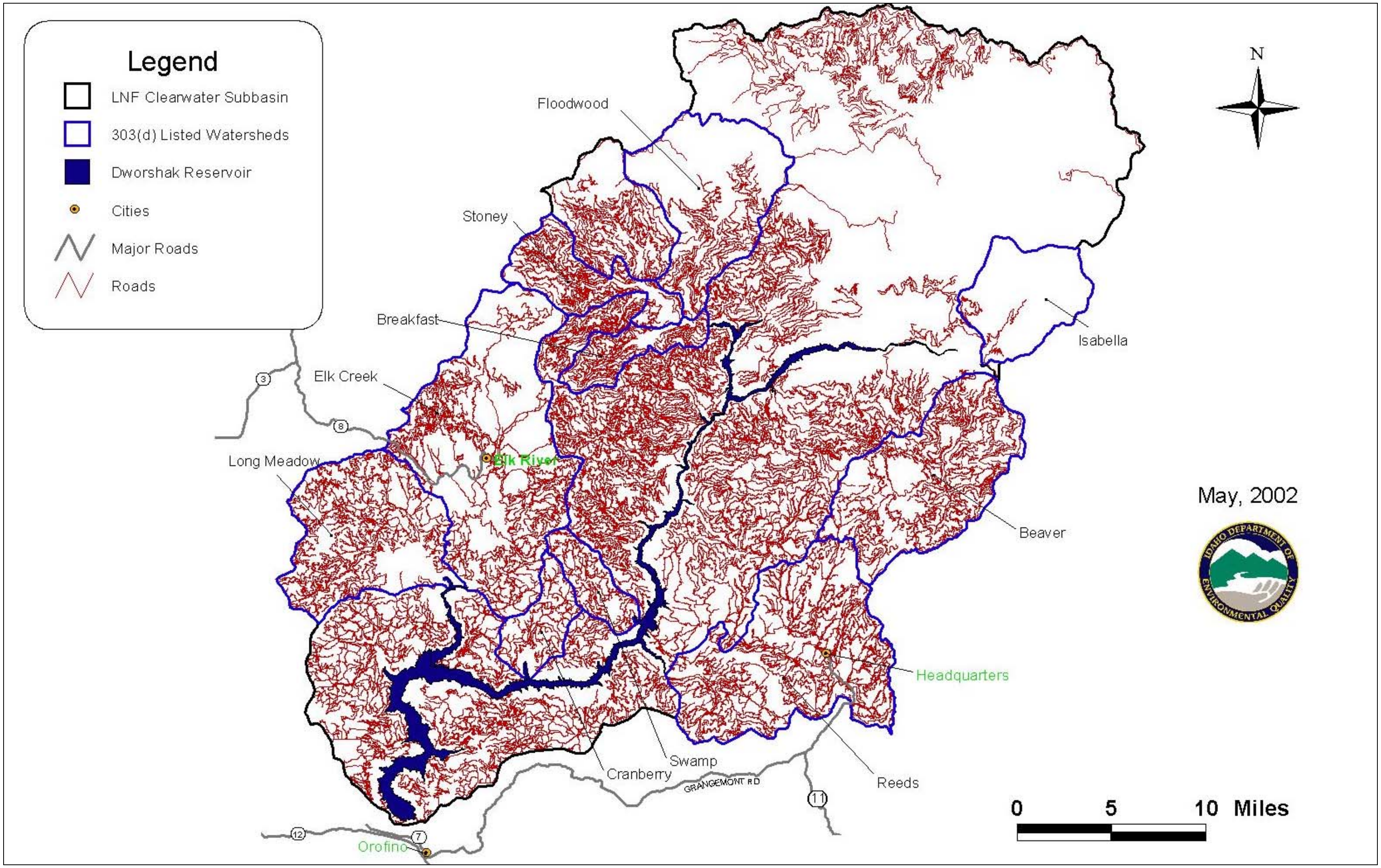
Map 4. Topographic Relief Map of the Lower North Fork Clearwater River Subbasin.



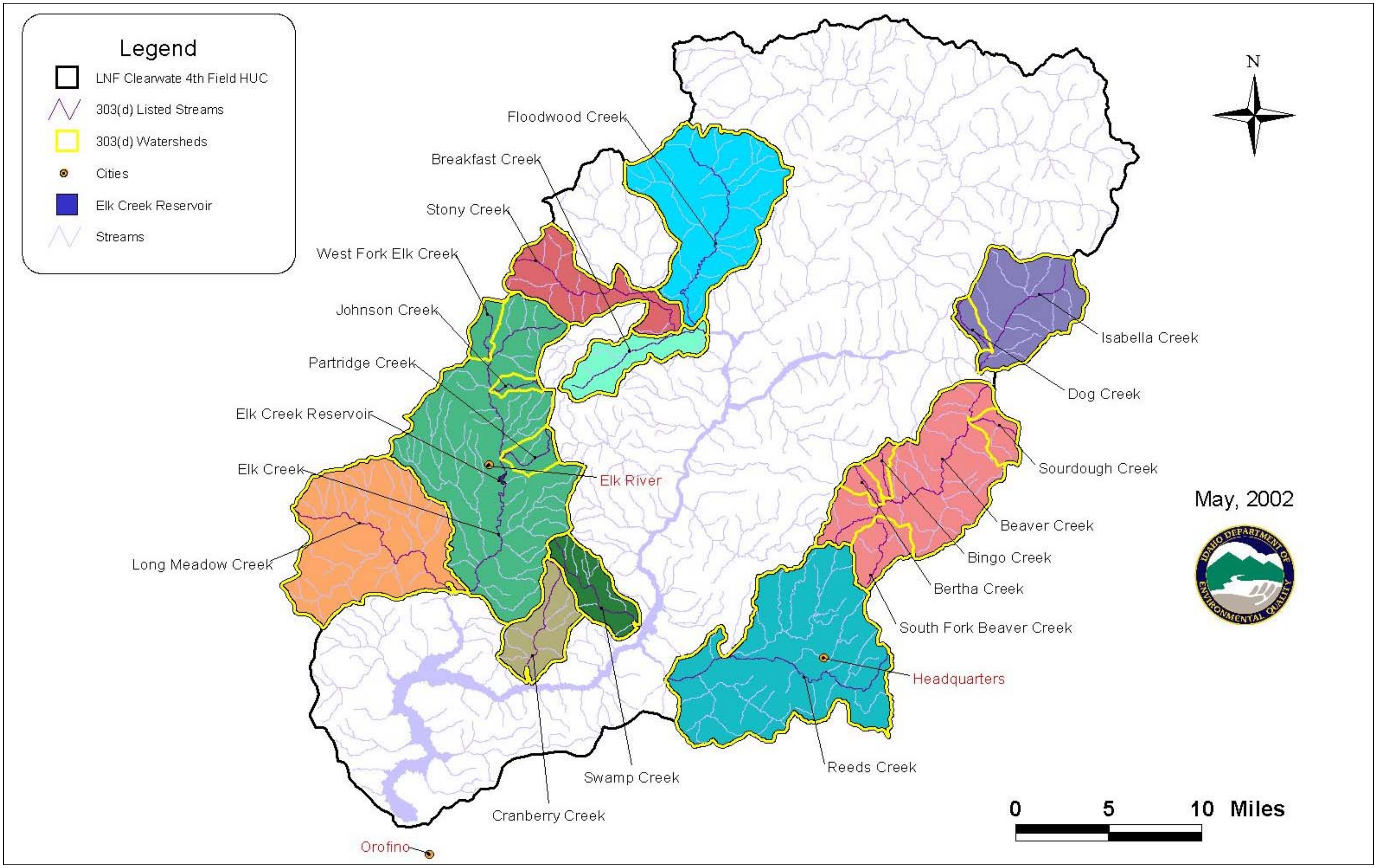
Map 5. Ownership of the Lower North Fork Clearwater River Subbasin.



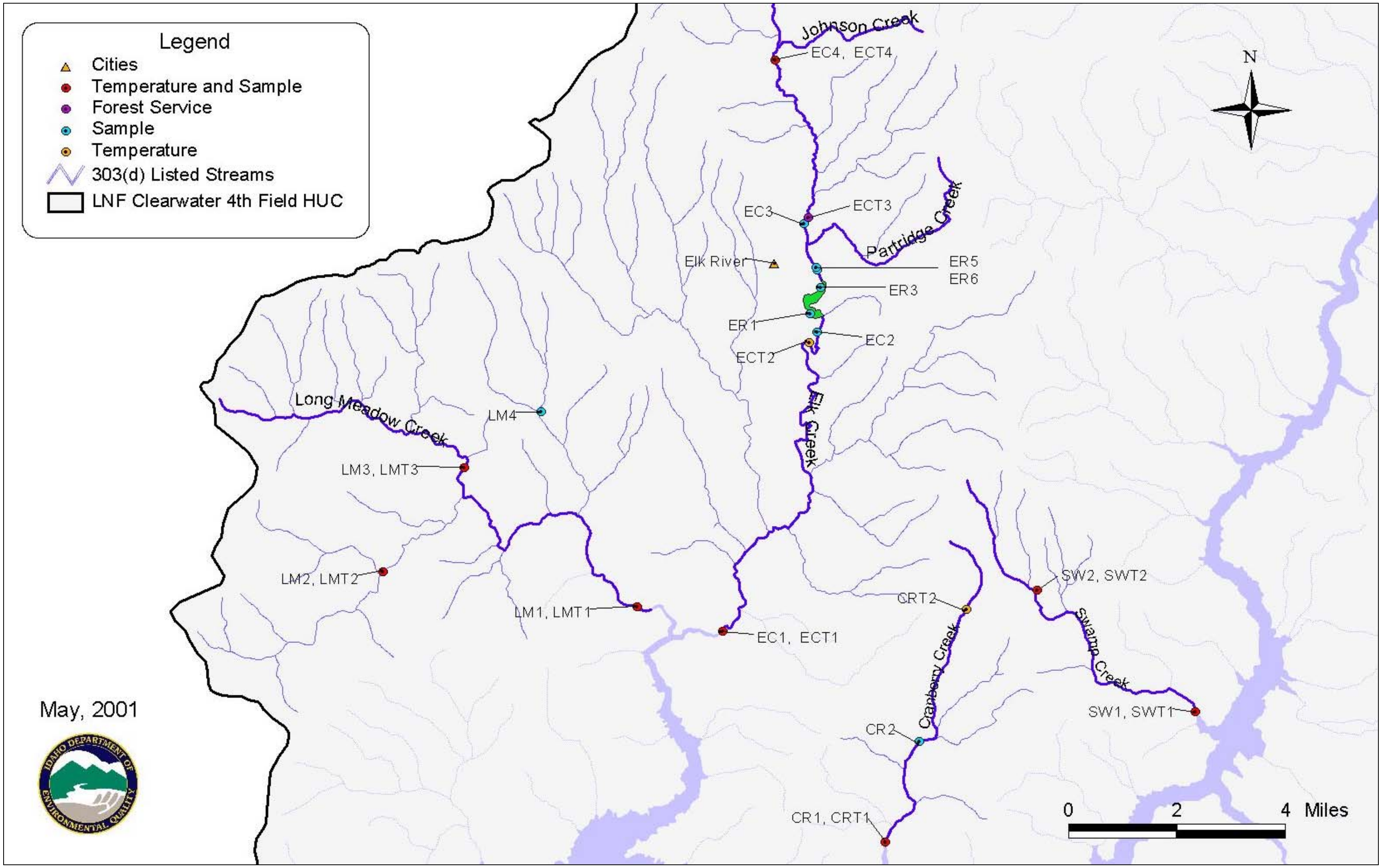
Map 6. Roads in the Lower North Fork Clearwater River Subbasin.



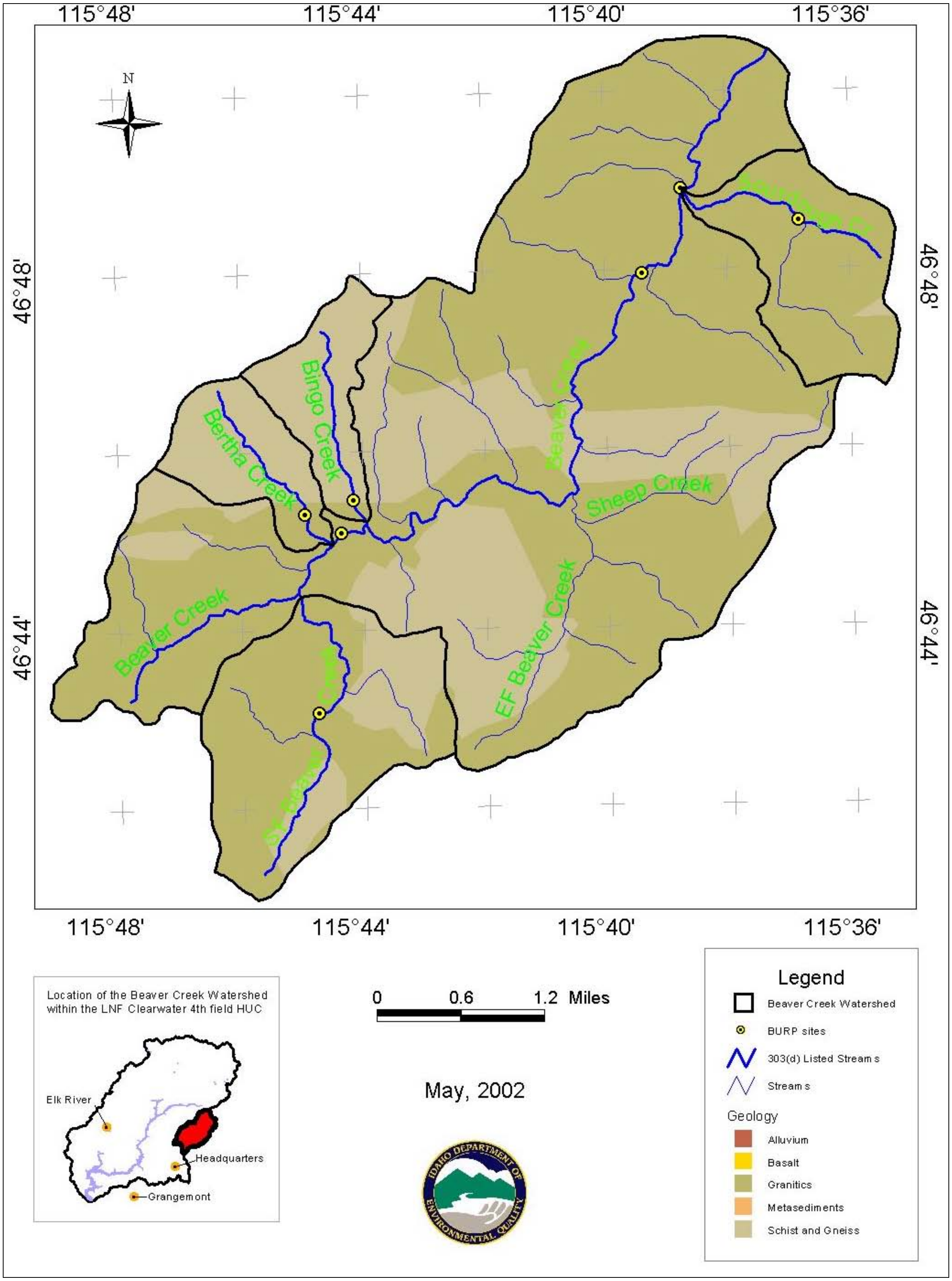
Map 7. Geographical location of the 303(d) listed waterbodies and watersheds.



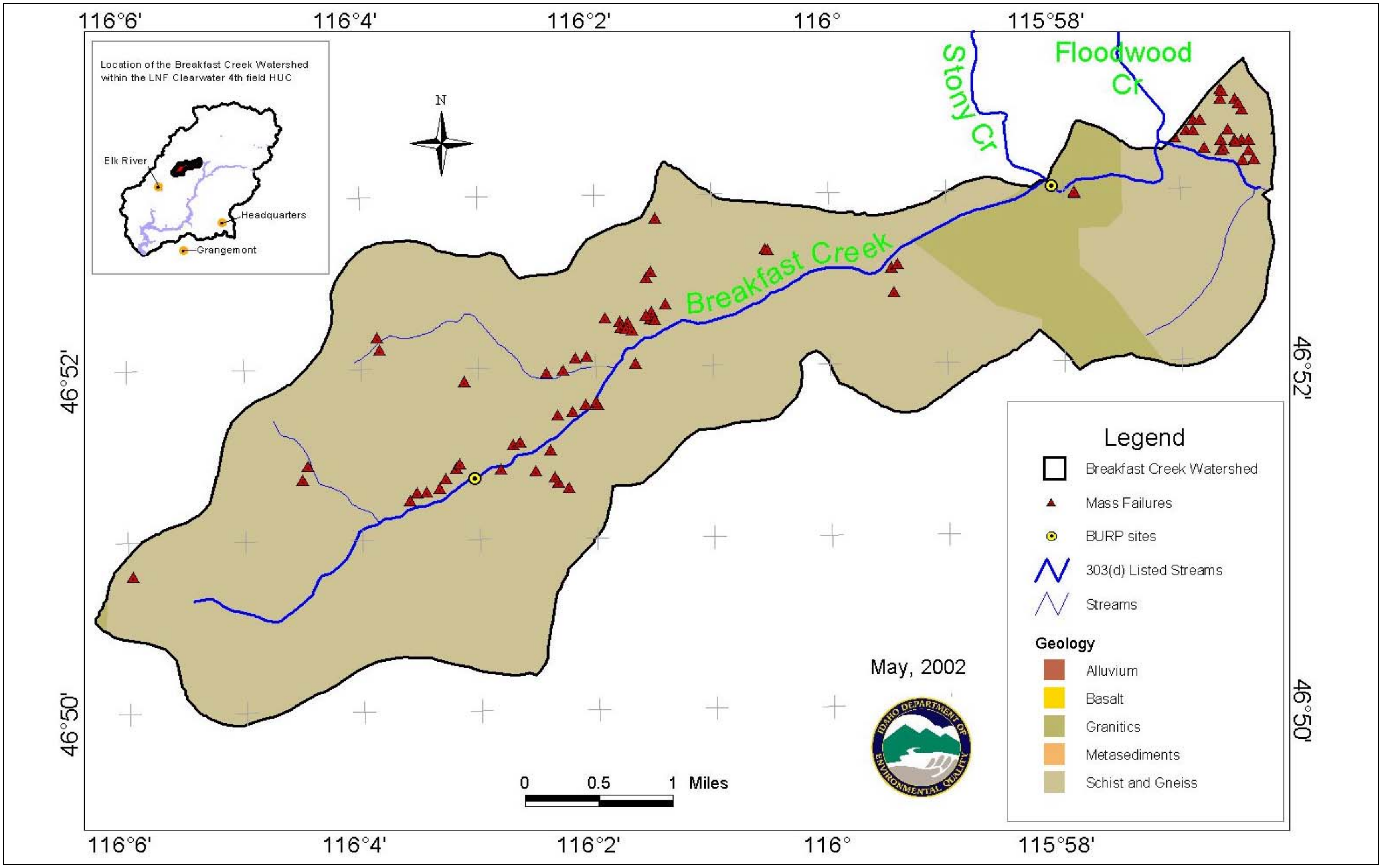
Map 8. Sample locations for the Lower North Fork Clearwater River Subbasin.



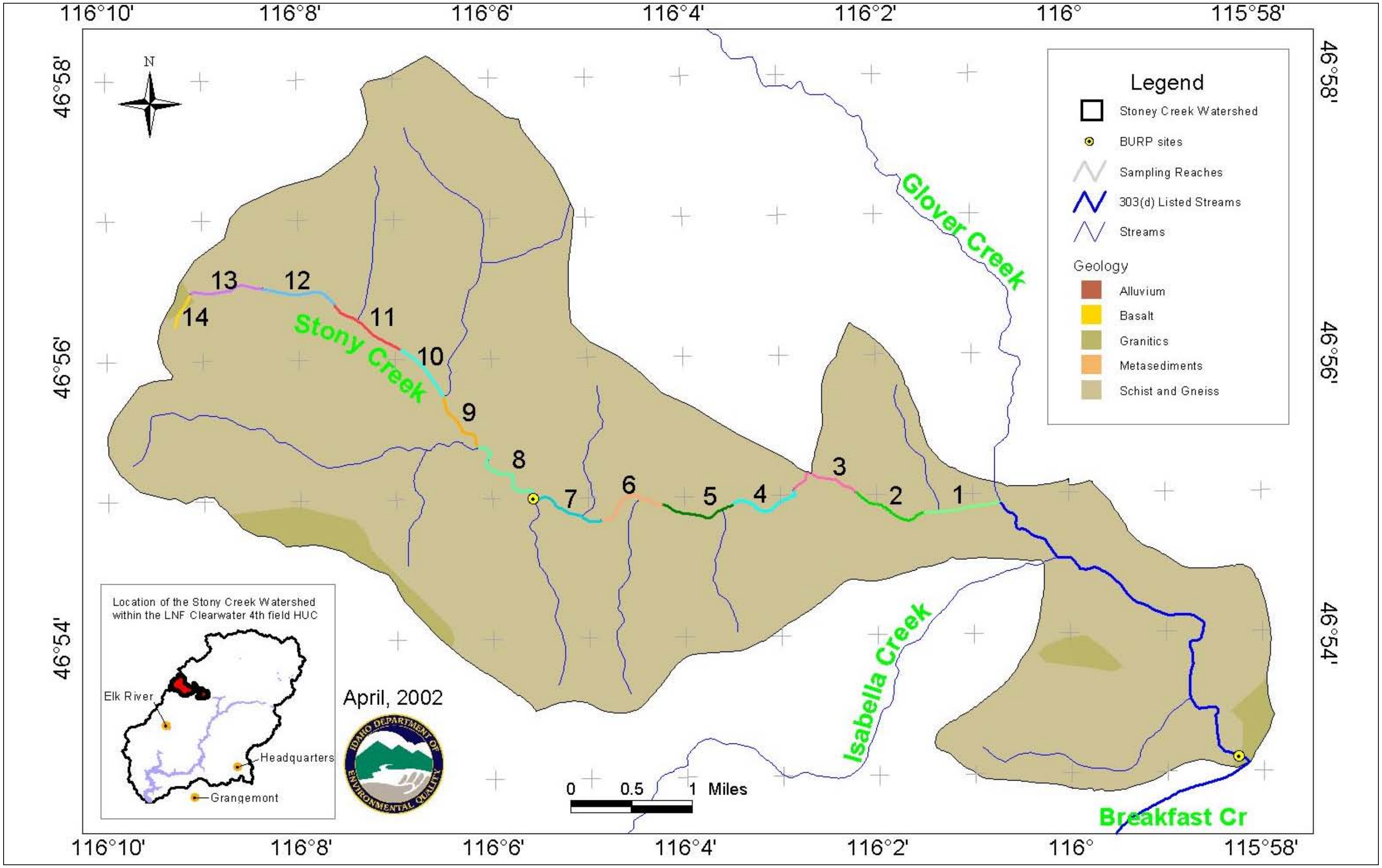
Map 9. Beaver Creek Watershed.



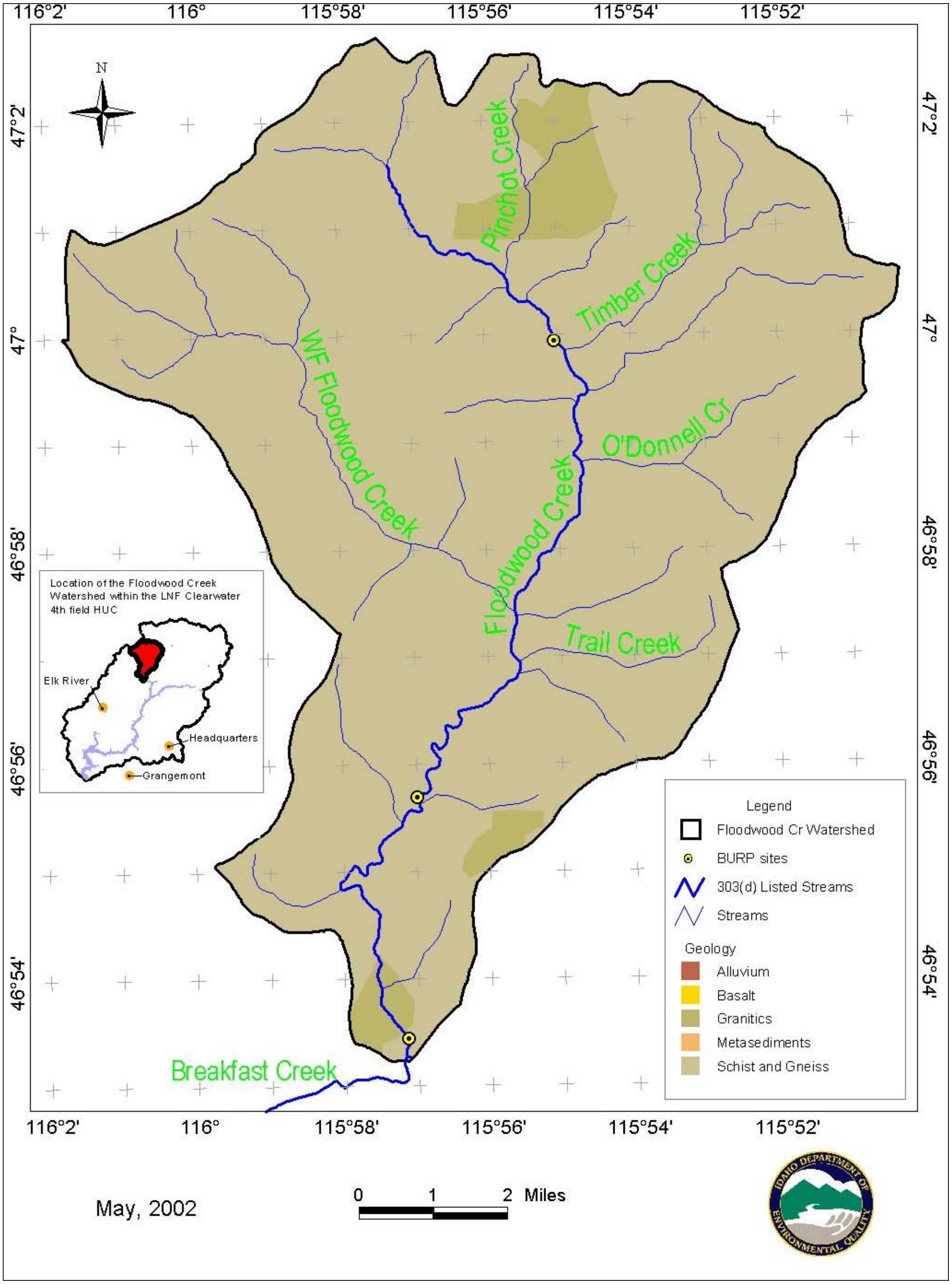
Map 10. Breakfast Creek Watershed.



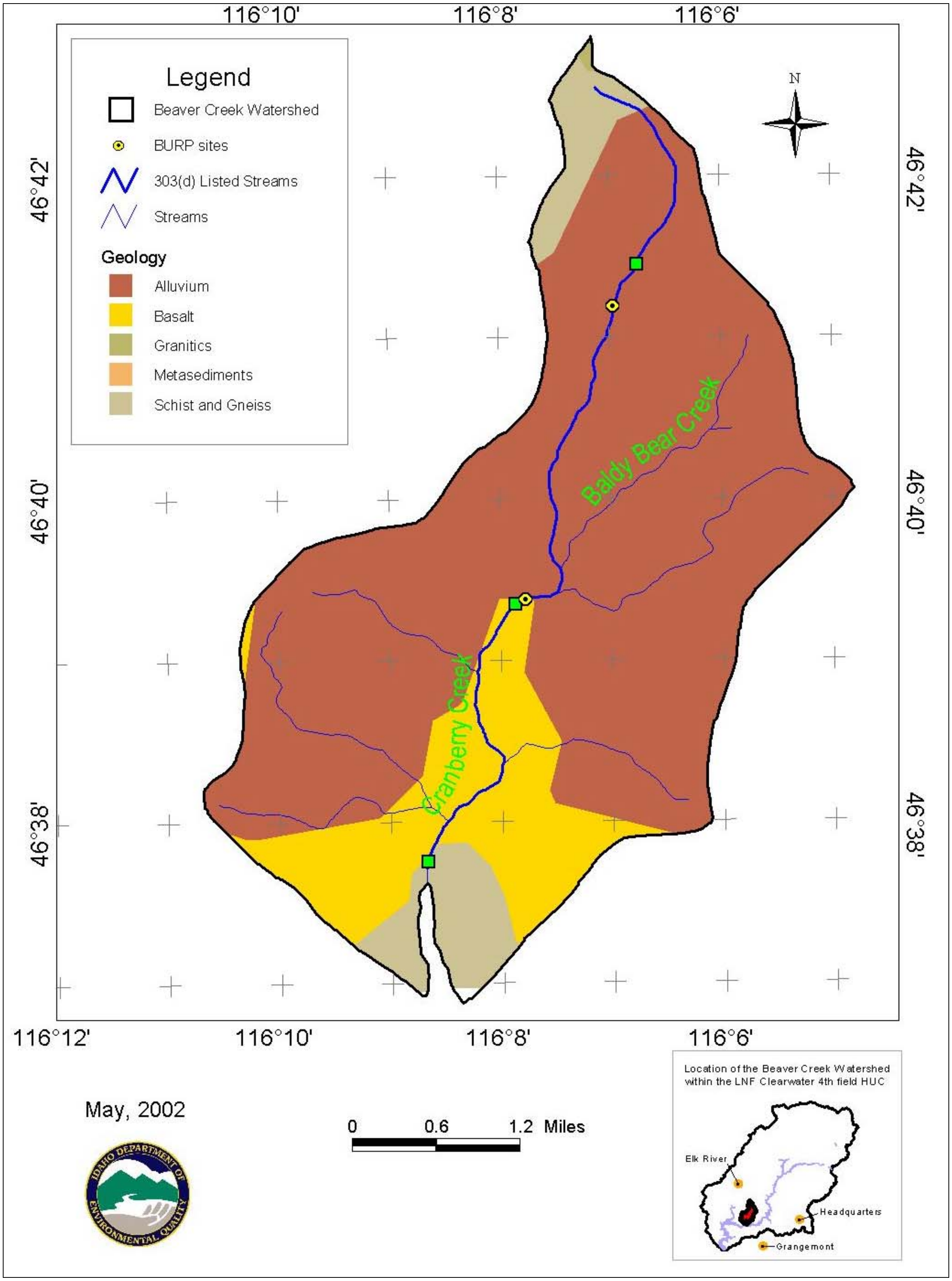
Map 11. Stony Creek Watershed.



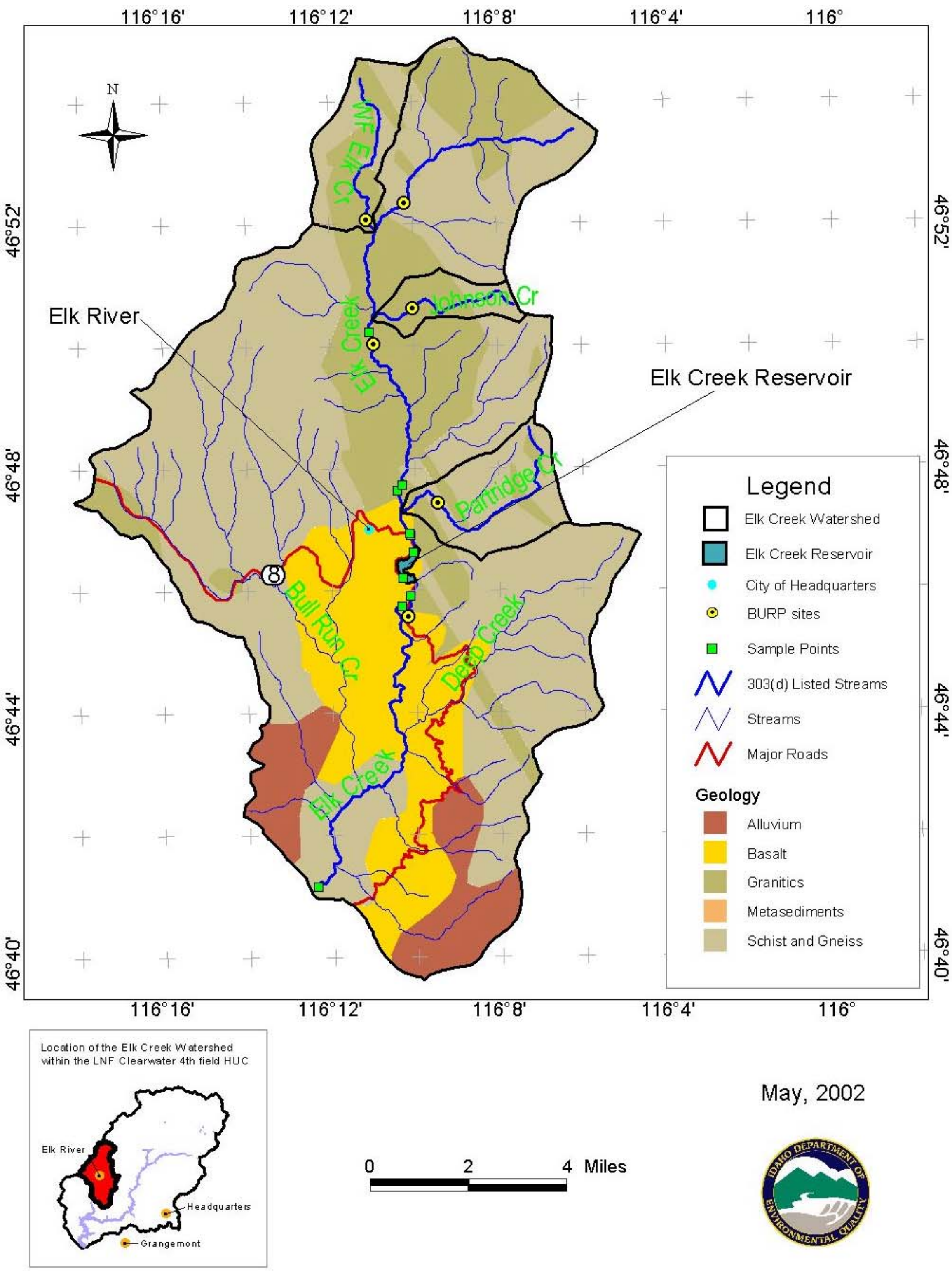
Map 12. Floodwood Creek Watershed.



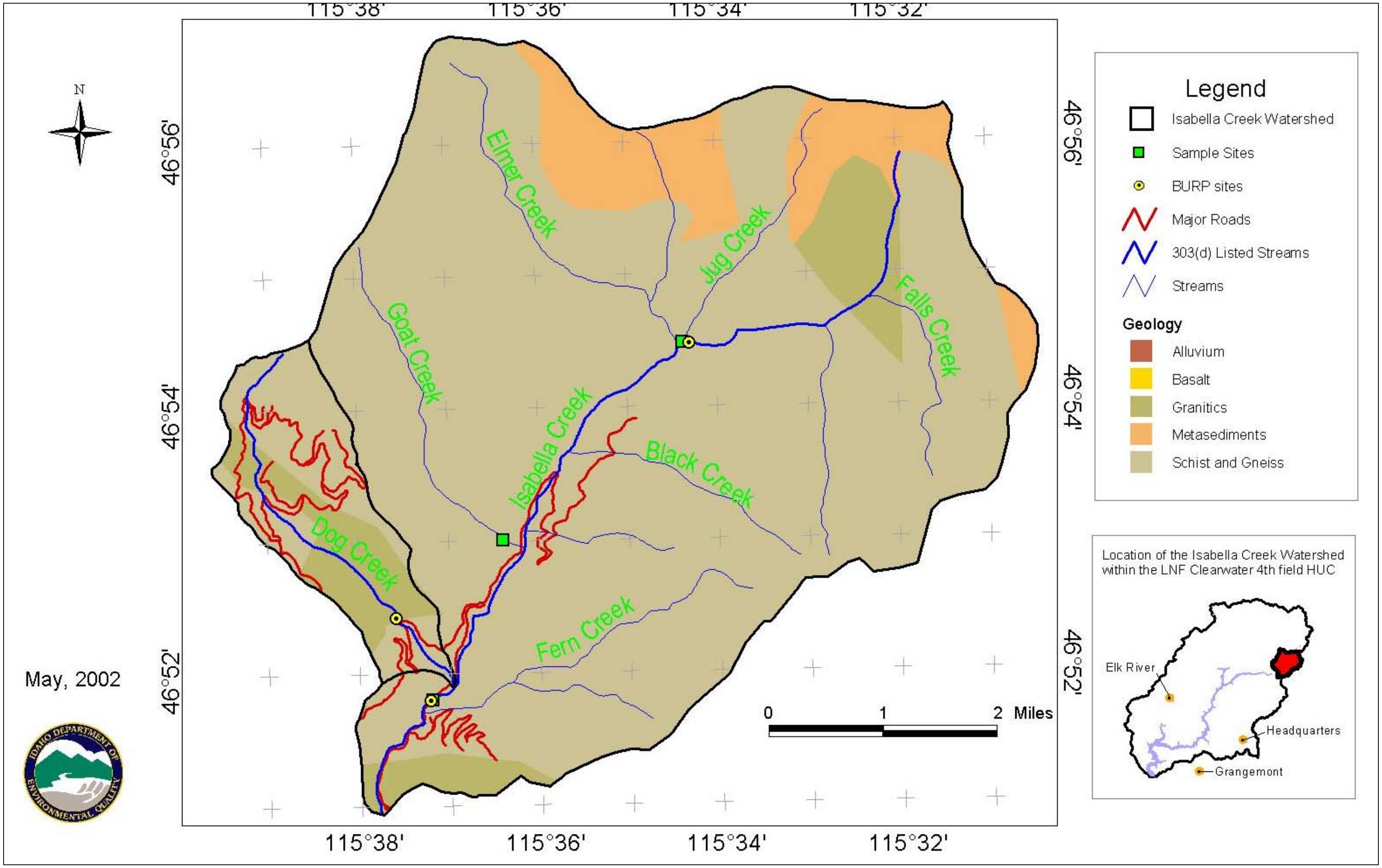
Map 13. Cranberry Creek Watershed.



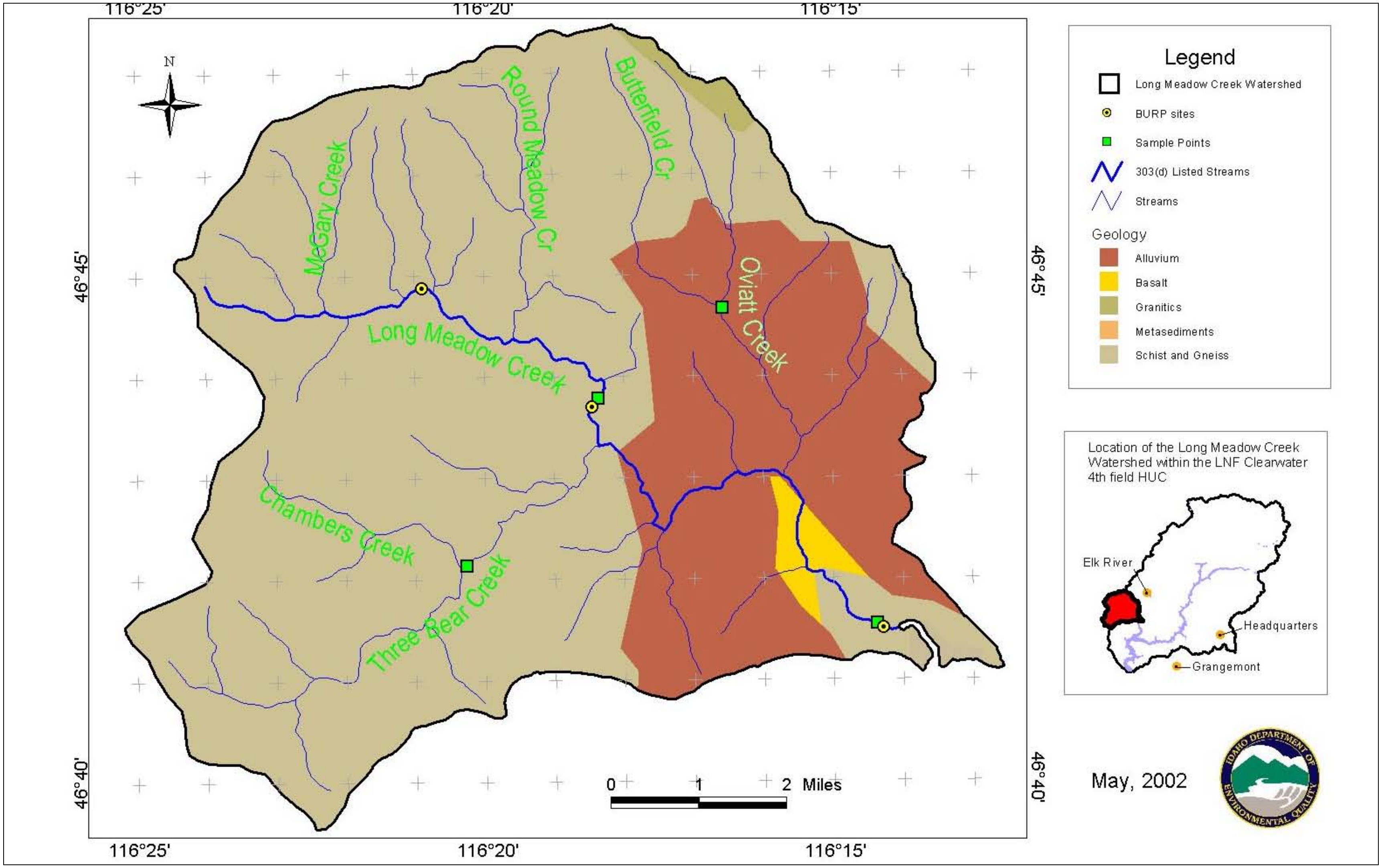
Map 14. Elk Creek Watershed.



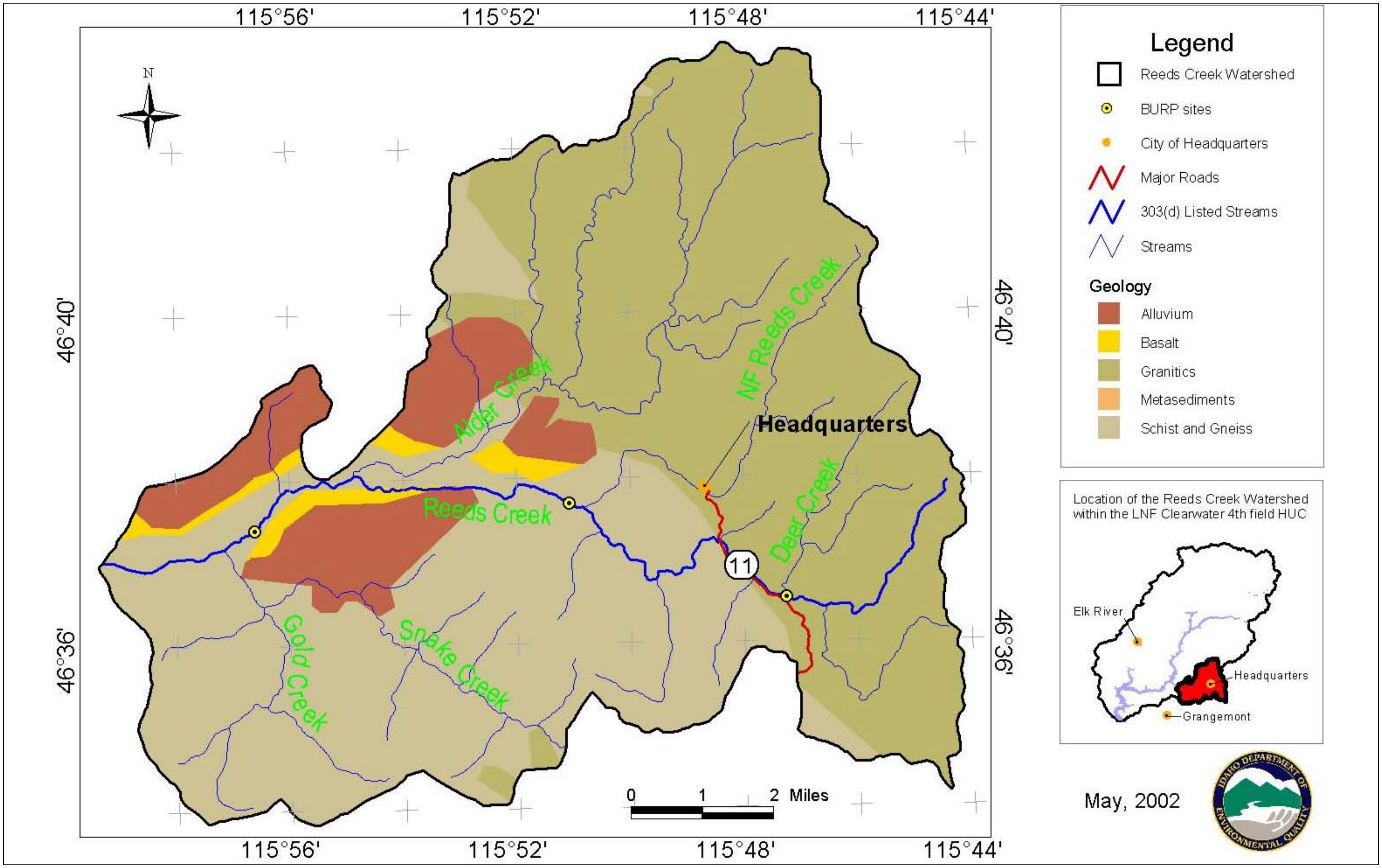
Map 15. Isabella Creek Watershed.



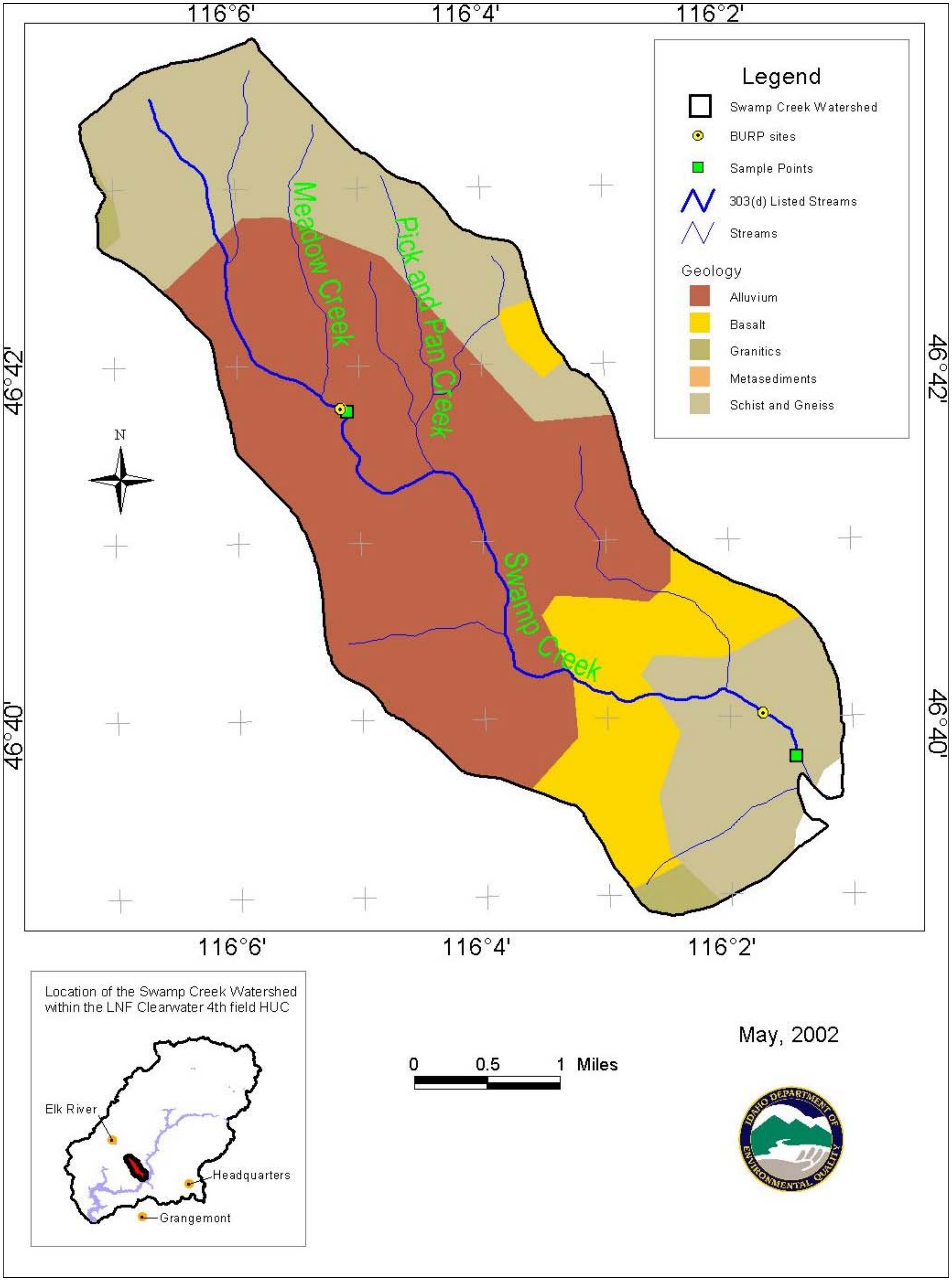
Map 16. Long Meadow Creek Watershed.



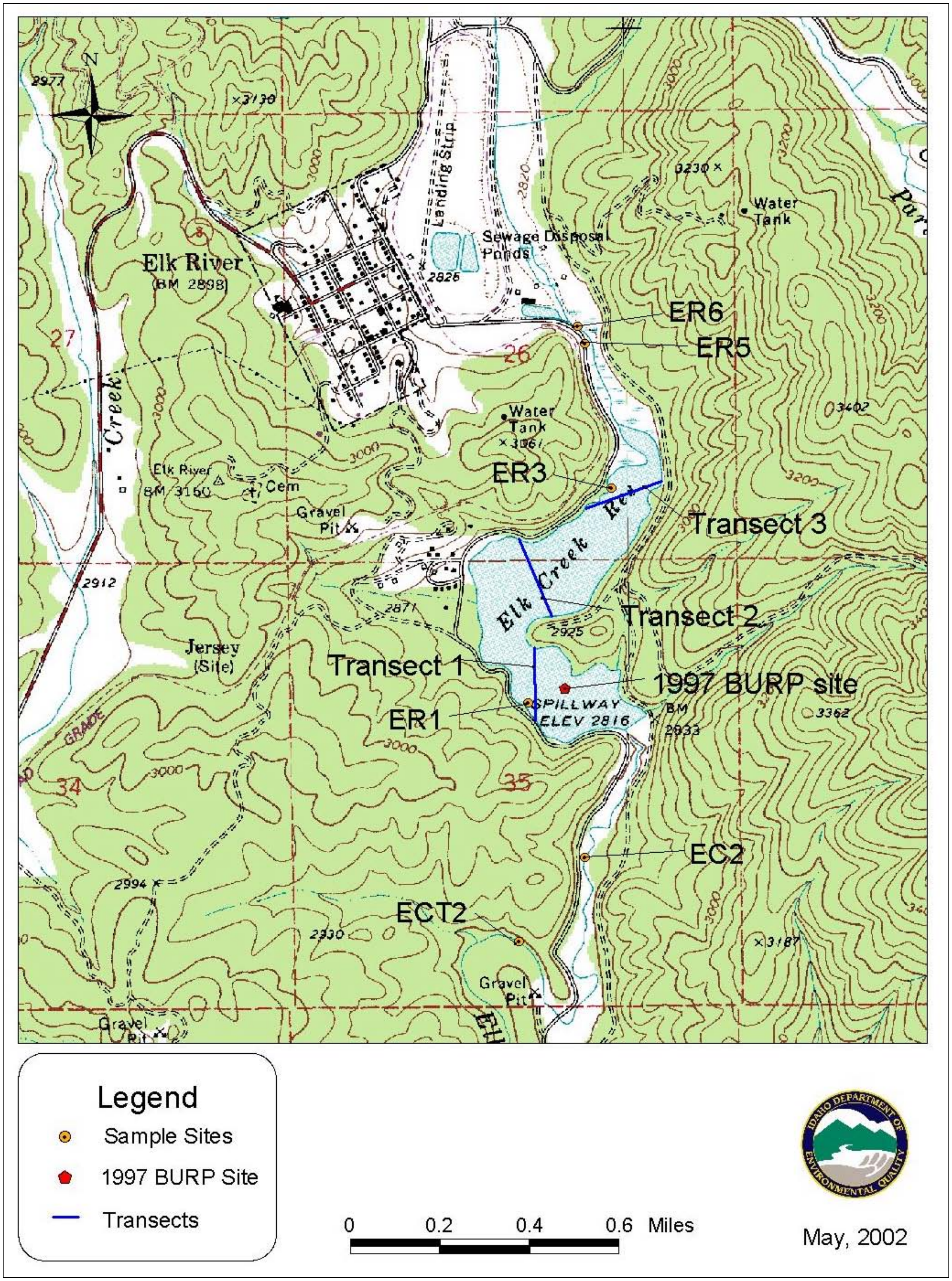
Map 17. Reeds Creek Watershed.



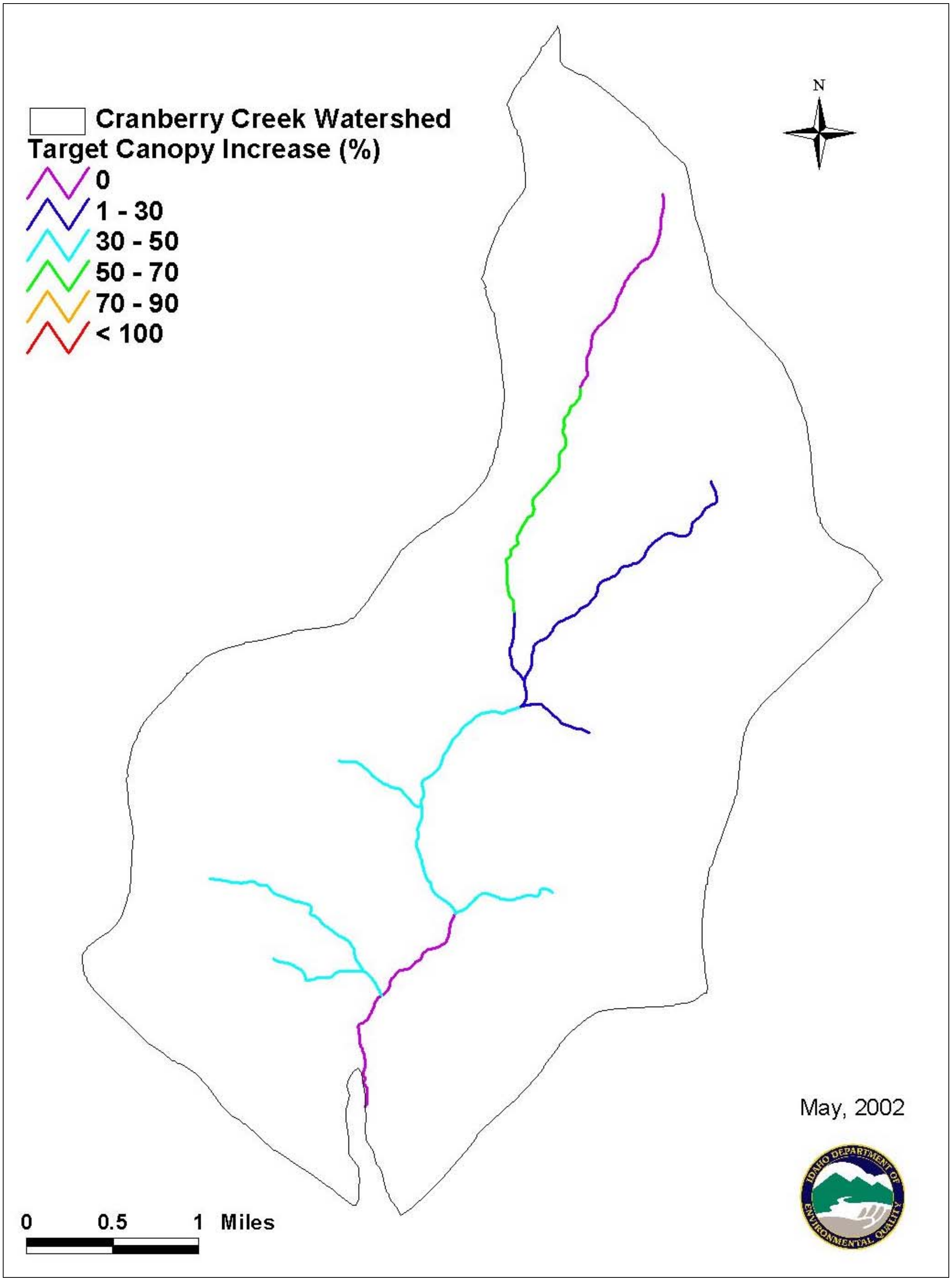
Map 18. Swamp Creek Watershed.



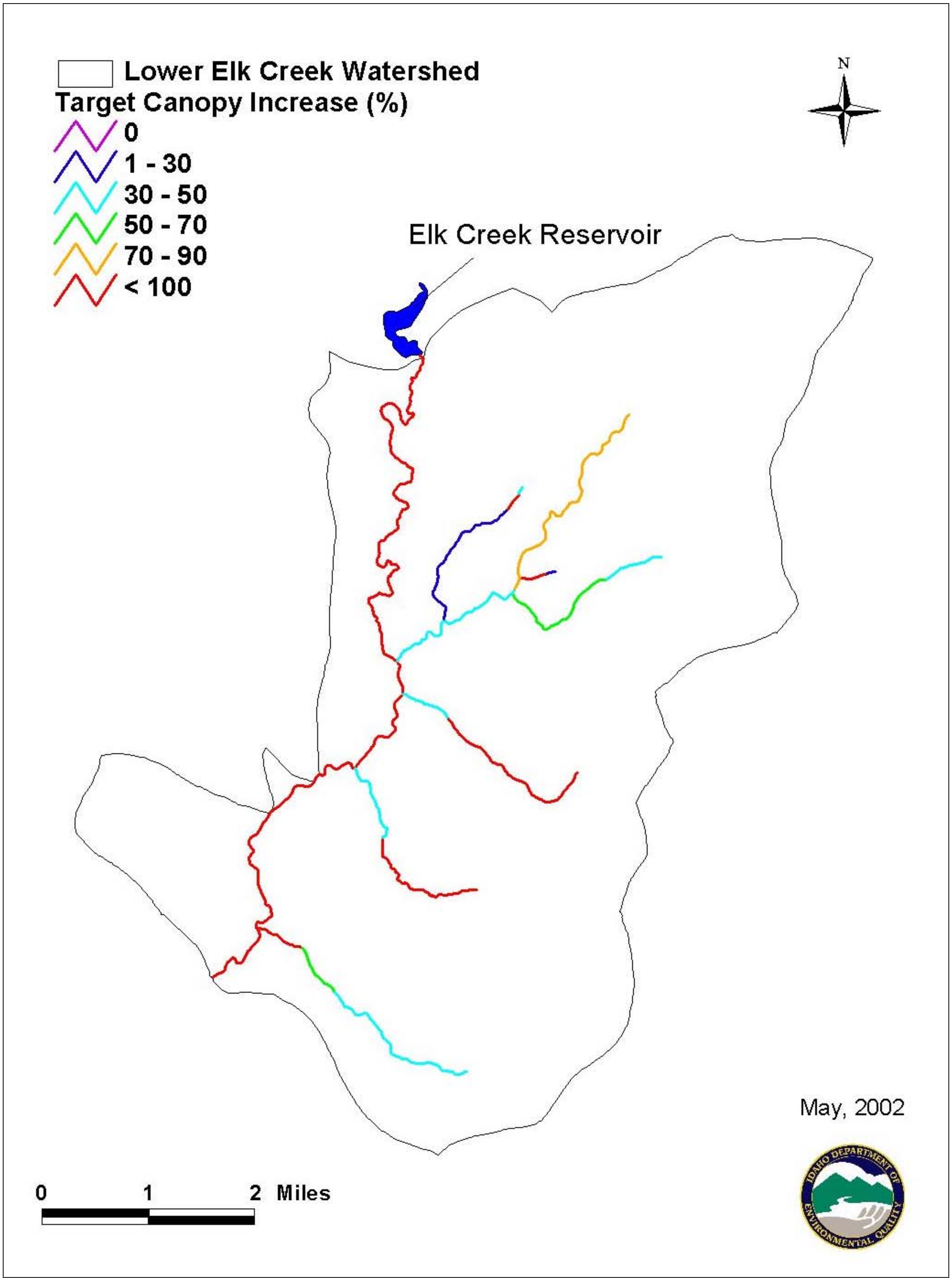
Map 19. Elk Creek Reservoir.



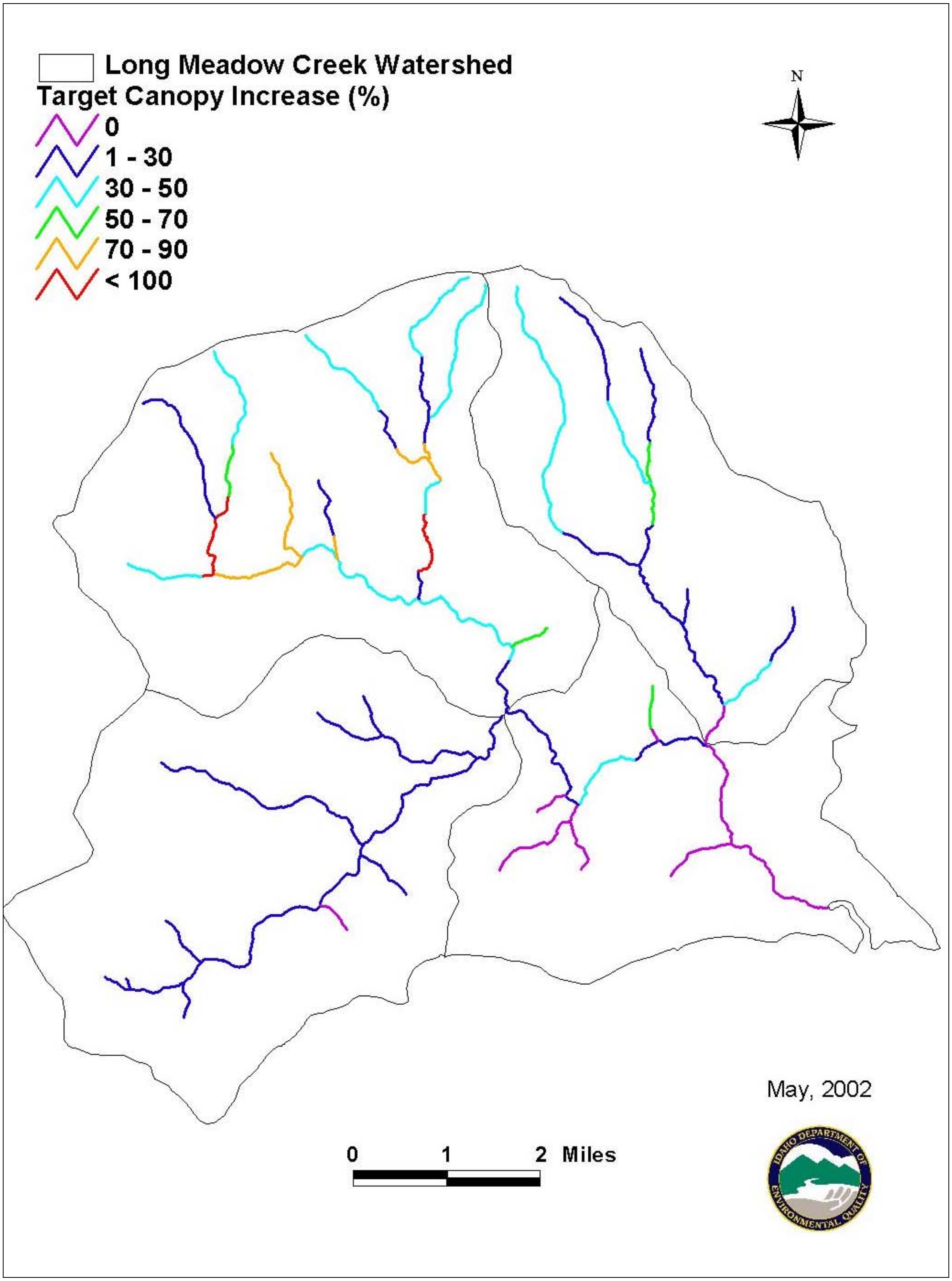
Map 20. Cranberry Creek Watershed Target Canopy Increase (%).



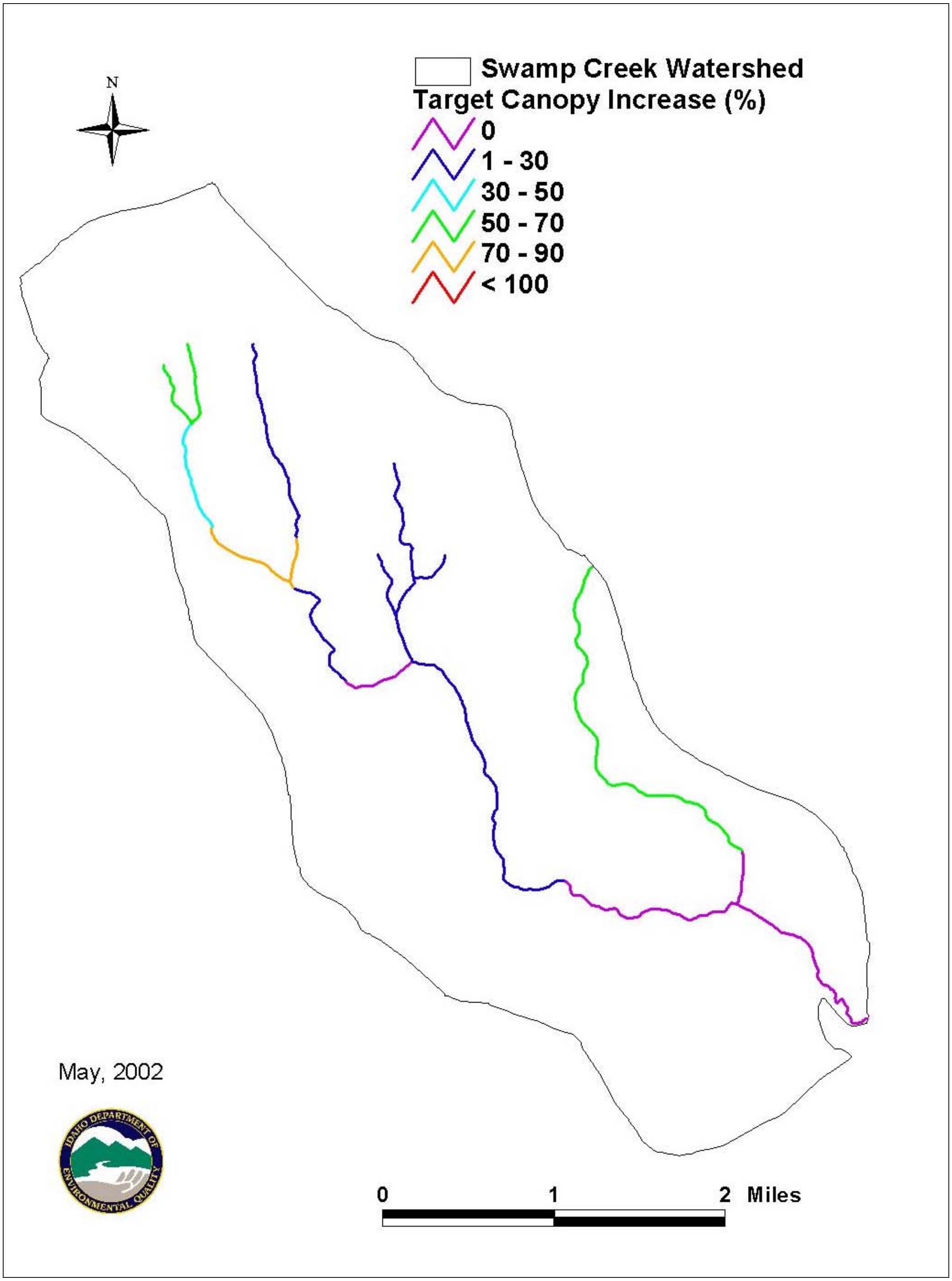
Map 21. Lower Elk Creek Watershed Target Canopy Increase (%).



Map 22. Long Meadow Creek Watershed Target Canopy Increase (%).



Map 23. Swamp Creek Watershed Target Canopy Increase (%).



Appendix B. Tables

Table B-1. Stony Creek fish data results July 30 and 31 2001.

	Species	# Age Classes	Total # of Fish	TemperatureºC
Site 1	RBT[1]	3+j[4]	16	11.5
Site 2	RBT, CTT[2]	3+j	13	11.5
Site 3	CTT	3+j	16	12.2
Site 4	CTT, RBTxCTT[3]	3+j	34	11.5
Site 5	RBT, RBTxCTT	3+j	12	7.3
Site 6	CTT	3+j	19	13.0
Site 7	CTT, RBTxCTT	3+j	27	11.5
Site 8	CTT, RBTxCTT	3+j	31	11.5
Site 9	CTT, RBTxCTT	3+j	27	11.5
Site 10	CTT	3+j	24	11.5
Site 11	CTT	3+j	20	11.0
Site 12	No Fish Found	Fish barrier	0	9.4

[1] Rainbow trout
[2] Westslope cutthroat trout
[3] Rainbow and cutthroat hybrids
[4] Three age classes and juveniles

Table B-2. Sediment Delivery and erosion source evaluation chart.

SEDIMENT DELIVERY AND EROSION SOURCE EVALUATION: ROADS.

Watershed Name ____________ Watershed Number _________________ Road Segment________________________

Date ____________________Observers _________________________

Roads	A	B	C	Weight	Weighted Score
Cut Slopes	Erosion well controlled by resistant soils, rock, grass, or other means. 1	Erosion delivering considerable sediment to ditches and/or road beds; surface sloughs and small slumps <2 yd^3 are common. 2	Erosion fills ditches at deposition areas; surface sloughs and small slumps <2 yd^3 are frequent. 3	3	
Fill Slopes	Erosion well controlled by resistant soils, rock, grass, slash windrows, etc. 1	Fill slope erosion is common. 2	Fill slope erosion is frequent. 3	2	
Ditches	Little or no sign of downcutting. 1	Downcutting occurs but never more than six inches deep. 2	Downcutting common and deeper than six inches 3	1	
Road Surfaces	Little or no rutting or erosion of road surface. 1	Ruts and/or rills obvious. Rills generally less than two inches deep. 2	Rutting and/or erosion common. Rills may be more than two inches deep. 3	4	

Total Road Sediment Sources Score ____________________

Road Delivery Multiplier

Sediment Delivery Factor	Few signs of ditches or relief culverts delivering sediment to a stream channel or draw. 1	Occasional signs of ditches and relief culverts delivering sediment to a stream channel or draw. 2	Frequent signs of ditches or relief culverts delivering sediment to a stream channel or draw. 3

Road Delivery Multiplier ________________

Total Score for Roads (Road Sediment Sources Score X Road Delivery Multiplier)= ________________

Low: <31 Moderate: 31-50 High: >50

SEDIMENT DELIVERY AND EROSION SOURCE EVALUATION: SKID TRAILS

Skid Trails	A	B	C	WEIGHT	WEIGHTED SCORE
Erosion	Erosion well controlled by grass, mulch, etc.; little or no rutting. 1	Occasional rutting or erosion; ruts often 1-2 inches deep. 2	Significant rutting or erosion; ruts may be > 2 inches deep. 3	2	

Skid Trail Sediment Sources Score ____________

Skid Trail Delivery Multiplier

Sediment Delivery Factor	Skid trails located outside the SPZ; little or no sign of sediment being delivered to a stream channel or draw. 1	Some skid trails may be in SPZ; sediment occasionally delivered to a stream channel or draw. 2	Some skid trails in SPZ; sediment frequently delivered to stream channels or draws. 3

Skid Trail Delivery Multiplier _____________

Total Score for Skid Trails (Skid Trail Sediment Sources Score X Skid Trail Delivery Multiplier)= _____________

Low: <7 Moderate: 7-10 High >10

Comments:

SEDIMENT DELIVERY AND EROSION SOURCE EVALUATION: MASS FAILURES

Mass Failure	A	B	C	WEIGHT	WEIGHTED SCORE
Erosion	Slumps infrequent or very small; mostly healed over. 1	Slumps moderate in frequency and size. 2	Slumps frequent or large; many are raw. 3	9	

Mass Failure Sediment Sources Score __________

Mass Failure Delivery Multiplier

Sediment Delivery Factor	Failures do not reach stream channels. 1	Failures deliver substantial sediment directly to stream channels. 2	Failures generally reach streams in mass and are subject to heavy subsequent stream erosion. 3

Mass Failure Delivery Multiplier __________

Total Score for Mass Failures (Mass Failure Sediment Sources Score X Mass Failure Delivery Multiplier) = __________
Low: <28 Moderate: 28-45 High:>45

Comments:

TOTAL SEDIMENT DELIVERY SCORE (Total Roads Score + Total Skid Trails Score + Total Mass Failure Score) _____
Low: <66 Moderate: 66-105 High: >105

Record the overall rating here and in the Analysis Summary Table (page I-3)

Comments:

Table B-3. Climate data for stations in and around the LNFCRS.

OROFINO, IDAHO (106681), National Weather Station
Elevation = 1030 feet
Period of Record = 8/01/1948 to 12/30/1981

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Mean Temperature (^oF)	30.8	37.9	43.0	50.8	58.9	65.9	72.7	71.6	63.0	50.9	40.0	33.8	51.6
Average Max. Temperature (^oF)	37.6	46.9	54.6	64.7	74.1	81.8	91.8	90.5	80.6	64.1	48.0	40.0	64.6
Average Min. Temperature (^oF)	24.0	28.9	31.4	36.9	43.7	49.9	53.6	52.7	45.4	37.6	32.0	27.7	38.7
Average Total Precipitation (in.)	3.1	2.4	2.3	2.2	2.2	2.0	0.7	0.9	1.2	2.1	2.9	3.5	25.3
Ave. Number of days 90^oF and above	0.0	0.0	0.0	0.2	2.5	6.7	20.2	18.2	6.1	0.1	0.0	0.0	54.0

DWORSHAK FISH HATCHERY, IDAHO (102845), National Weather Station
Elevation = 1000 feet
Period of Record : 12/1/1966 to 12/31/2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Mean Temperature (^oF)	32.7	37.9	44.5	51.3	58.8	65.6	72.4	72.6	63.5	51.5	40.3	33.4	52.0
Average Max. Temperature (^oF)	39.1	46.5	55.4	63.8	72.3	79.7	89.0	90.1	79.5	64.2	47.6	39.2	63.9
Average Min. Temperature (^oF)	26.3	29.4	33.7	38.6	45.2	51.5	55.8	55.1	47.6	38.8	33	27.7	40.2
Average Total Precipitation (in.)	2.9	2.4	2.4	2.4	2.4	1.7	1.1	0.8	1.4	1.8	3.1	3.1	25.6
Ave. Number of days 90^oF and above	0.0	0.0	0.0	0.2	1.7	5.6	16.6	17.9	5.9	0.0	0.0	0.0	47.8

HEADQUARTERS, IDAHO (104150), National Weather Service
Elevation = 3138 feet
Period of Record = 6/ 1/1959 to 12/31/2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Mean Temperature (^oF)	26.8	29.8	34.1	40.9	48.8	56.5	62.6	62.2	53.4	43.5	34.0	26.9	43.3
Average Max. Temperature (^oF)	35.1	40.2	45.2	53.4	63.0	71.2	80.5	80.9	70.2	57.4	42.9	34.7	56.2
Average Min. Temperature (^oF)	18.4	19.4	22.9	28.5	34.7	41.8	44.7	43.4	36.5	29.9	25.1	19.3	30.4
Average Total Precipitation (in.)	5.5	4.1	3.8	3.3	3.1	2.5	1.2	1.3	1.9	3.1	5.1	5.4	40.1
Ave. Number of days 90^oF and above	0.0	0.0	0.0	0.0	0.2	1.2	5.1	5.9	1.0	0.0	0.0	0.0	13.4

SHANGHI SUMMIT, IDAHO (15C04S), National Resource Conservation Service
Elevation = 4570
Period of Record = 2/1/1983 to 12/1/2001

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Mean Temperature (°F)	25.9	28.2	33.0	38.6	46.5	53.4	60.7	61.1	52.0	41.5	30.4	24.3	41.5
Average Max. Temperature (°F)	32.0	37.0	43.4	49.9	58.6	65.9	74.5	75.9	66.3	52.2	36.6	30.1	52.1
Average Min. Temperature (°F)	20.9	21.8	25.6	30.4	36.8	42.9	48.9	49.2	41.9	33.5	25.3	19.2	33.2
Average Total Precipitation (in.)[1]	8.2	6.4	5.5	4.5	4.3	3.4	2.2	1.6	2.2	3.6	7.3	8.2	57.4
Ave. Number of days 90°F and above	0.0	0.0	0.0	0.0	0.1	0.1	0.8	0.9	0.2	0.0	0.0	0.0	2.14

ELK RIVER 1 S, IDAHO (102892), National Weather Service Station
Elevation = 2918
Period of Record = 1/ 1/1952 to 12/31/2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Mean Temperature (°F)	26.1	30.2	35.0	42.4	50.4	57.3	63.1	62.7	54.4	44.5	33.9	26.9	43.9
Average Max. Temperature (°F)	34.3	40.0	45.9	54.3	64.0	71.6	81.1	81.4	71.8	58.7	42.3	34.5	56.7
Average Min. Temperature (°F)	17.9	20.4	24.1	30.5	36.8	42.9	45.3	43.9	37.0	30.2	25.6	19.5	31.2
Average Total Precipitation (in.)	5.4	4.2	3.5	2.8	2.8	2.4	1.2	1.1	1.8	2.7	4.6	5.03	37.6
Ave. Number of days 90°F and above	0.0	0.0	0.0	0.0	0.2	1.1	5.1	5.9	1.0	0.0	0.0	0.0	13.4

ELK BUTTE, IDAHO (16C15S), National Resource Conservation Service
Elevation = 5690
Period of Record = 10/22/1982 to 12/1/2001

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Mean Temperature (°F)	23.7	25.5	29.2	34.9	42.1	49.4	58.9	59.5	50.6	39.4	27.7	21.9	38.6
Average Max. Temperature (°F)	28.4	31.7	37.6	44.2	52.5	60.4	69.5	70.8	61.0	46.8	32.0	26.4	46.8
Average Min. Temperature (°F)	20.1	21.2	24.8	29.7	36.5	42.7	50.3	51.0	44.1	33.9	24.0	18.2	33.1
Average Total Precipitation (in.)[2]	9.3	7.6	6.2	3.7	3.8	3.0	1.6	1.5	2.1	3.6	8.1	9.1	59.7
Ave. Number of days 90°F and above	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.1	0.1	0.0	0.0	0.0	0.2

[1] Period of record 1971-2000

[2] Period of record 1971-2000

Appendix C. Figures

Appendix 3. Figures

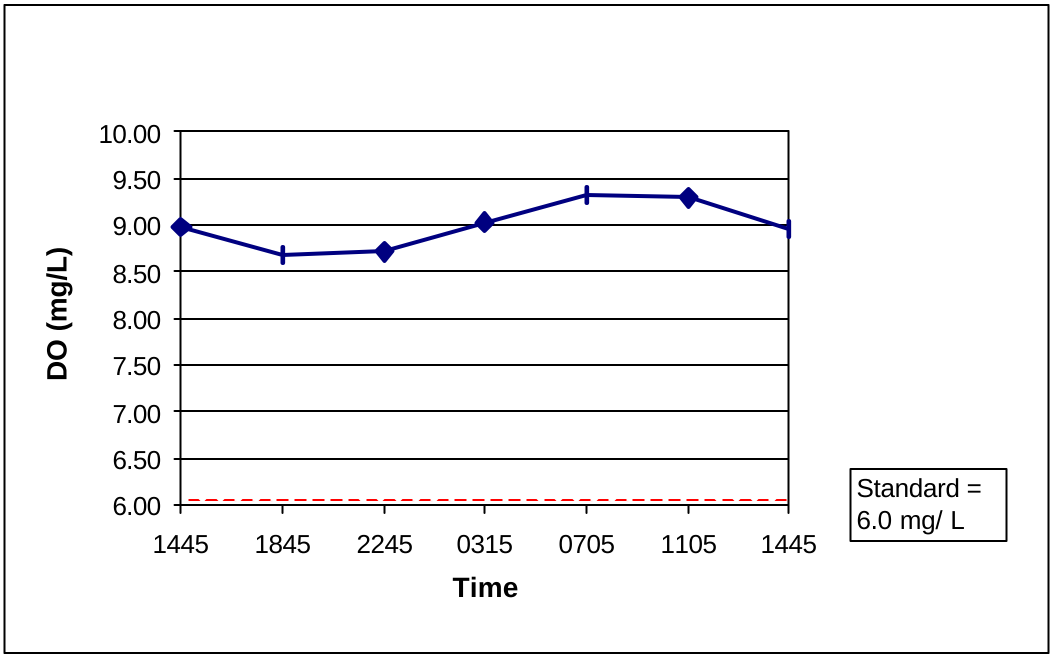


Figure 2. Breakfast Creek Diurnal Dissolved Oxygen

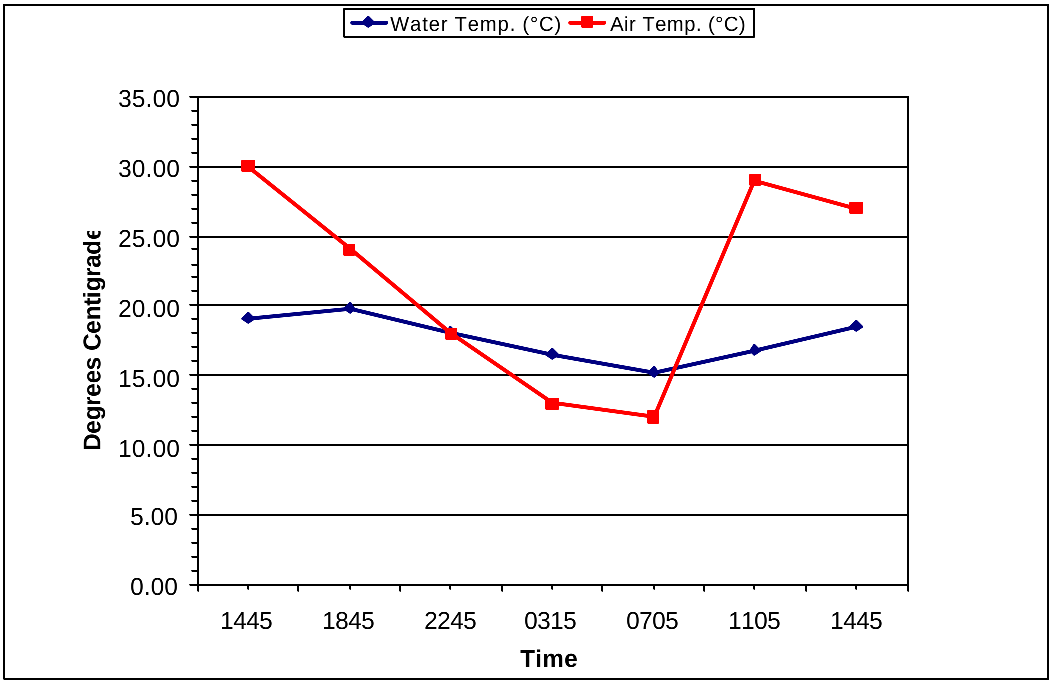


Figure 3. Breakfast Creek Diurnal Air and Water Temperatures

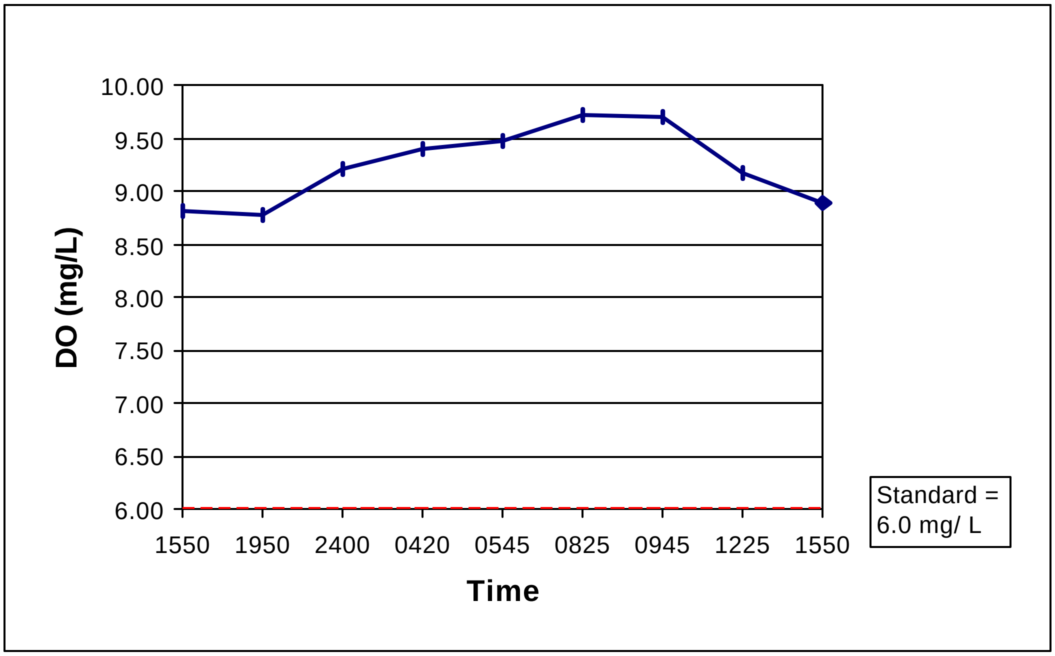


Figure 4. Stony Creek Diurnal Dissolved Oxygen

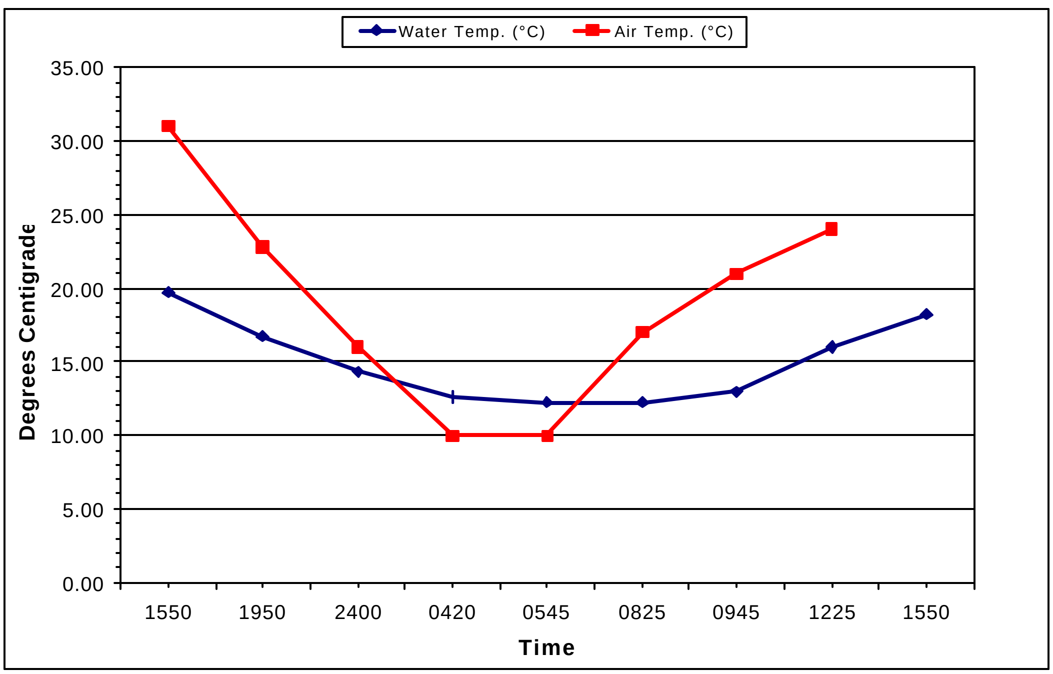


Figure 5. Stony Creek Diurnal Air and Water Temperatures

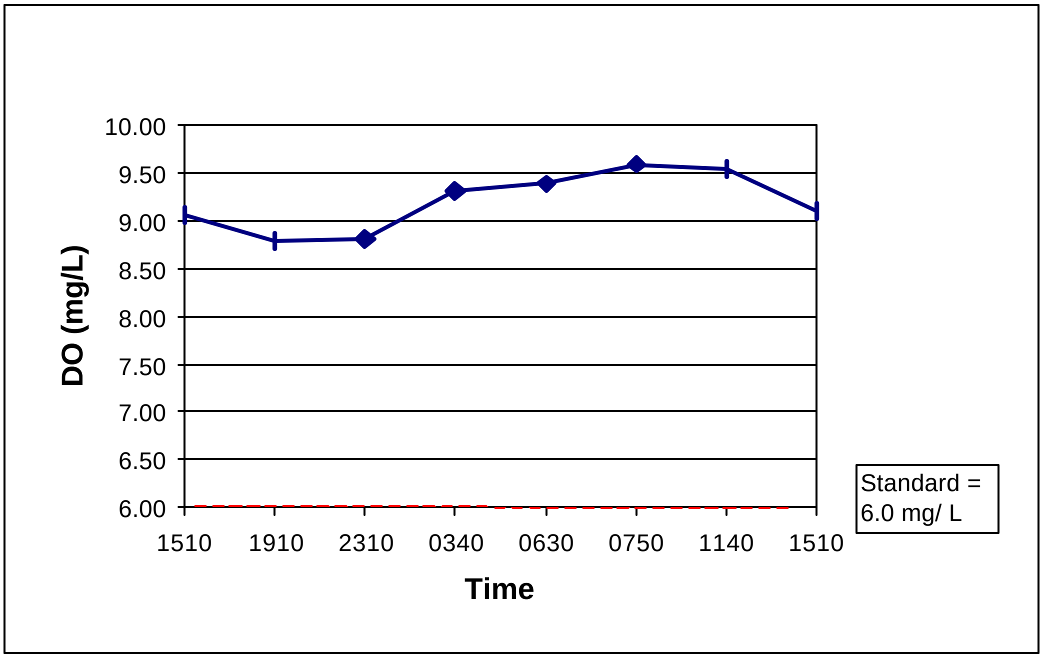


Figure 6. Floodwood Creek Diurnal Dissolved Oxygen

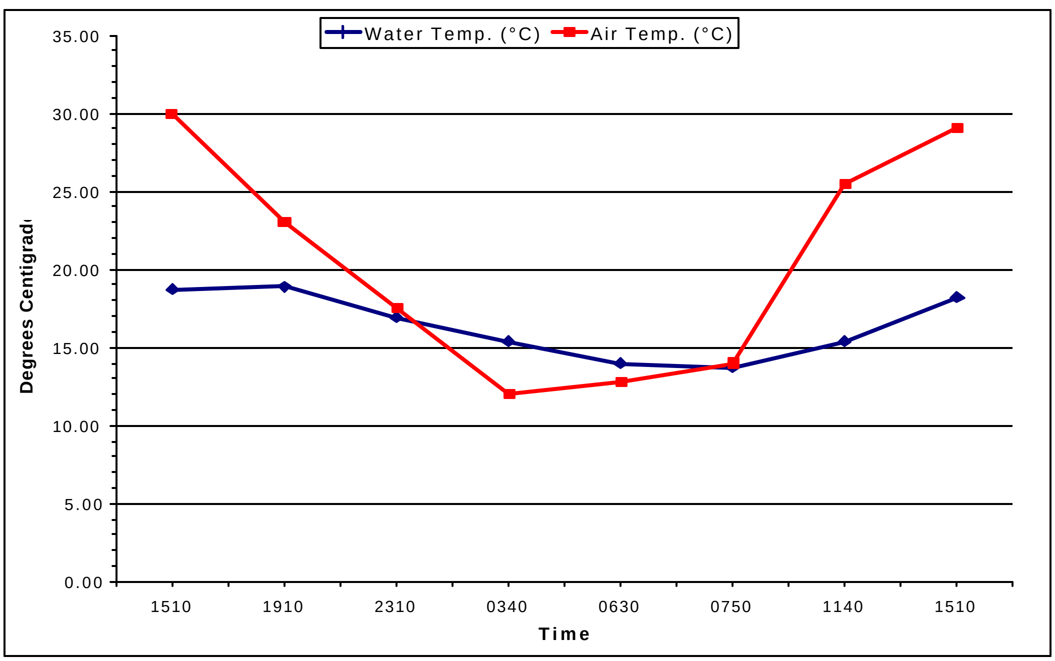


Figure 7. Floodwood Creek Diurnal Air and Water Temperatures

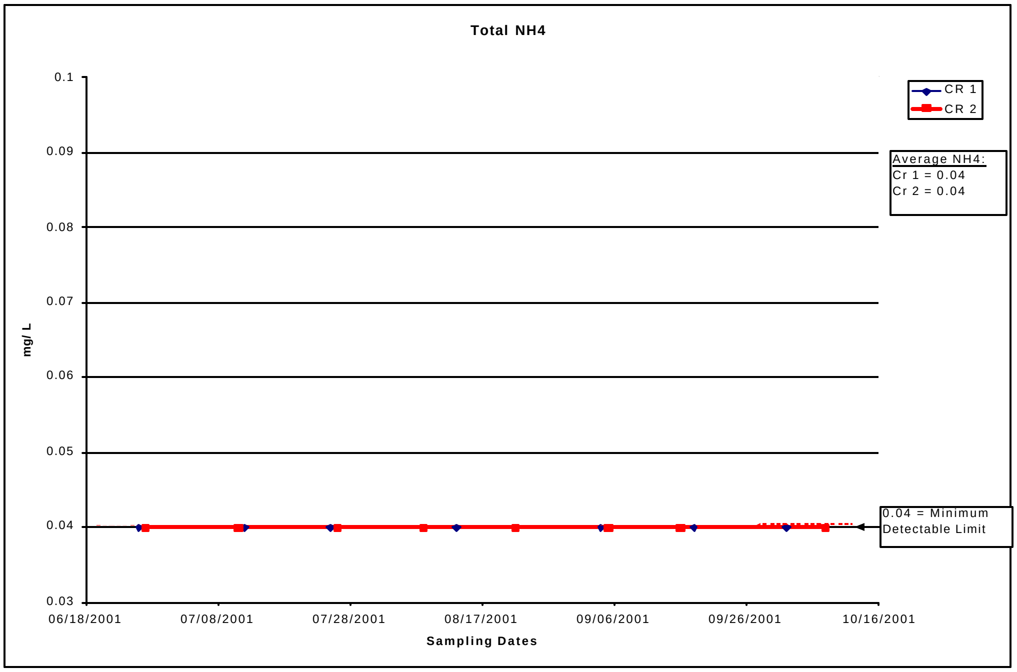


Figure 8. Cranberry Creek Ammonia Results

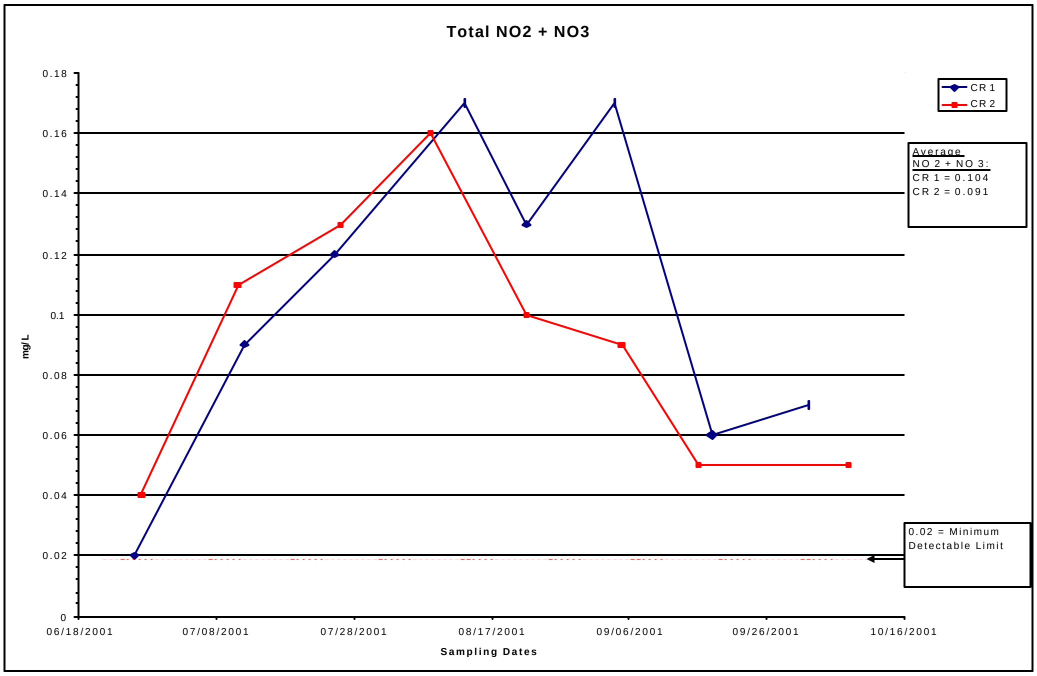


Figure 9. Cranberry Creek Nitrate and Nitrite Results

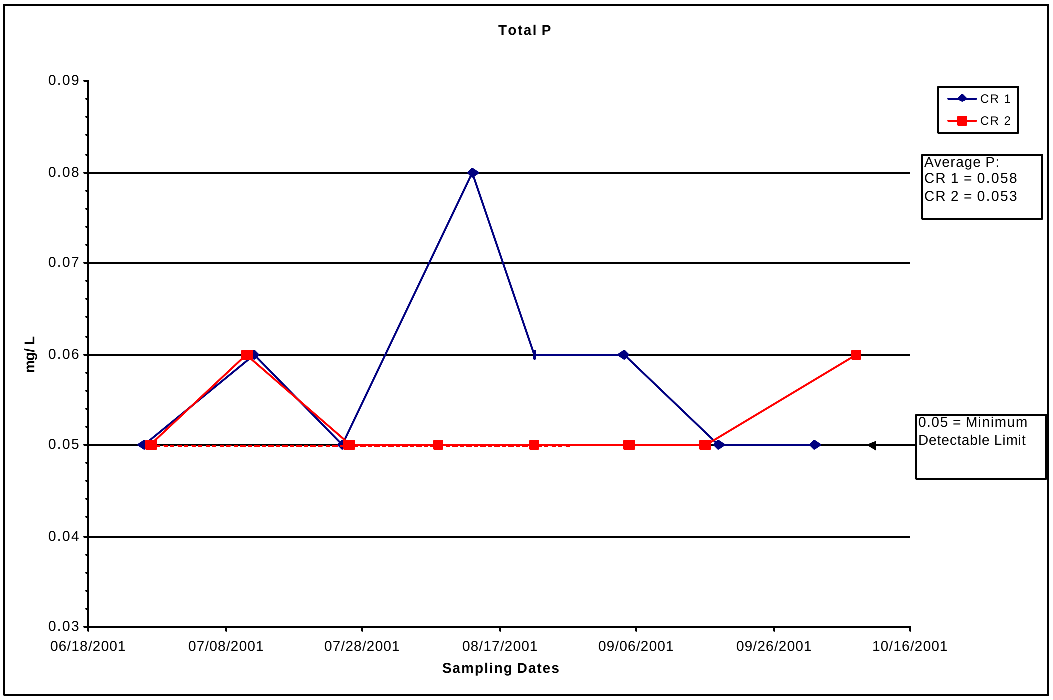


Figure 10. Cranberry Creek Total Phosphorus Results

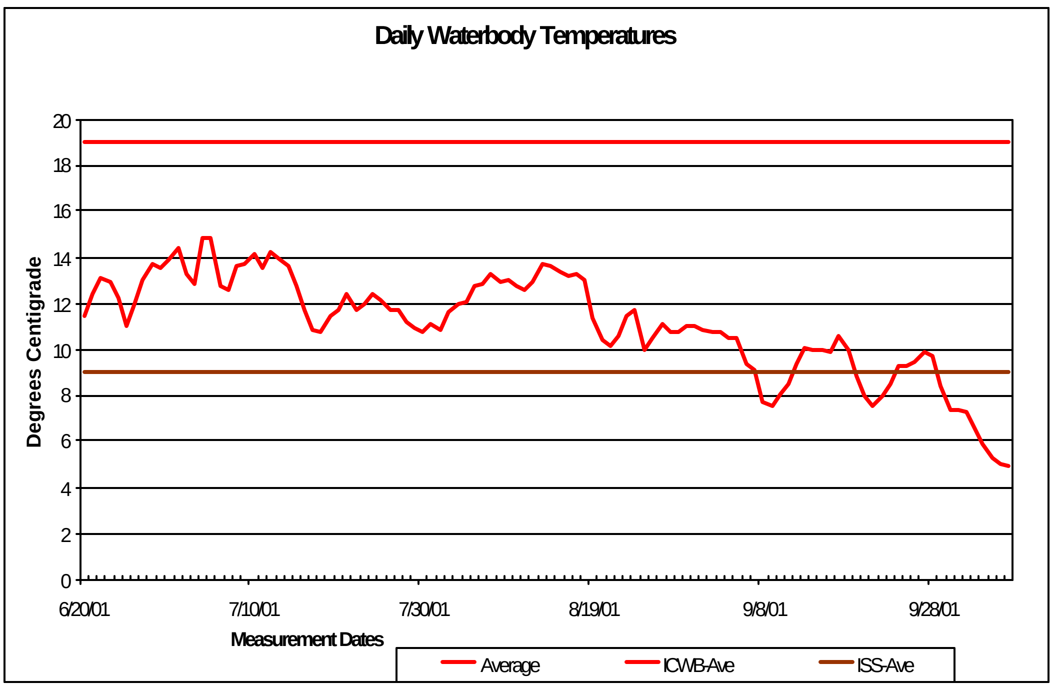


Figure 11. Cranberry Water Temperature Headwaters (CRT2)

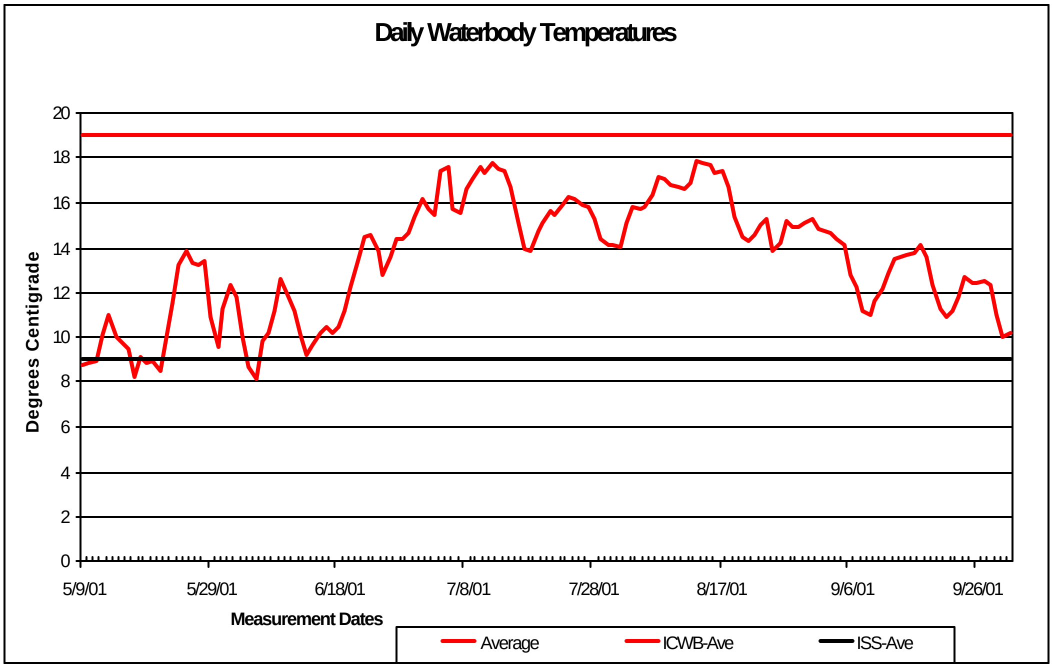


Figure 12. Cranberry Water Temperature at the Mouth (CRT1)

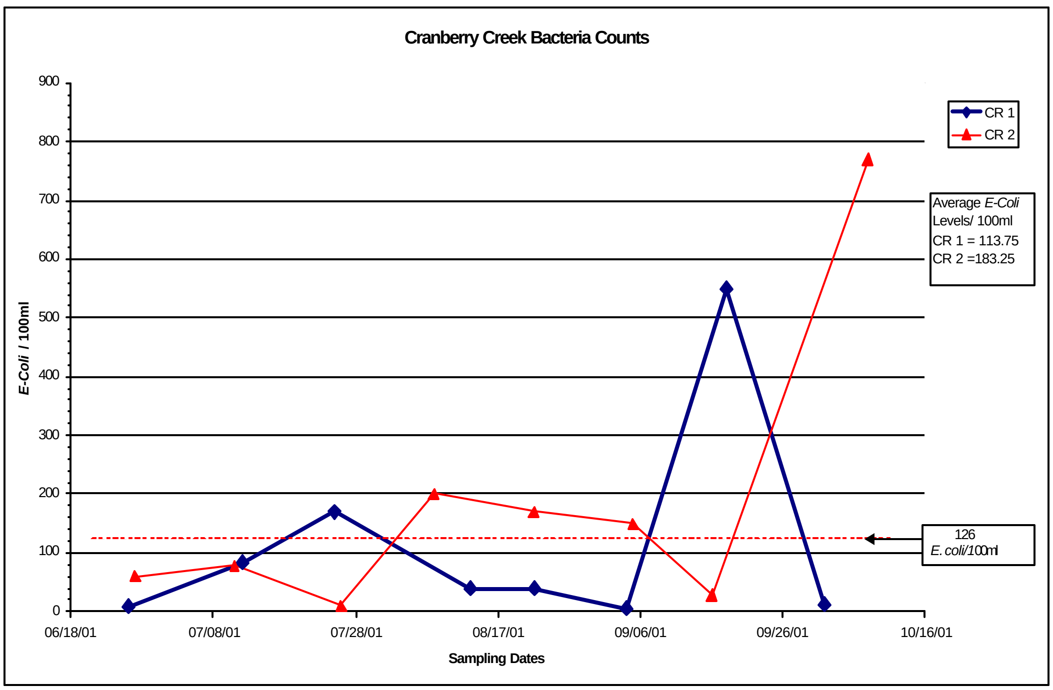


Figure 13. Cranberry Creek Bacteria Results

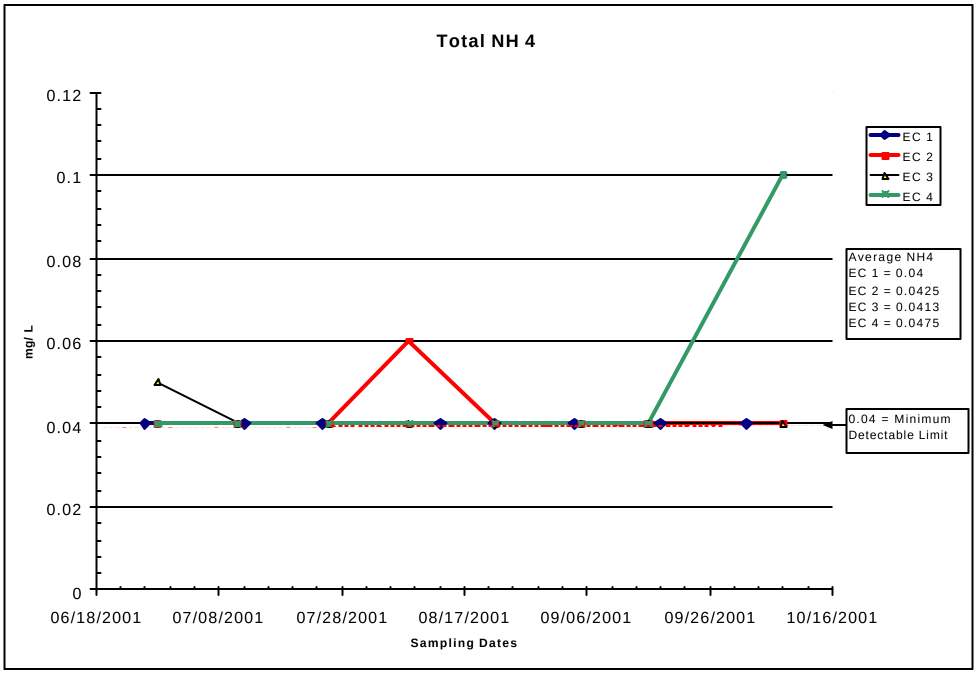


Figure 14. Elk Creek Ammonia Results

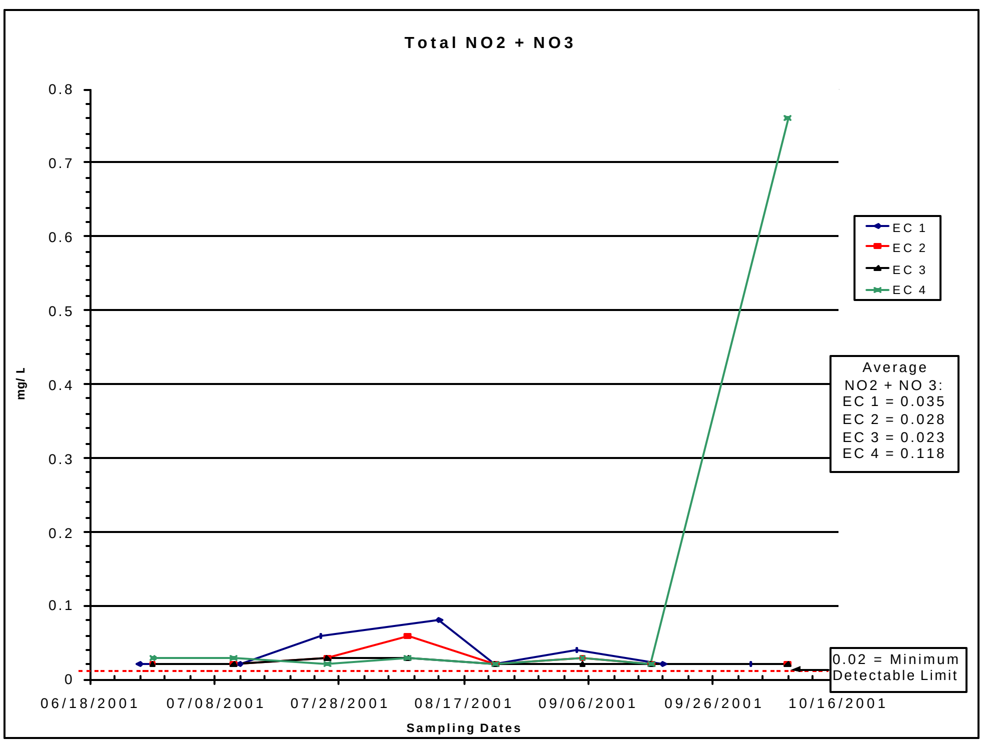


Figure 15. Elk Creek Nitrogen Results

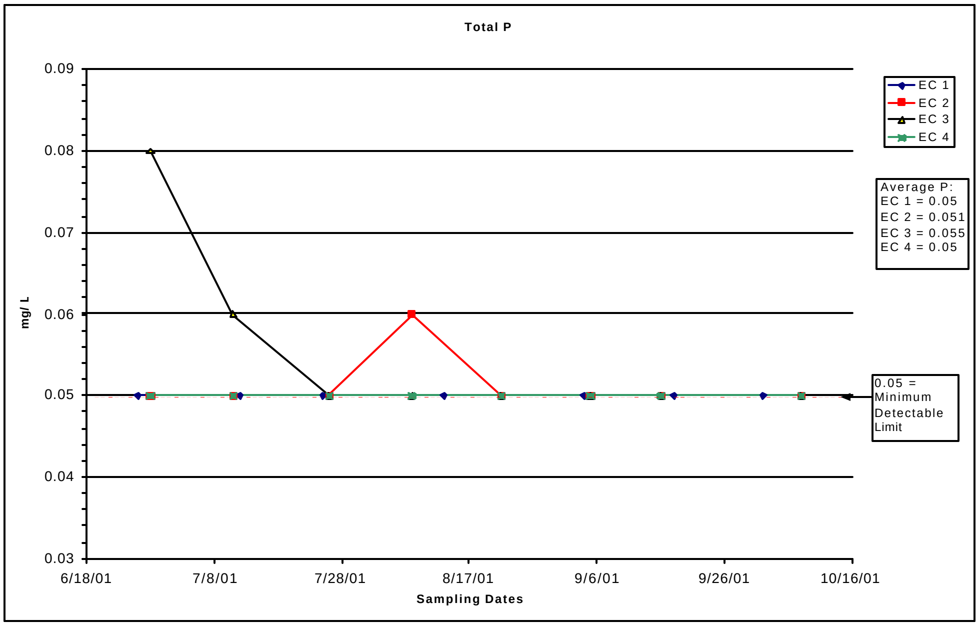


Figure 16. Elk Creek Total Phosphorus Results

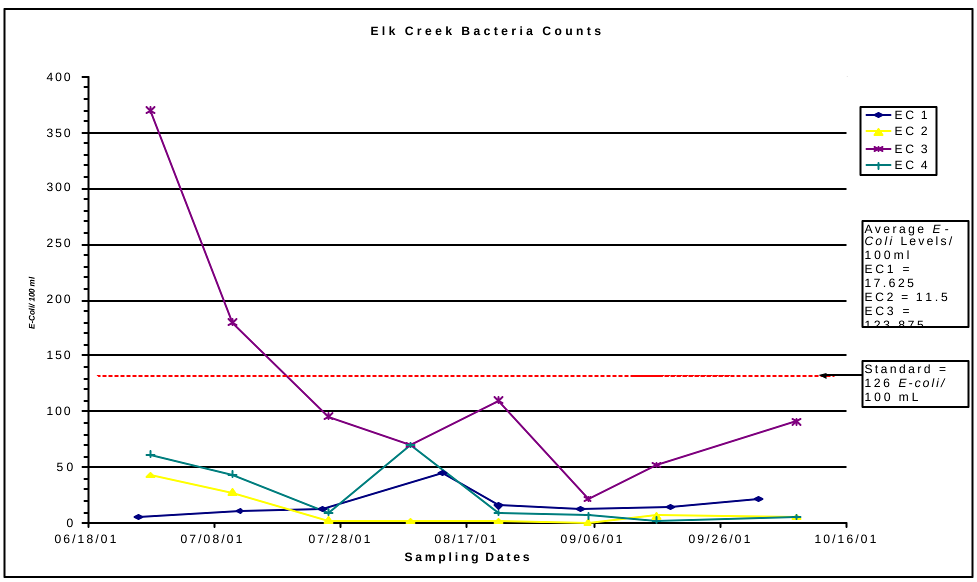


Figure 17. Elk Creek Bacteria Results

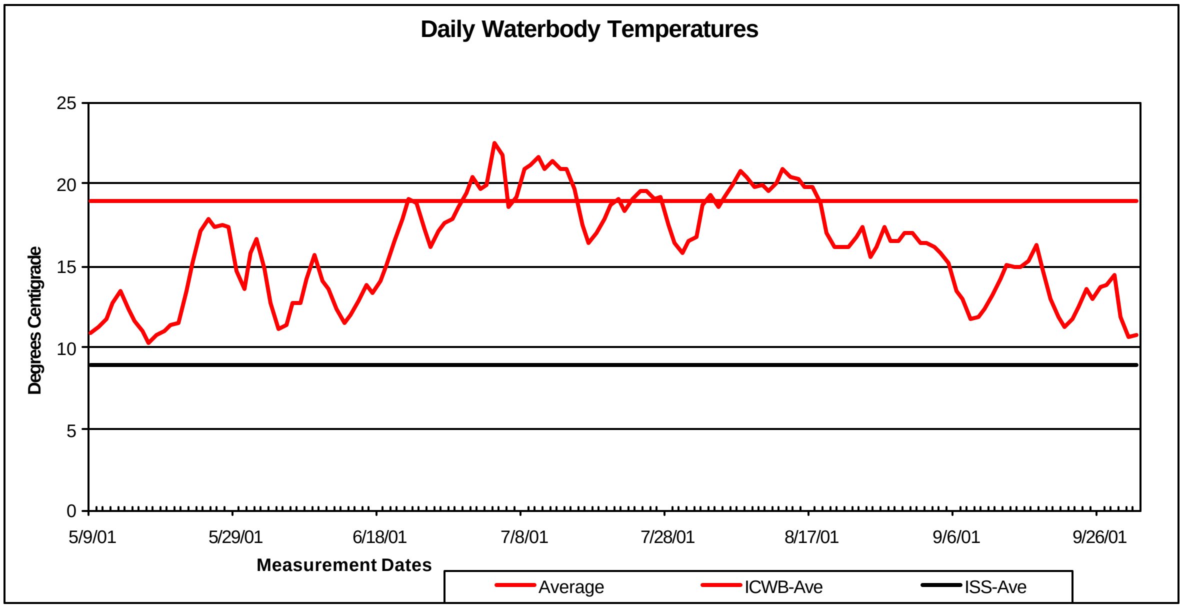


Figure 18. Elk Creek Water Temperature at the Mouth (ECT1)

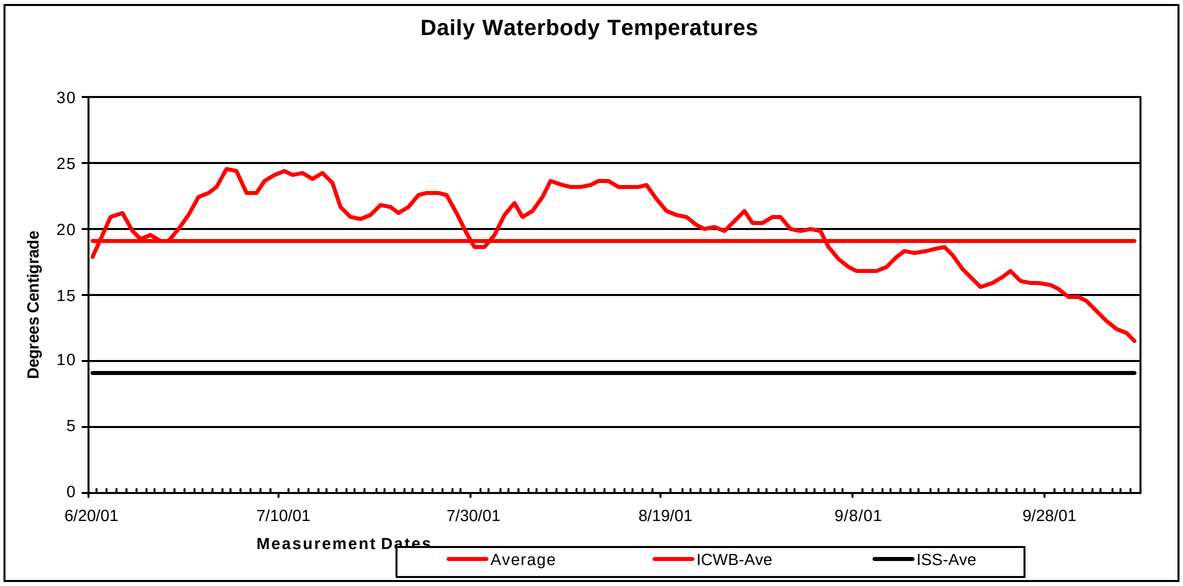


Figure 19. Elk Creek Water Temperature just below Elk Creek Reservoir (ECT2)

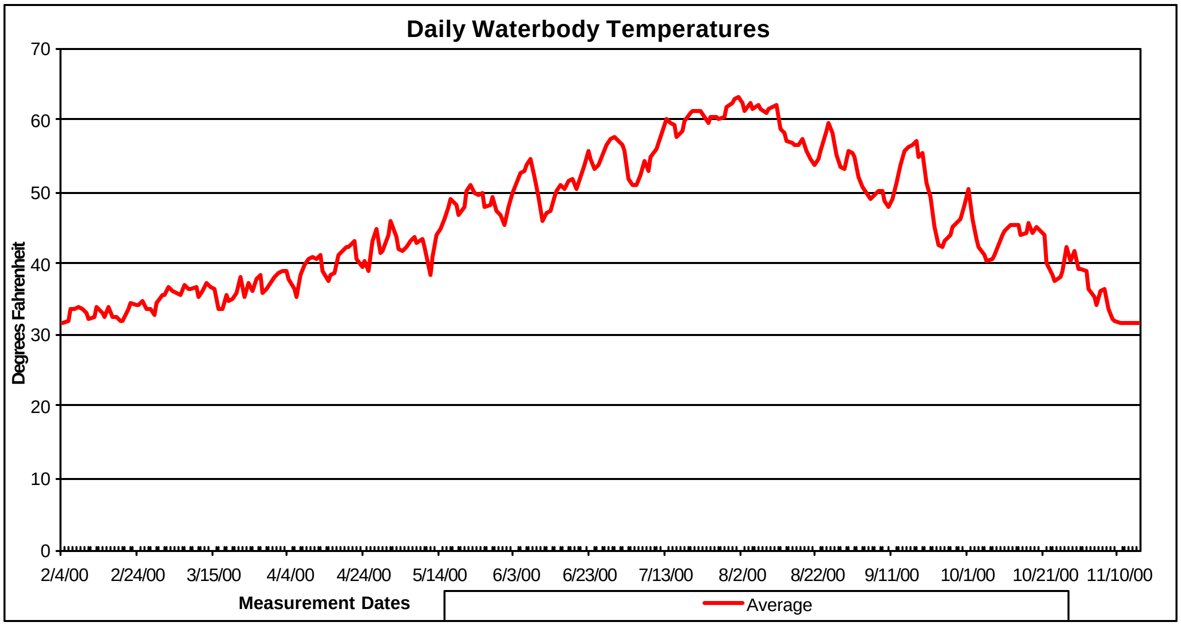


Figure 20. Elk Creek-upper Water Temp. above Elk Creek Reservoir (ECT3)

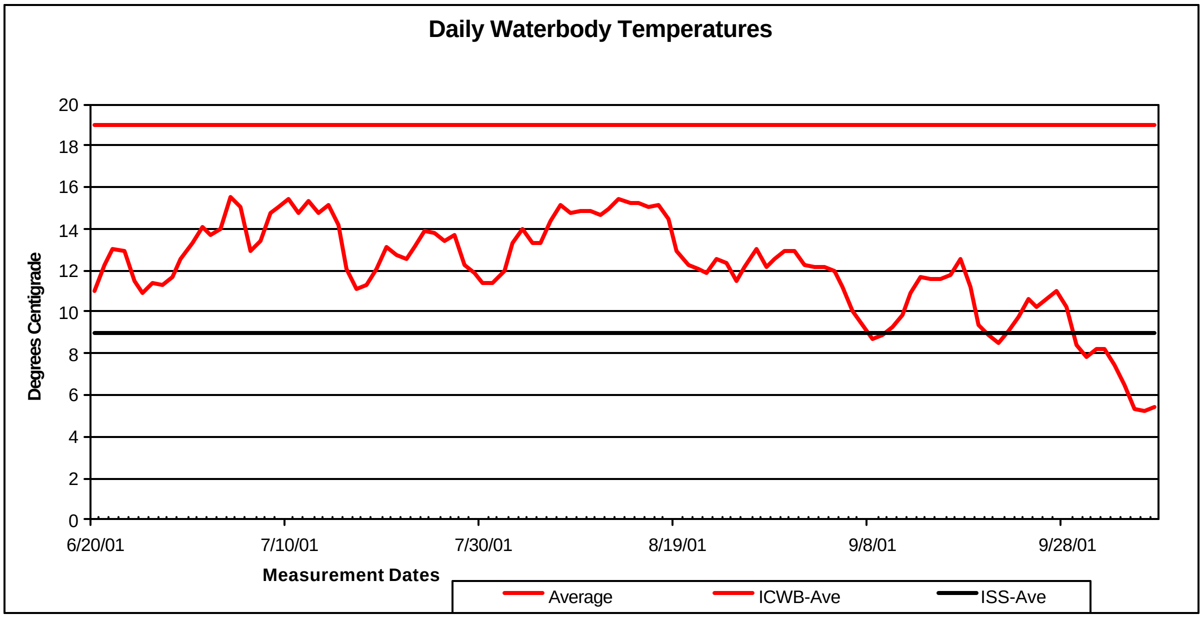


Figure 21. Elk Creek-upper Water Temperature Headwaters (ECT4)

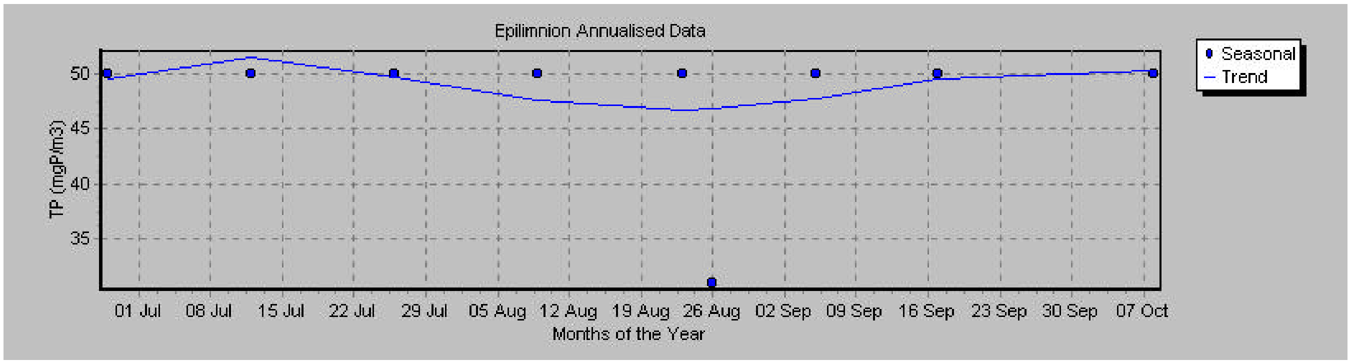


Figure 22. Elk Creek Reservoir Total Phosphorus Results

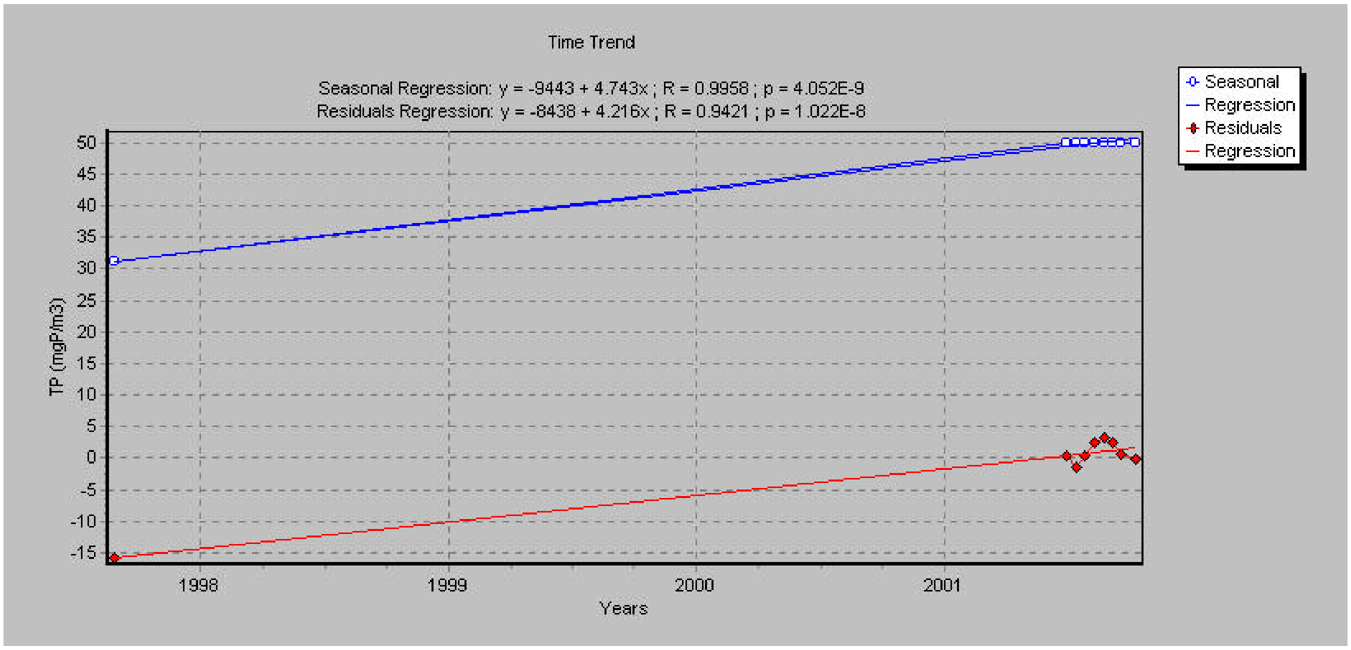


Figure 23. Elk Creek Reservoir Phosphorus Levels over Time

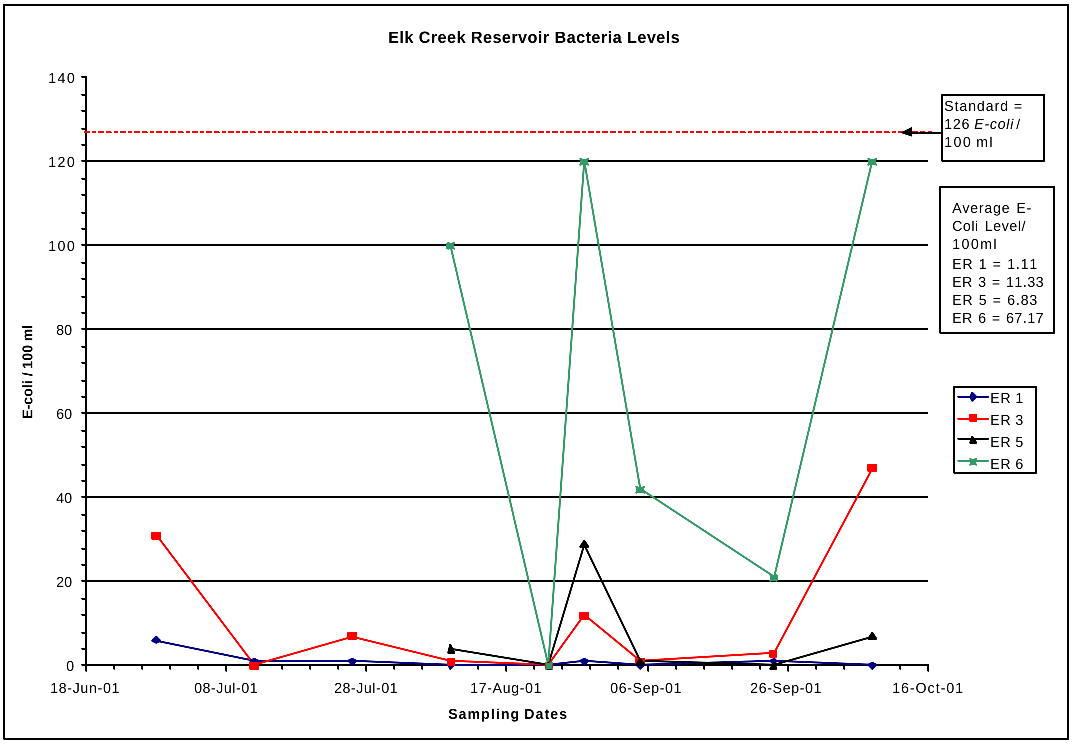


Figure 24. Elk Creek Reservoir Bacteria Levels

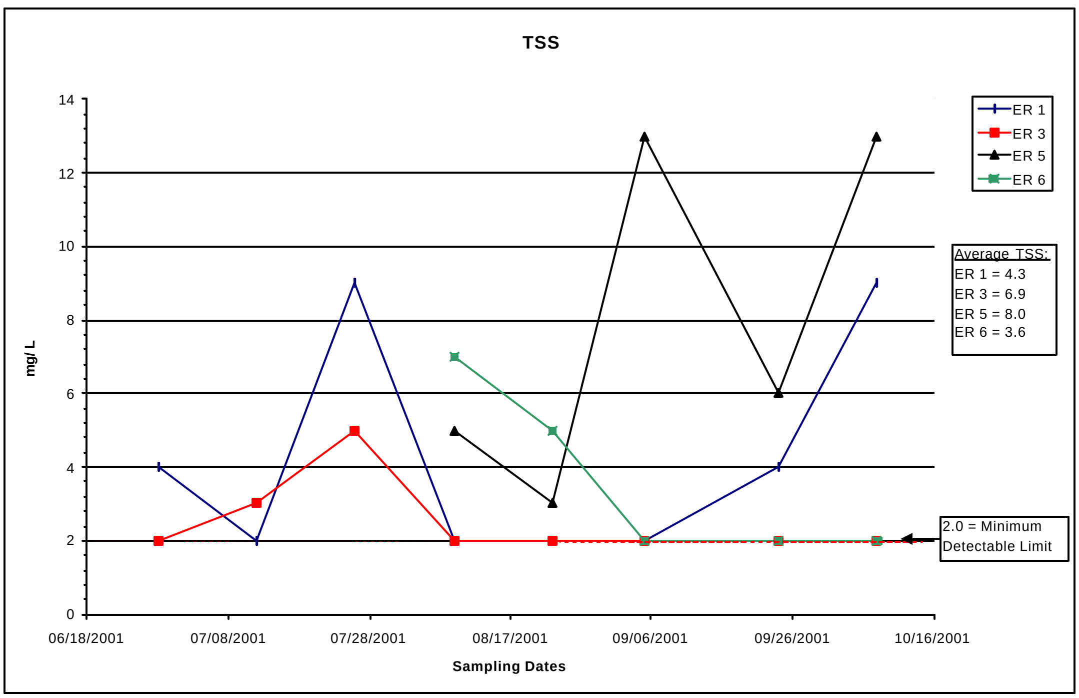


Figure 25. Elk Creek Reservoir Sediment levels

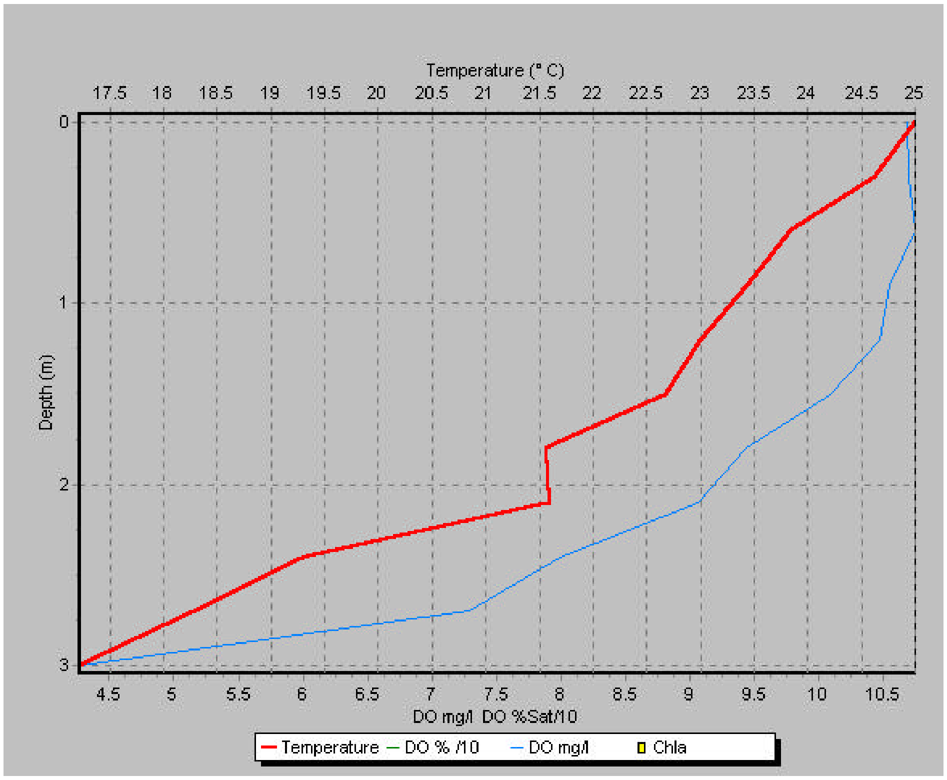


Figure 26. Elk Creek Reservoir Transect 1 Temperature and DO Profile

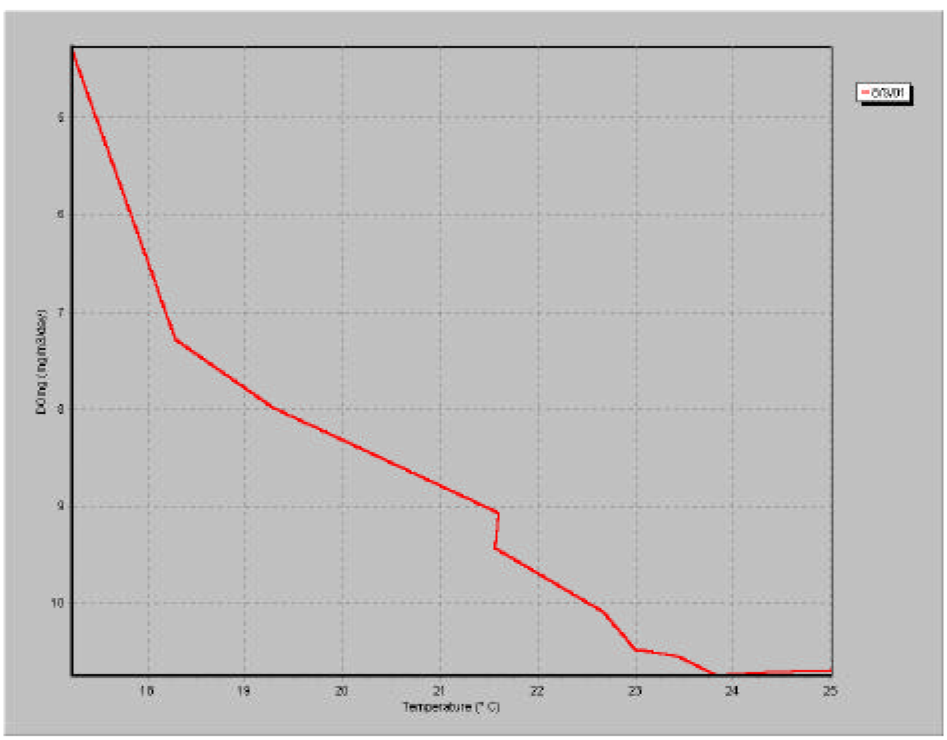


Figure 27. Elk Creek Reservoir Transect 1 Temperature vrs DO

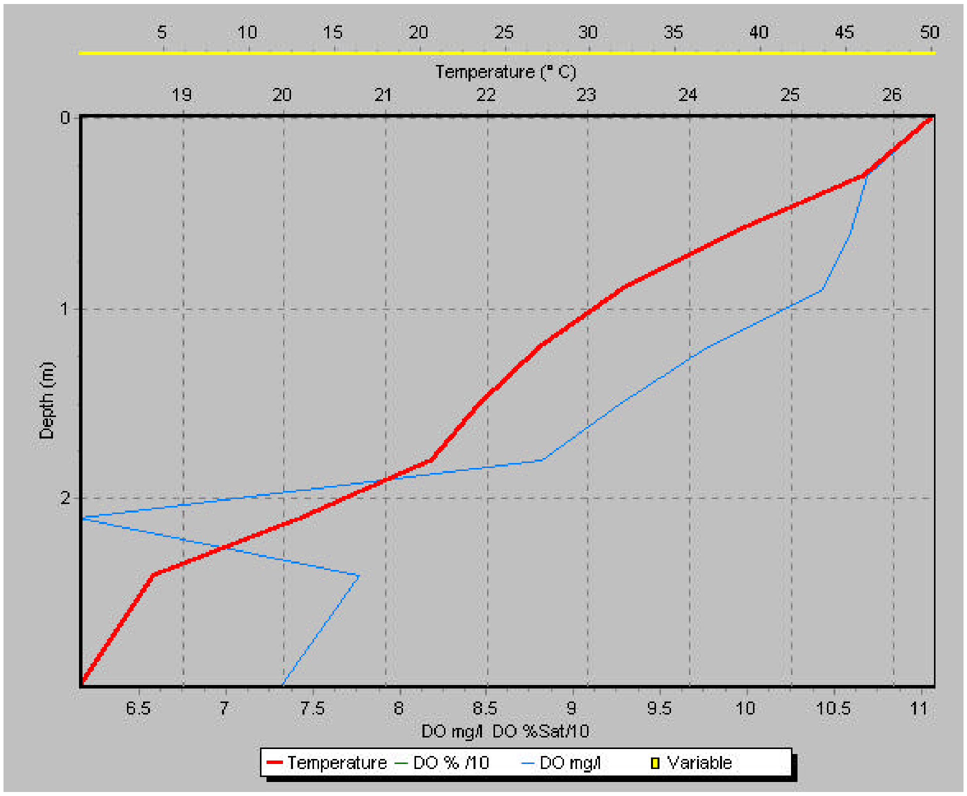


Figure 28. Elk Creek Reservoir Transect 2 Temperature and DO Profile

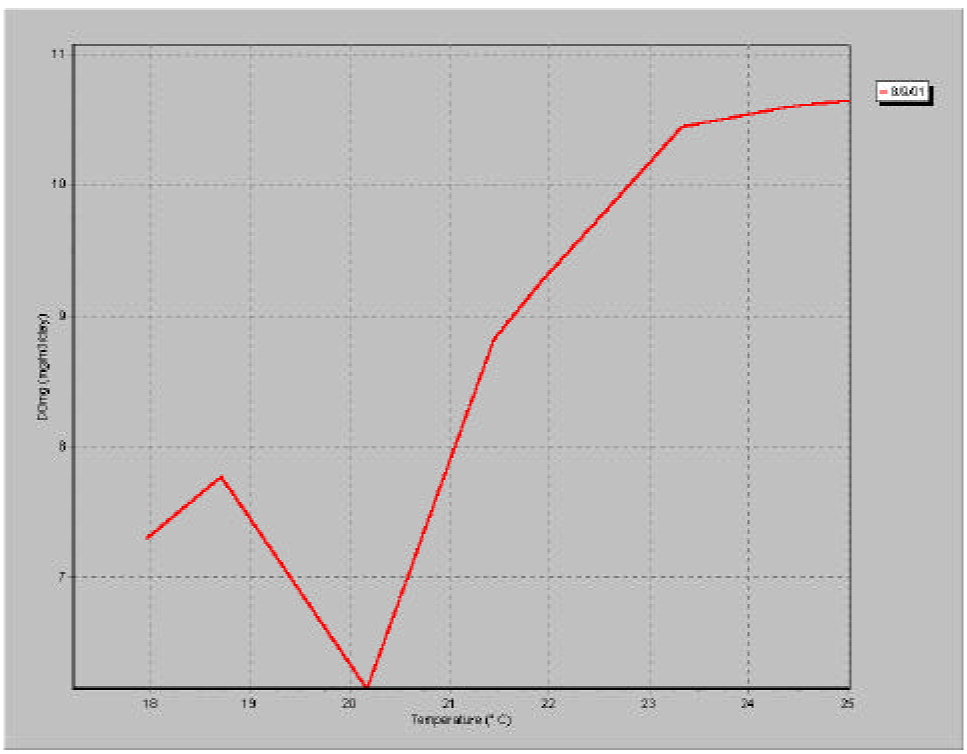


Figure 29. Elk Creek Reservoir Transect 2 Temperature vrs DO

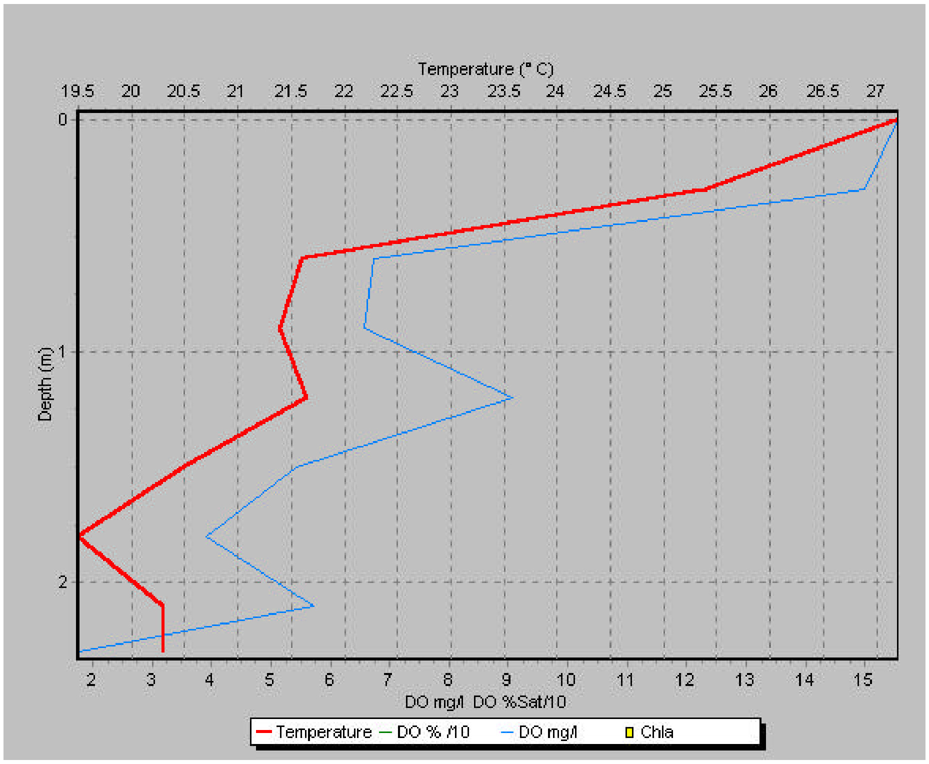


Figure 30. Elk Creek Reservoir Transect 3 Temperature and DO Profile

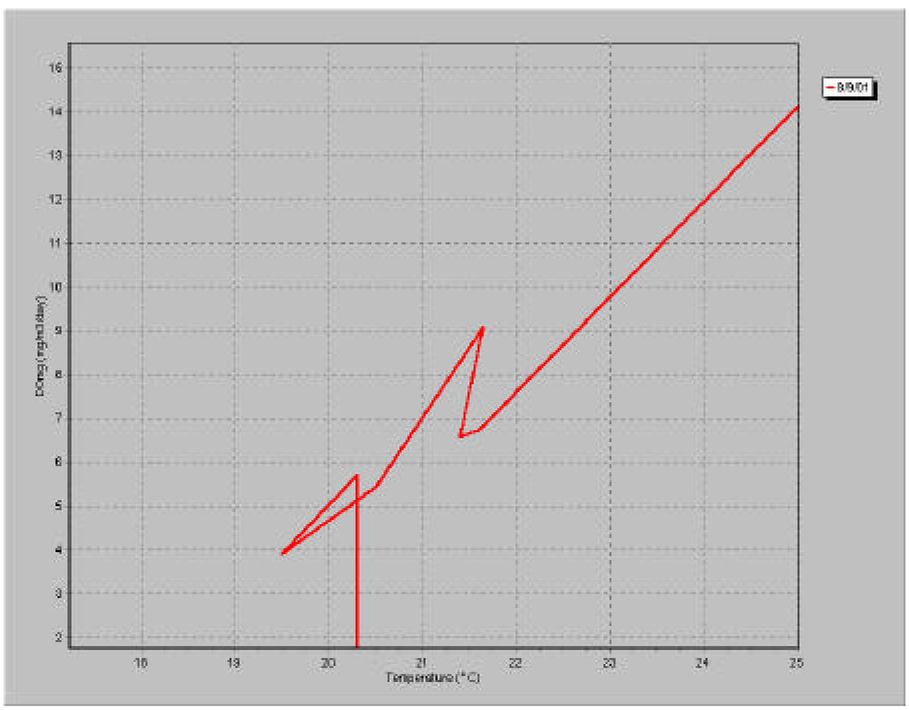


Figure 31. Elk Creek Reservoir Transect 3 Temperature vrs DO

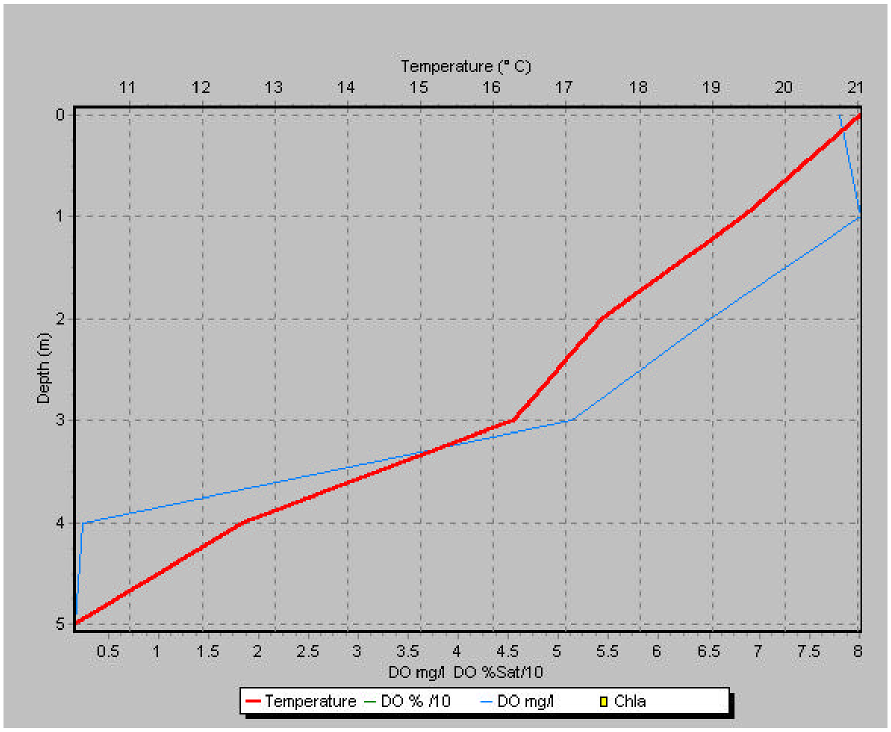


Figure 32. Elk Creek Reservoir 1997 Site Temperature and DO Profile

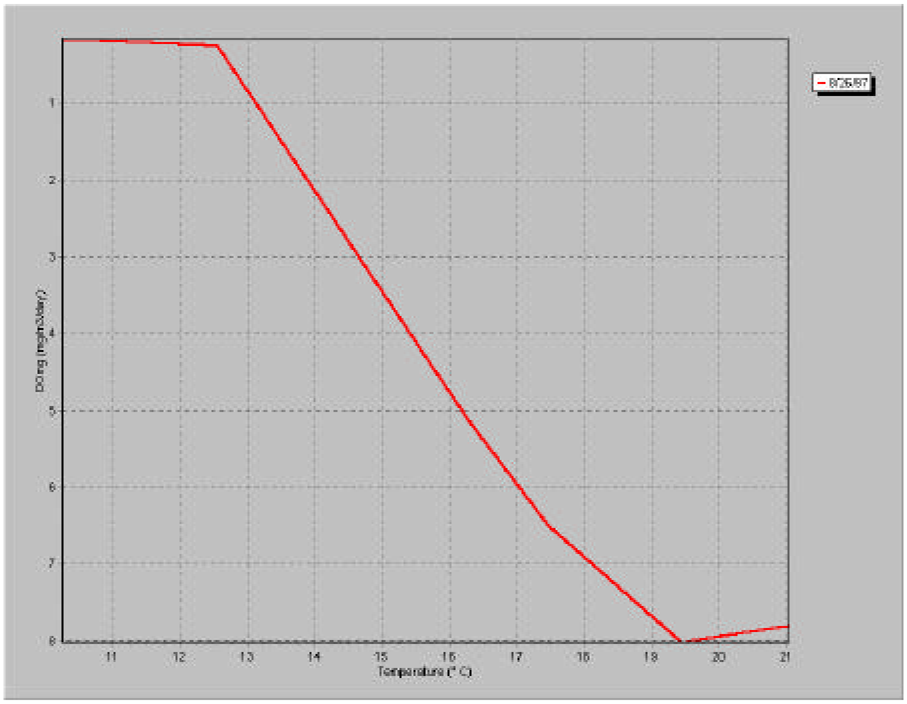


Figure 33. Elk Creek Reservoir 1997 Site Temperature vrs DO

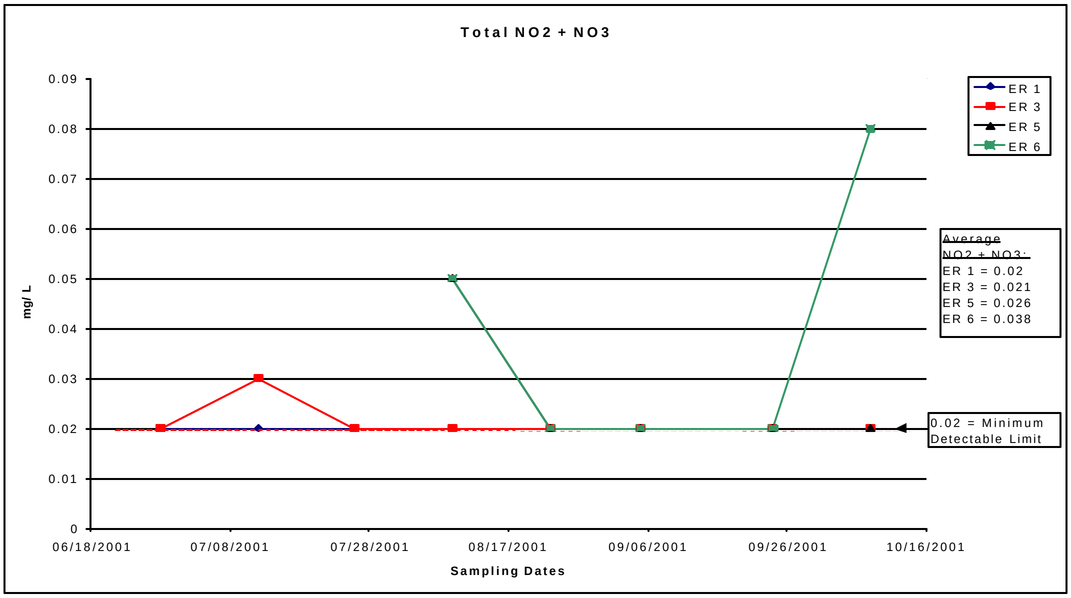


Figure 34. Elk Creek Reservoir Nitrogen Results

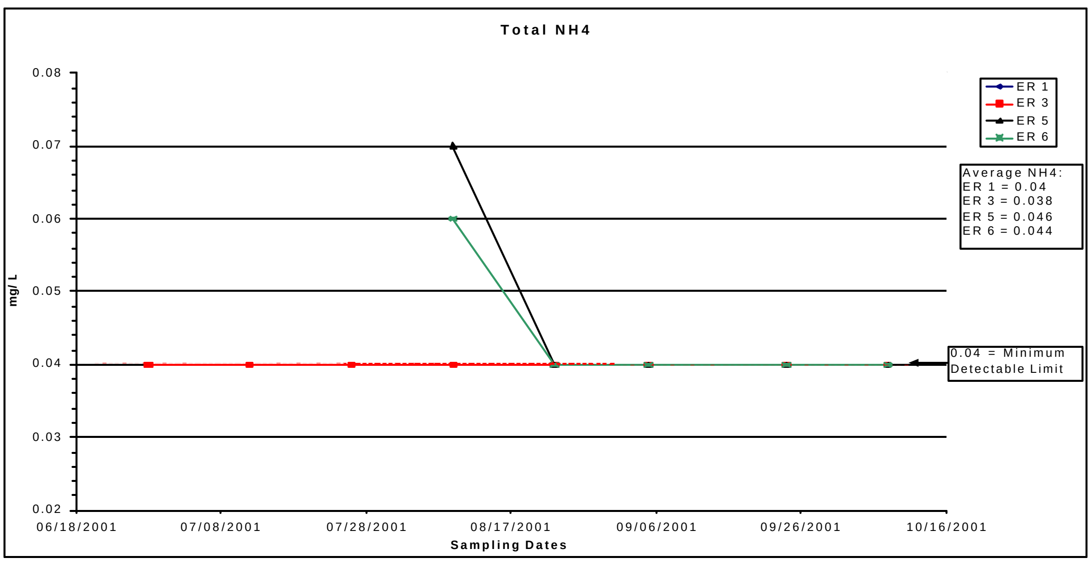


Figure 35. Elk Creek Reservoir Ammonia Results

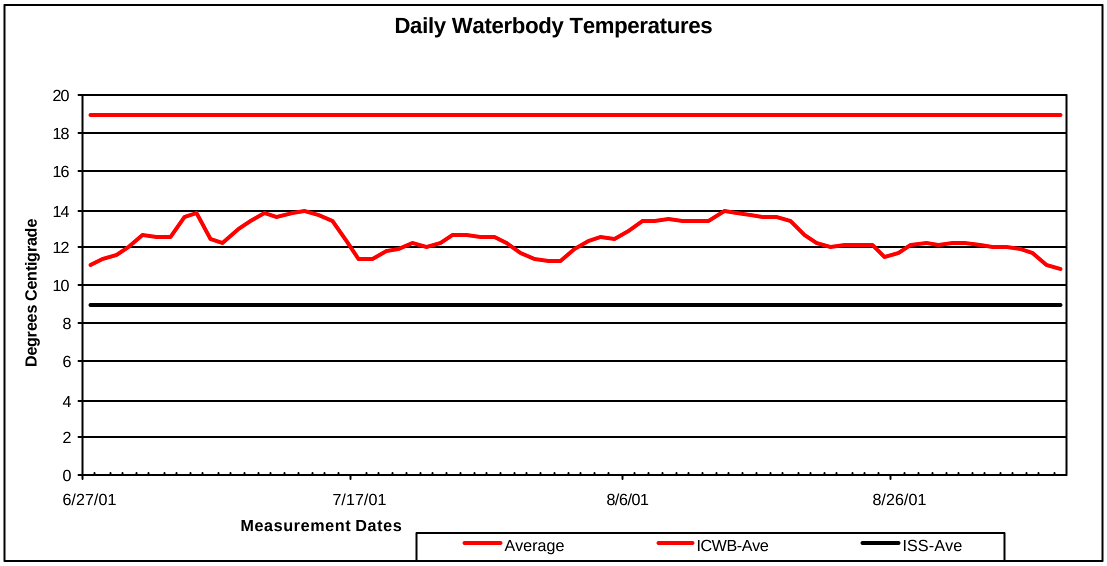


Figure 36. Isabella Creek Water Temperatures above Elmer Creek

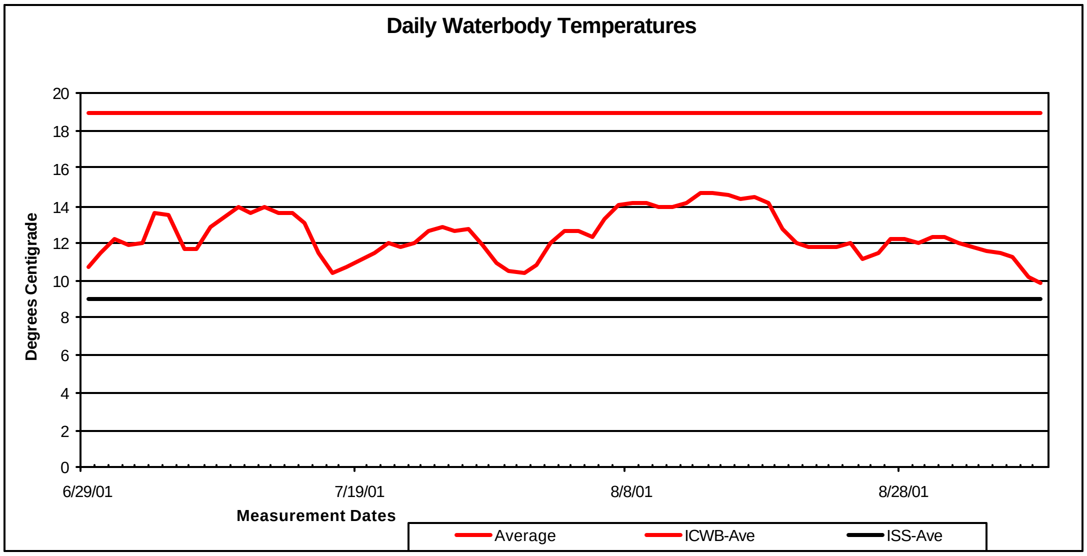


Figure 37. Goat Creek Water Temperatures at Mouth

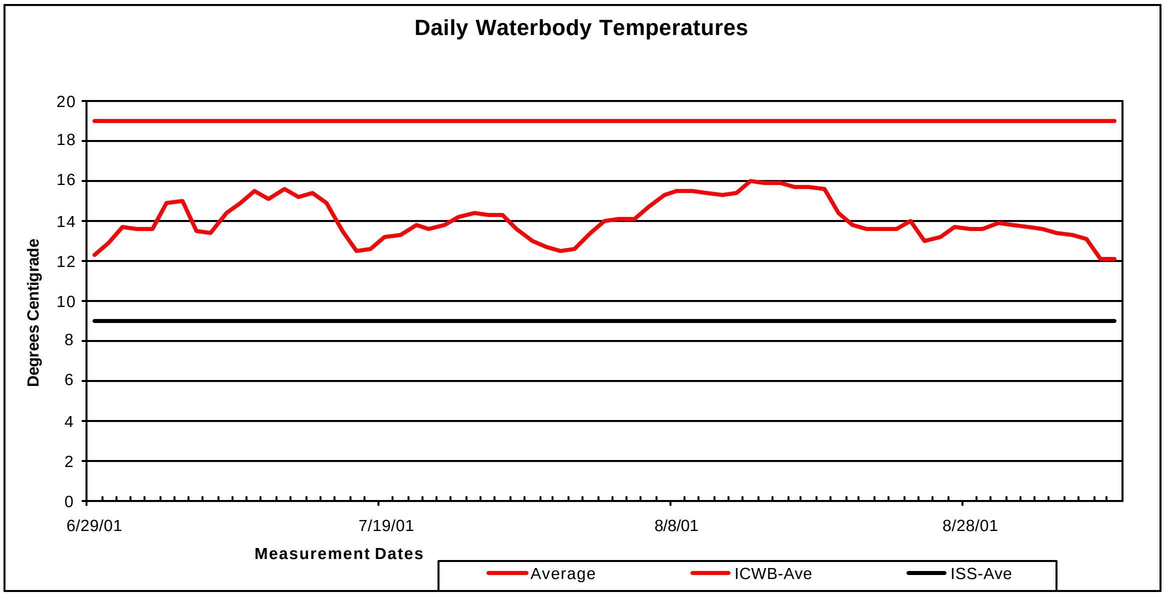


Figure 38. Isabella Creek Water Temperatures near Fern Creek

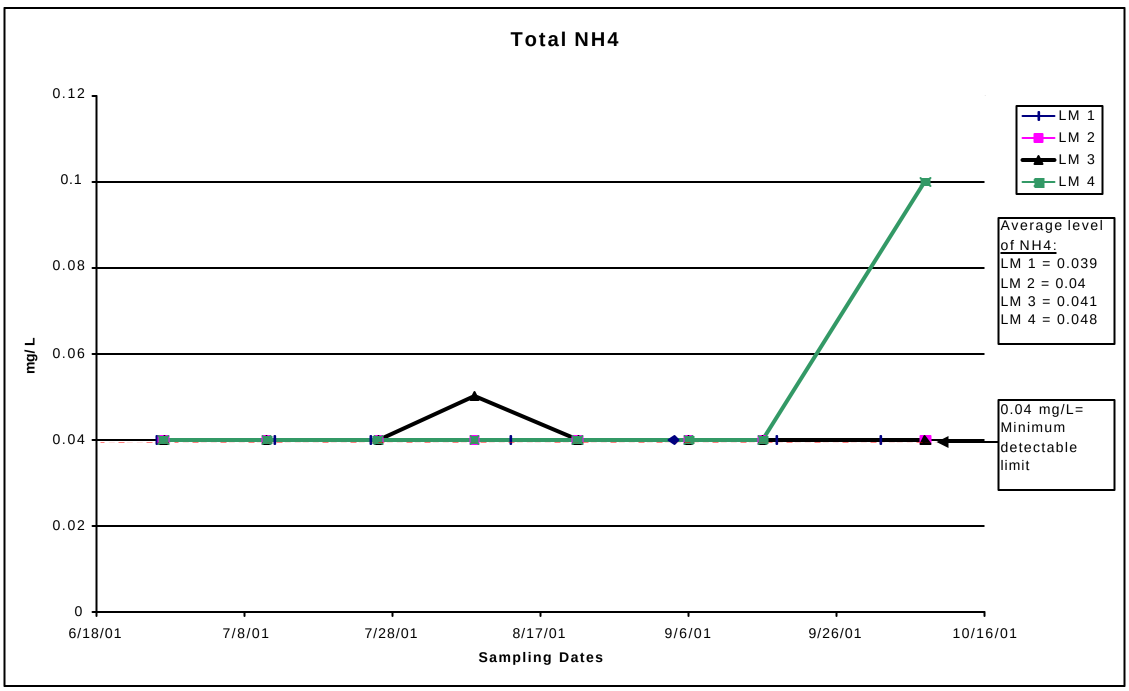


Figure 39. Long Meadow Creek Ammonia Results

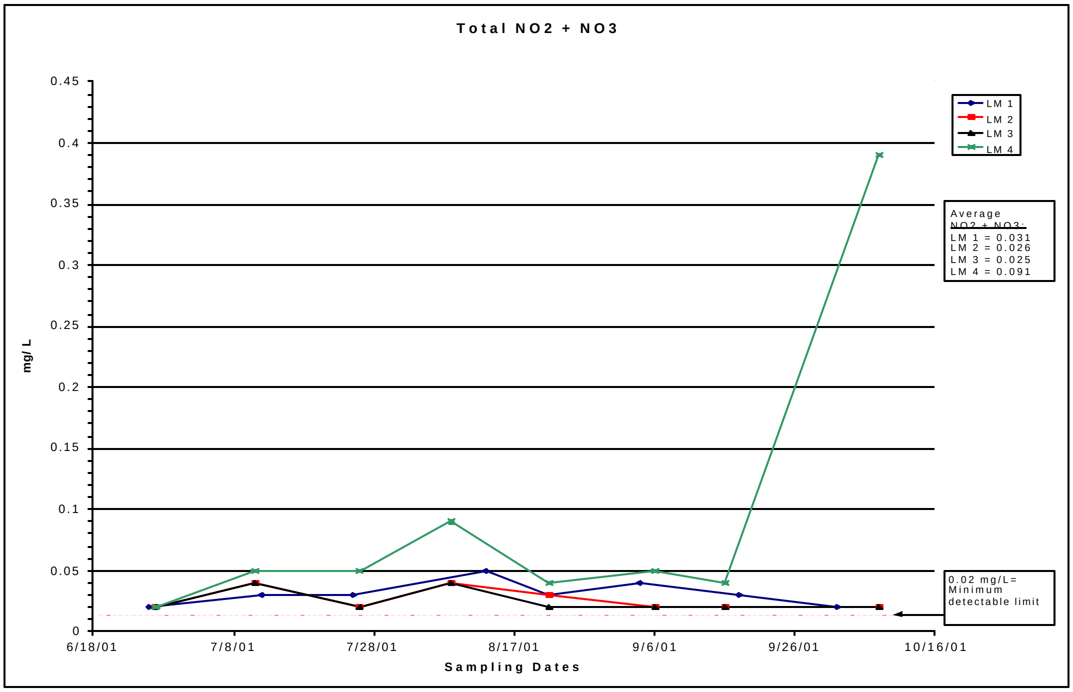


Figure 40. Long Meadow Creek Nitrogen Results

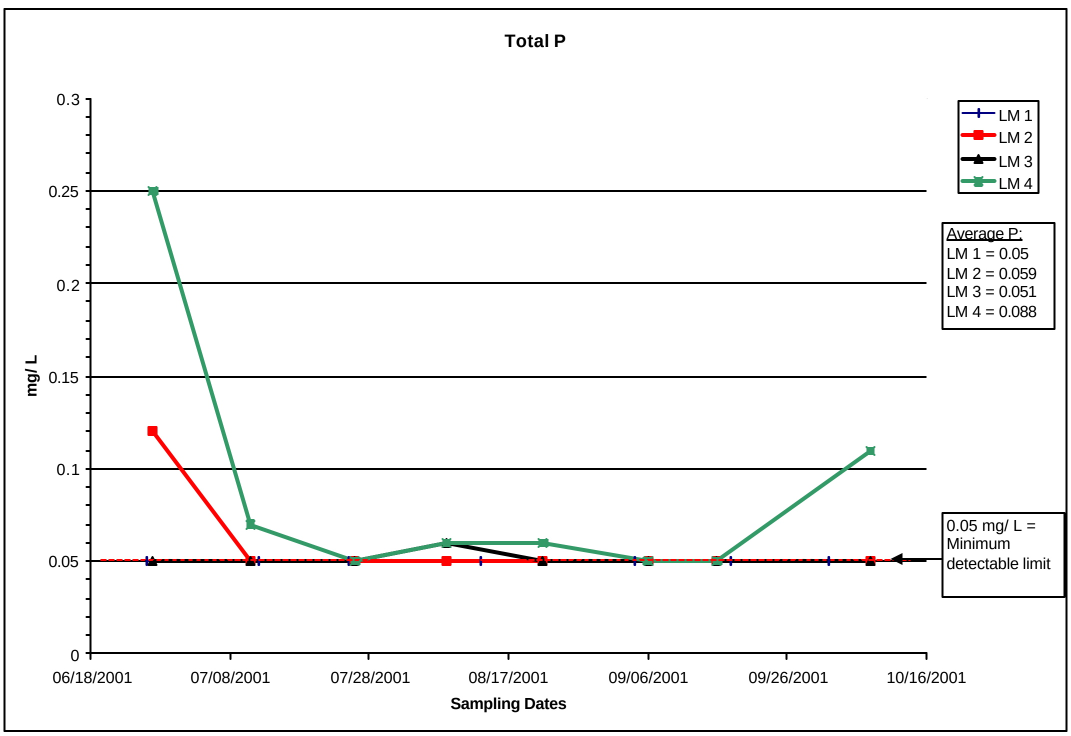


Figure 41. Long Meadow Creek Total Phosphorus Results

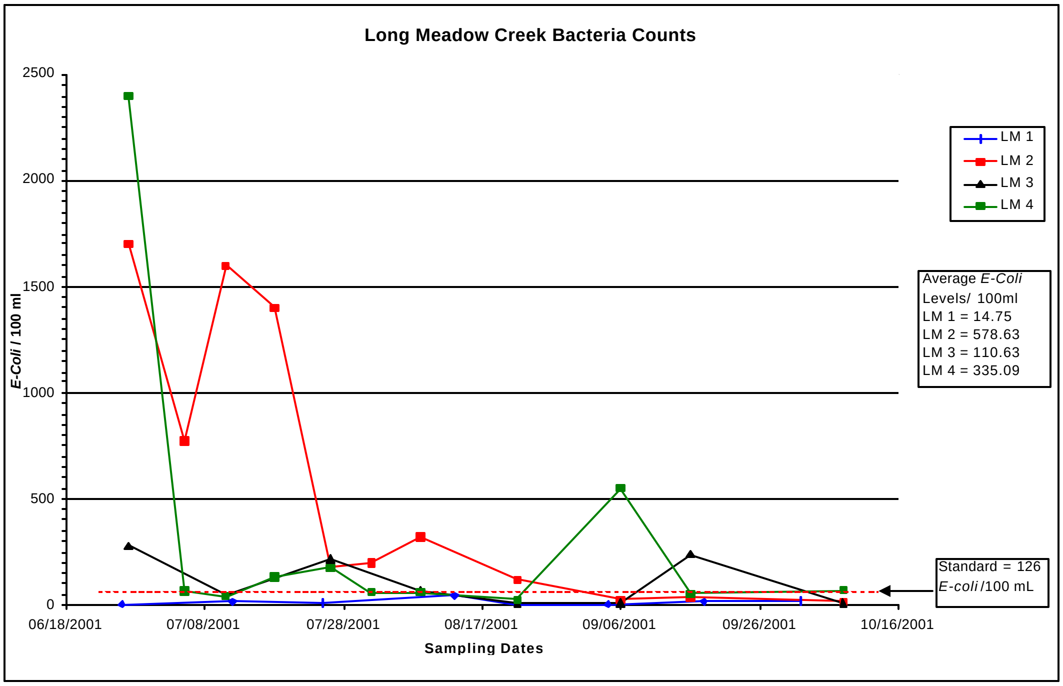


Figure 42. Long Meadow Creek Bacteria Results

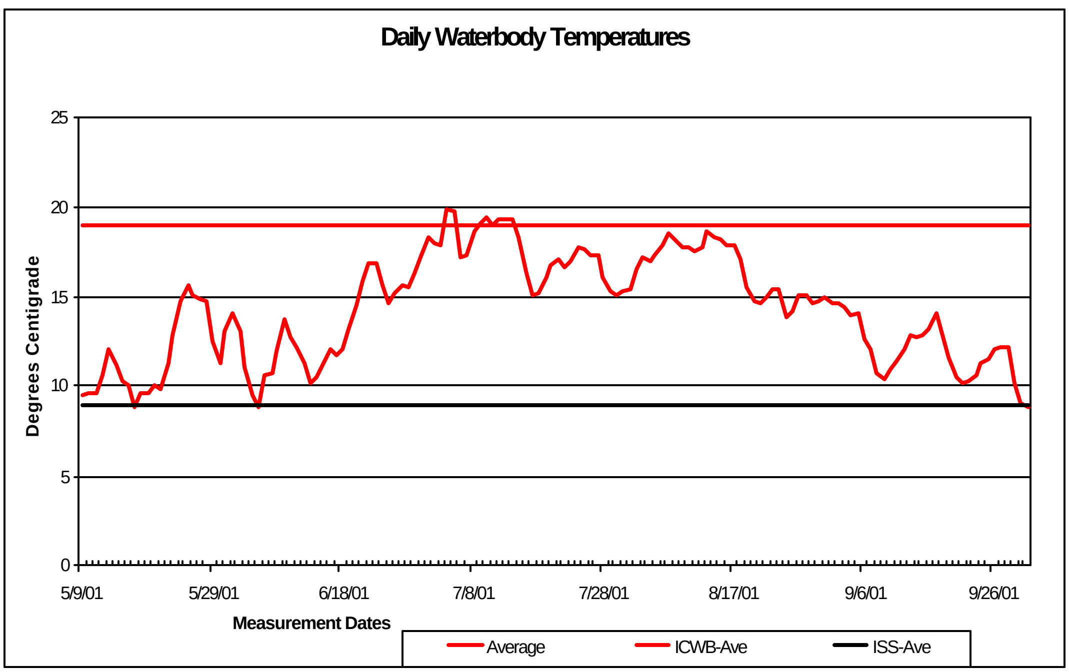


Figure 43. Long Meadow Creek Water Temperature at Mouth (LMT1)

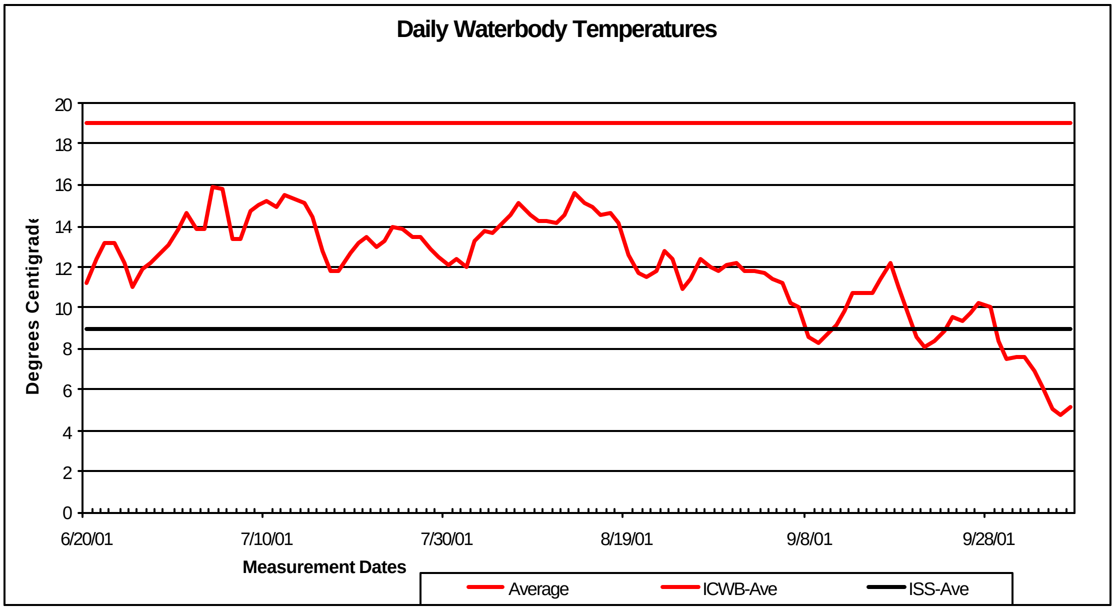


Figure 44. Long Meadow Creek Water Temperature Headwaters (LMT2)

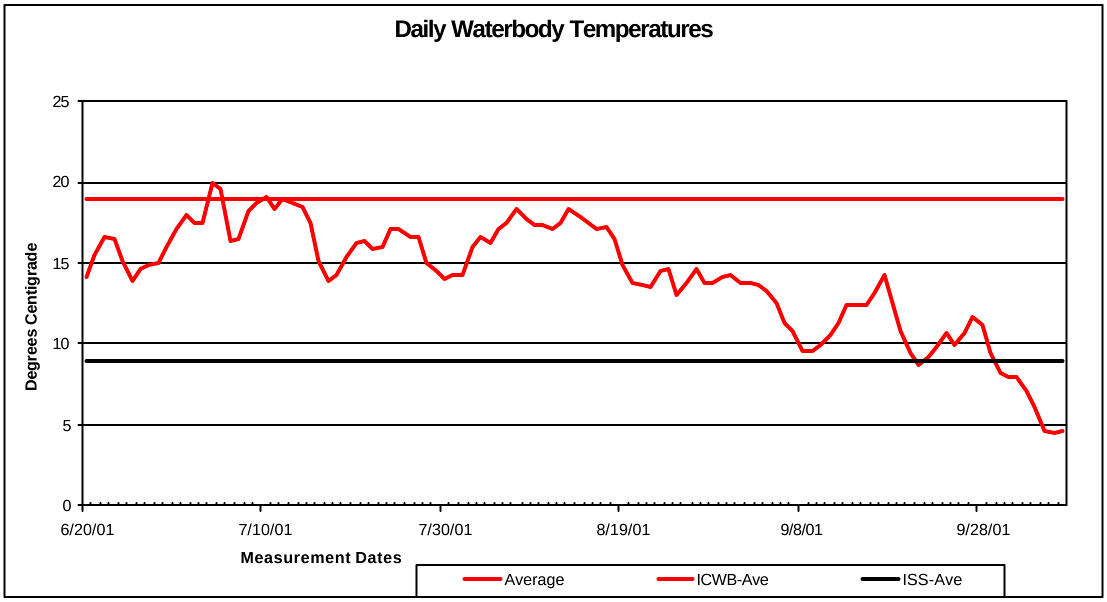


Figure 45. Long Meadow Creek Water Temperature Headwaters (LMT3)

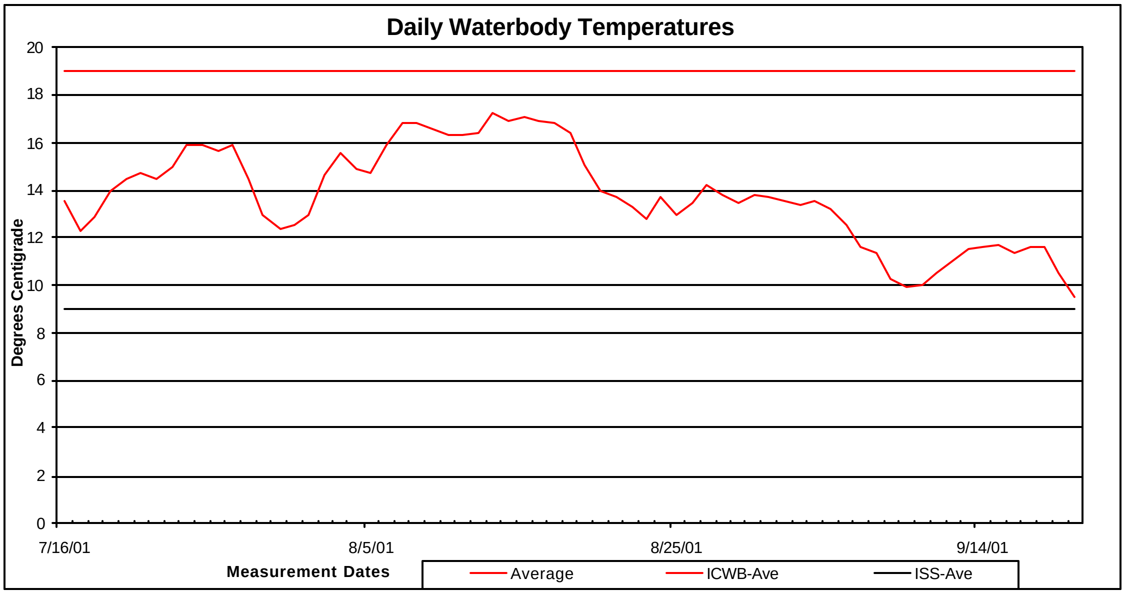


Figure 46. Reeds Creek Temperature

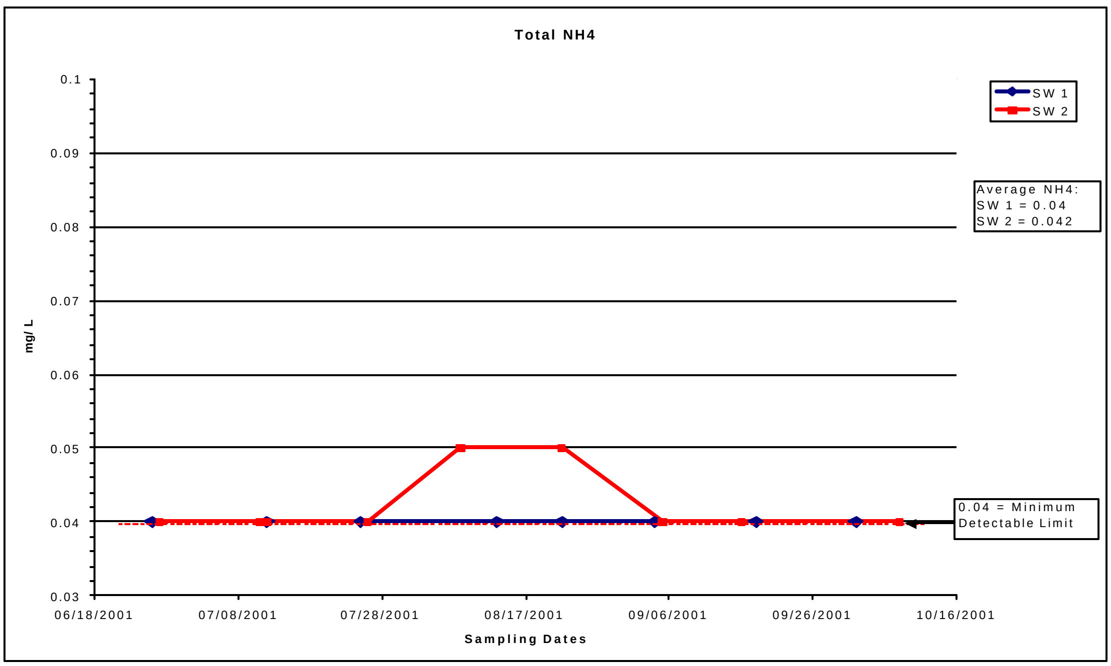


Figure 47. Swamp Creek Ammonia Results

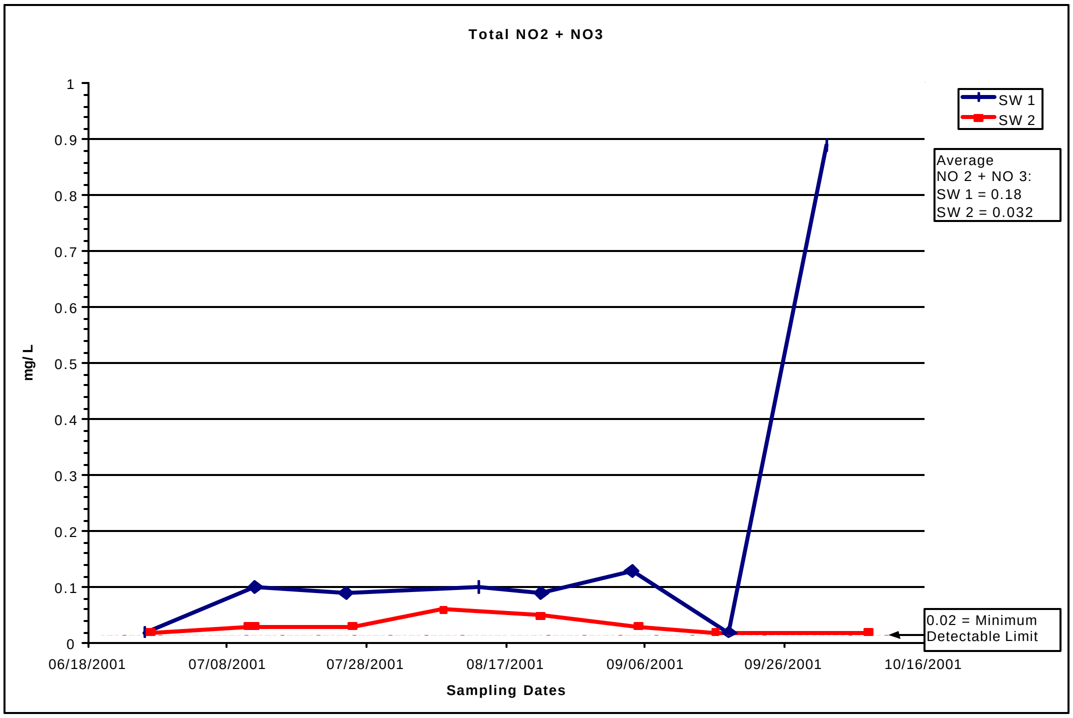


Figure 48. Swamp Creek Nitrogen Results

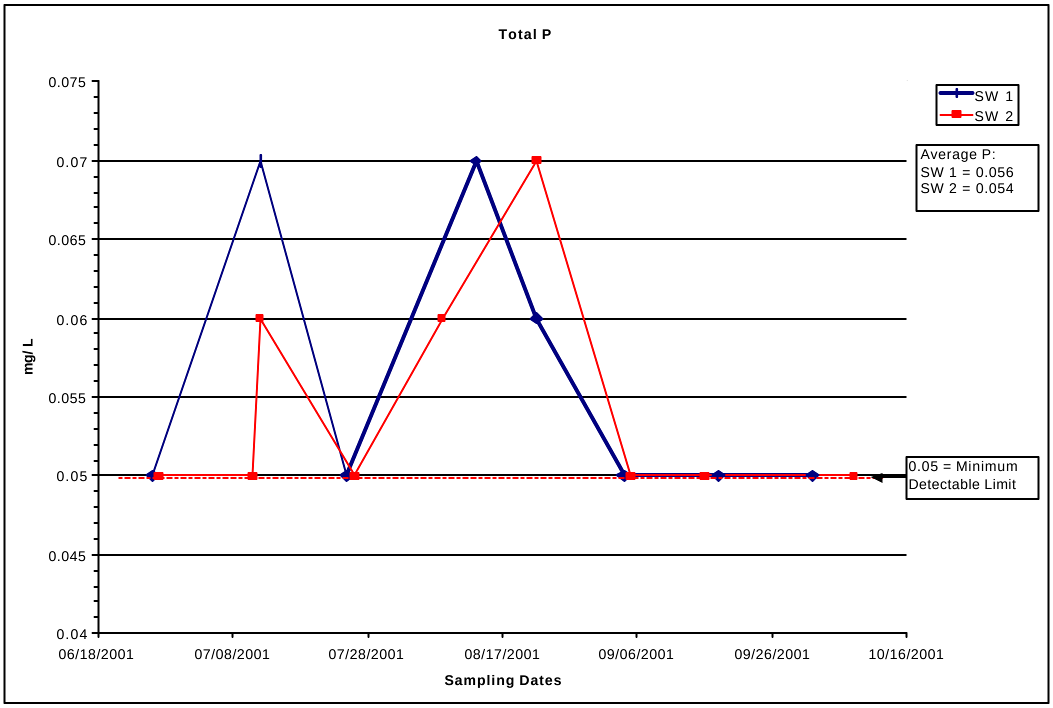


Figure 49. Swamp Creek Total Phosphorus Results

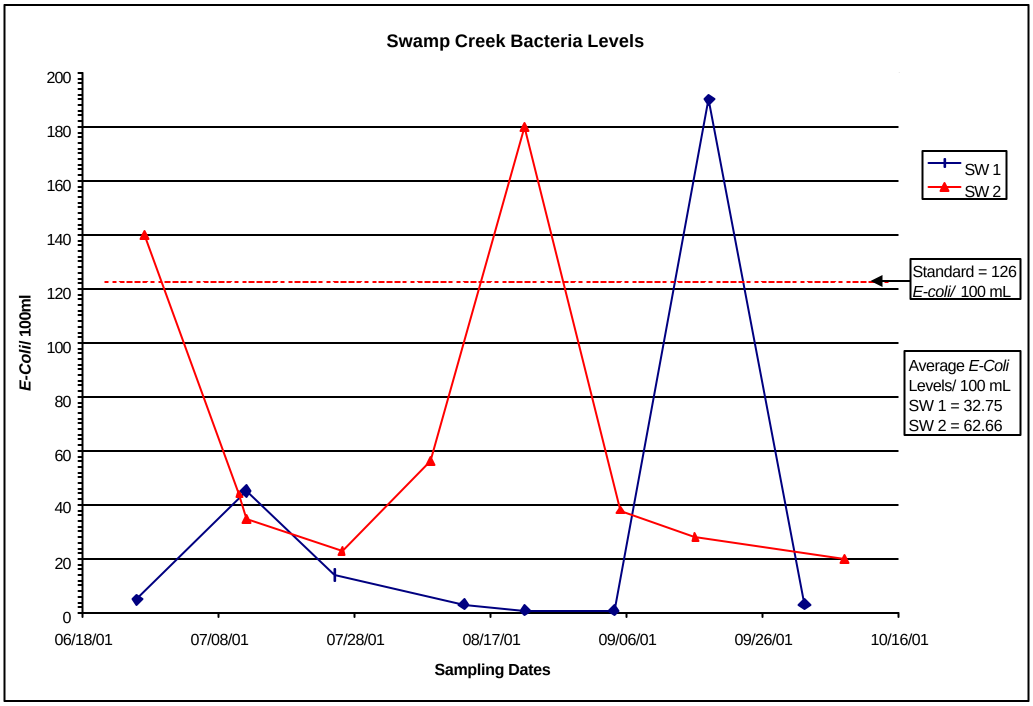


Figure 50. Swamp Creek Bacteria Results

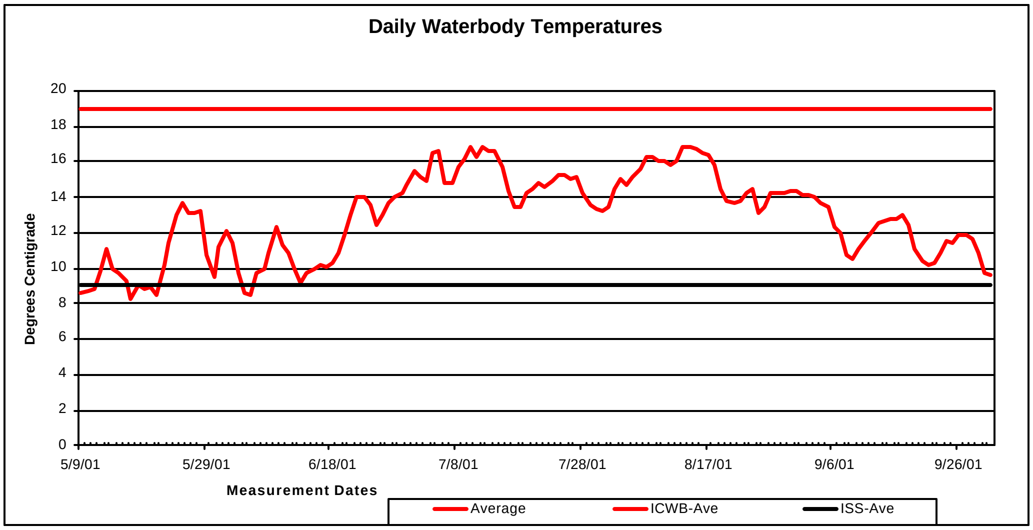


Figure 51. Swamp Creek Water Temperature at Mouth (SWT1)

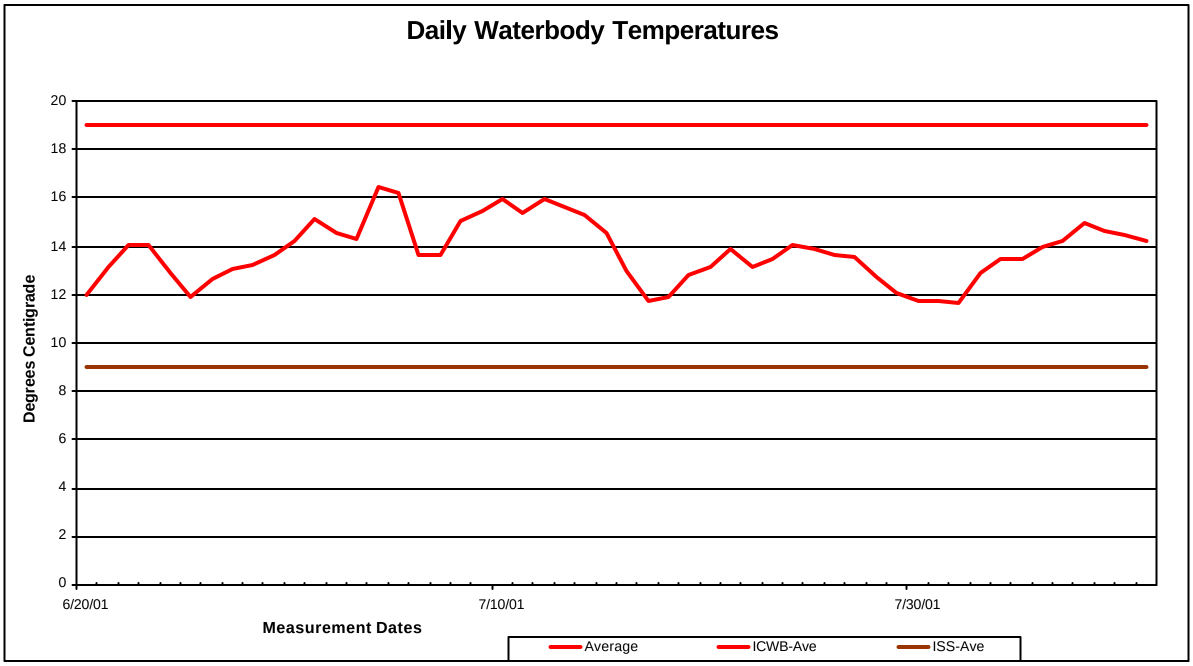


Figure 52. Swamp Creek Water Temperature Headwaters (SWT2)

Appendix D. Temperature TMDLs

The following descriptions and equations were used to determine each of the categories (top of the table) for all of the temperature TMDLs. The equations were generated by comparing CWE and the SSTEMP models, and are based on temperature, elevation and orientation.

Segment ID - Number assigned to each stream segment length
Segment length - Length of each segment in feet
Current Canopy - Current canopy cover over the stream in %
Elevation - Elevation of segment
Predicted CWE %
    (29.09861 / 0.08492) - ((Elevation x 0.00262) / 0.08492) - (Temperature / 0.08492)
Target Canopy - Required canopy to achieve temperature standard
Target Canopy Increase - Required canopy increase
Orientation - Orientation of the stream segment
    NS - North to South or South to North
    EW - East to West or West to East
    NWSE - Northwest to Southeast or Southeast to Northwest
    NESW - Northeast to Southwest or Southwest to Northeast
Heat Load Capacity - (watts per m^2)
    NS = (100-target canopy) x (2.1 + 17)
    EW = (100-target canopy) x (2.56 + 18)
    NWSE or NESW = (100-target canopy) x (2.33 + 17.5)
Current Heat Loading - (watts per m^2)
    NS = (100-current canopy) x (2.1 + 17)
    EW = (100-current canopy) x (2.56 + 18)
    NWSE or NESW = (100-current canopy) x (2.33 + 17.5)
Target Heat Load Reduction
    ((Current Heat Load-Heat Load Capacity) / Current Heat Load) x 100

Table D-1. Cranberry Creek temperature TMDL.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
669	366.30	50	1600	176	100	50	NWSE	18	134	87
559	487.60	100	1600	176	100	0	NS	17	17	0
566	249.31	100	1600	176	100	0	NS	17	17	0
589	787.25	100	1600	176	100	0	NESW	18	18	0
590	801.71	100	1600	176	100	0	NESW	18	18	0
591	419.69	100	1600	176	100	0	NESW	18	18	0
592	1071.86	100	1600	176	100	0	NS	17	17	0
593	259.24	100	1600	176	100	0	NS	17	17	0
594	703.64	100	1600	176	100	0	NESW	18	18	0
595	636.48	100	1600	176	100	0	NS	17	17	0
499	37.53	100	1700	172	100	0	NESW	18	18	0
662	711.09	50	1800	169	100	50	EW	18	146	88
668	535.07	50	1800	169	100	50	NWSE	18	134	87
685	161.25	50	1800	169	100	50	NS	17	122	86
671	740.81	60	1800	169	100	40	NWSE	18	111	84
683	225.03	60	1800	169	100	40	NESW	18	111	84
480	37.99	100	1800	169	100	0	NESW	18	18	0
588	701.74	100	1800	169	100	0	NESW	18	18	0
596	782.93	100	1800	169	100	0	NESW	18	18	0

Table D-1., Cranberry Creek temperature TMDL Cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
597	512.26	100	1800	169	100	0	NESW	18	18	0
670	644.42	60	1900	166	100	40	NWSE	18	111	84
598	720.99	50	2000	163	100	50	NWSE	18	134	87
599	866.74	50	2000	163	100	50	NWSE	18	134	87
600	606.65	50	2000	163	100	50	NWSE	18	134	87
684	178.37	50	2000	163	100	50	NWSE	18	134	87
687	637.46	50	2000	163	100	50	NS	17	122	86
682	433.94	60	2000	163	100	40	NESW	18	111	84
408	164.15	50	2200	157	100	50	NS	17	122	86
686	400.75	50	2200	157	100	50	NS	17	122	86
608	322.85	60	2200	157	100	40	NESW	18	111	84
609	241.36	60	2200	157	100	40	NESW	18	111	84
610	931.68	60	2200	157	100	40	NS	17	101	83
659	291.65	60	2200	157	100	40	EW	18	120	85
661	324.42	60	2200	157	100	40	NESW	18	111	84
666	178.44	60	2200	157	100	40	NWSE	18	111	84
672	448.99	60	2200	157	100	40	EW	18	120	85
673	638.18	60	2200	157	100	40	EW	18	120	85

Table D-1., Cranberry Creek temperature TMDL Cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
681	100.28	60	2200	157	100	40	NESW	18	111	84
689	264.15	60	2200	157	100	40	NWSE	18	111	84
676	271.32	60	2300	154	100	40	NWSE	18	111	84
677	1161.79	60	2300	154	100	40	NWSE	18	111	84
339	168.01	60	2400	151	100	40	NS	17	101	83
601	214.52	60	2400	151	100	40	NESW	18	111	84
602	684.56	60	2400	151	100	40	EW	18	120	85
603	796.39	60	2400	151	100	40	NESW	18	111	84
604	383.70	60	2400	151	100	40	NESW	18	111	84
605	299.62	60	2400	151	100	40	NESW	18	111	84
606	198.46	60	2400	151	100	40	NESW	18	111	84
607	610.43	60	2400	151	100	40	NESW	18	111	84
660	524.70	60	2400	151	100	40	EW	18	120	85
665	1142.73	60	2400	151	100	40	NWSE	18	111	84
674	999.34	60	2400	151	100	40	NWSE	18	111	84
675	358.96	60	2400	151	100	40	NWSE	18	111	84
679	232.43	60	2400	151	100	40	EW	18	120	85
680	567.74	60	2400	151	100	40	EW	18	120	85
688	1087.33	60	2400	151	100	40	NWSE	18	111	84

Table D-1., Cranberry Creek temperature TMDL Cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
655	587.33	80	2400	151	100	20	EW	18	69	74
691	326.66	80	2400	151	100	20	NWSE	18	64	73
454	54.48	60	2500	148	100	40	EW	18	120	85
657	312.84	60	2600	145	100	40	NWSE	18	111	84
658	409.02	60	2600	145	100	40	NWSE	18	111	84
664	1657.19	60	2600	145	100	40	NWSE	18	111	84
667	676.82	60	2600	145	100	40	NWSE	18	111	84
678	1006.26	60	2600	145	100	40	EW	18	120	85
611	1053.37	70	2600	145	100	30	NS	17	80	79
612	410.11	70	2600	145	100	30	NS	17	80	79
613	881.10	70	2600	145	100	30	NS	17	80	79
647	1324.11	70	2600	145	100	30	NESW	18	87	80
656	806.11	80	2600	145	100	20	NWSE	18	64	73
690	694.95	80	2600	145	100	20	NWSE	18	64	73
695	793.00	30	2800	139	100	70	NS	17	164	90
663	318.80	60	2800	139	100	40	NWSE	18	111	84
614	810.30	70	2800	139	100	30	NS	17	80	79
646	1114.79	70	2800	139	100	30	NESW	18	87	80
693	868.08	70	2800	139	100	30	NESW	18	87	80

Table D-1., Cranberry Creek temperature TMDL Cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
257	58.74	30	3000	132	100	70	NS	17	164	90
624	738.68	30	3000	132	100	70	NESW	18	181	90
625	630.22	30	3000	132	100	70	NESW	18	181	90
626	145.34	30	3000	132	100	70	NS	17	164	90
694	1106.27	30	3000	132	100	70	NS	17	164	90
645	1045.08	70	3000	132	100	30	NESW	18	87	80
692	1336.03	70	3000	132	100	30	NESW	18	87	80
615	322.56	30	3200	126	100	70	NESW	18	181	90
616	935.82	30	3200	126	100	70	NESW	18	181	90
617	573.64	30	3200	126	100	70	NESW	18	181	90
618	257.56	30	3200	126	100	70	NESW	18	181	90
619	347.53	30	3200	126	100	70	NESW	18	181	90
620	658.77	30	3200	126	100	70	NESW	18	181	90
621	257.84	30	3200	126	100	70	NESW	18	181	90
622	234.54	30	3200	126	100	70	NESW	18	181	90
623	731.70	30	3200	126	100	70	NESW	18	181	90
648	230.81	90	3200	126	100	10	NESW	18	41	57
649	389.08	90	3200	126	100	10	NESW	18	41	57
650	1085.94	90	3200	126	100	10	NESW	18	41	57

Table D-1., Cranberry Creek temperature TMDL Cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
651	334.58	90	3200	126	100	10	NESW	18	41	57
652	777.96	90	3200	126	100	10	NESW	18	41	57
653	526.44	90	3200	126	100	10	NESW	18	41	57
654	284.62	90	3200	126	100	10	NESW	18	41	57
628	1242.22	100	3200	126	100	0	NESW	18	18	0
629	529.32	100	3200	126	100	0	NESW	18	18	0
630	202.05	100	3200	126	100	0	NESW	18	18	0
631	440.47	100	3200	126	100	0	NESW	18	18	0
632	41.91	100	3200	126	100	0	NESW	18	18	0
633	306.77	100	3200	126	100	0	NESW	18	18	0
634	635.98	100	3200	126	100	0	NESW	18	18	0
635	110.51	100	3200	126	100	0	NESW	18	18	0
636	142.70	100	3200	126	100	0	NESW	18	18	0
637	650.00	100	3200	126	100	0	NESW	18	18	0
638	836.33	100	3200	126	100	0	NESW	18	18	0
639	335.77	100	3200	126	100	0	NESW	18	18	0
640	253.68	100	3200	126	100	0	NESW	18	18	0
641	294.25	100	3200	126	100	0	NESW	18	18	0
642	146.63	100	3200	126	100	0	NESW	18	18	0

Table D-1., Cranberry Creek temperature TMDL Cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
643	233.44	100	3200	126	100	0	NESW	18	18	0
644	322.06	100	3200	126	100	0	NESW	18	18	0

Table D-2. Elk Creek temperature TMDL.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
1458	211.49	7	1600	176	100	93	NS	17	212	92
1459	440.22	7	1600	176	100	93	NS	17	212	92
1460	604.00	7	1600	176	100	93	NS	17	212	92
1461	1646.97	7	1600	176	100	93	NS	17	212	92
1462	242.61	7	1600	176	100	93	NS	17	212	92
1463	361.88	7	1600	176	100	93	NS	17	212	92
1464	658.91	7	1600	176	100	93	NS	17	212	92
1465	1092.49	7	1600	176	100	93	NS	17	212	92
1466	327.87	7	1600	176	100	93	NWSE	18	234	93
1467	32.81	7	1600	176	100	93	NS	17	212	92
1894	486.23	7	1600	176	100	93	NESW	18	234	93
1895	292.31	7	1600	176	100	93	NESW	18	234	93
1896	974.78	7	1600	176	100	93	NESW	18	234	93
1974	591.03	7	1600	176	100	93	NESW	18	234	93
1984	3107.68	7	1600	176	100	93	NESW	18	234	93
1985	406.17	7	1600	176	100	93	NS	17	212	92
2033	374.74	7	1600	176	100	93	NESW	18	234	93
2054	237.46	68	1800	169	100	32	NWSE	18	92	81
1377	930.99	7	1800	169	100	93	NWSE	18	234	93

Table D-2., **Elk Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
1893	265.00	7	1800	169	100	93	NESW	18	234	93
1973	337.60	7	1800	169	100	93	EW	18	256	93
1979	217.15	7	1800	169	100	93	NESW	18	234	93
1980	1689.50	7	1800	169	100	93	NESW	18	234	93
1981	135.81	7	1800	169	100	93	EW	18	256	93
1982	619.36	7	1800	169	100	93	NESW	18	234	93
1983	165.51	7	1800	169	100	93	NESW	18	234	93
2014	518.42	7	1800	169	100	93	NWSE	18	234	93
2015	612.76	7	1800	169	100	93	NWSE	18	234	93
2024	131.62	7	1800	169	100	93	NWSE	18	234	93
2031	1196.32	7	1800	169	100	93	NESW	18	234	93
2034	2440.72	7	1800	169	100	93	NESW	18	234	93
2051	1534.51	68	2000	163	100	32	NWSE	18	92	81
2055	136.42	68	2000	163	100	32	NWSE	18	92	81
2049	1225.12	38	2000	163	100	62	NWSE	18	162	89
1977	397.37	7	2000	163	100	93	NWSE	18	234	93
1978	25.58	7	2000	163	100	93	NWSE	18	234	93
2006	518.86	7	2000	163	100	93	NS	17	212	92

Table D-2., Elk Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
2007	29.59	7	2000	163	100	93	NWSE	18	234	93
2008	353.47	7	2000	163	100	93	NS	17	212	92
2009	828.51	7	2000	163	100	93	NS	17	212	92
2029	634.73	7	2000	163	100	93	NWSE	18	234	93
2032	3629.54	7	2000	163	100	93	NESW	18	234	93
2052	1262.72	68	2200	157	100	32	NWSE	18	92	81
2056	2277.35	68	2200	157	100	32	NESW	18	92	81
2069	1313.68	68	2200	157	100	32	NWSE	18	92	81
2022	497.67	38	2200	157	100	62	NWSE	18	162	89
2050	1065.69	38	2200	157	100	62	NWSE	18	162	89
1454	125.42	7	2200	157	100	93	EW	18	256	93
1455	1463.00	7	2200	157	100	93	NS	17	212	92
1456	57.30	7	2200	157	100	93	NS	17	212	92
1457	326.93	7	2200	157	100	93	NS	17	212	92
2030	708.19	7	2200	157	100	93	NS	17	212	92
2061	486.83	84	2400	151	100	16	NS	17	51	66
1282	1260.56	68	2400	151	100	32	NESW	18	92	81
1337	633.44	68	2400	151	100	32	NWSE	18	92	81
2023	1095.88	68	2400	151	100	32	NWSE	18	92	81

Table D-2., Elk Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
2053	1188.74	68	2400	151	100	32	NWSE	18	92	81
2057	1528.62	68	2400	151	100	32	NESW	18	92	81
2070	733.03	68	2400	151	100	32	NWSE	18	92	81
2073	2678.55	68	2400	151	100	32	NWSE	18	92	81
1892	227.56	7	2400	151	100	93	NS	17	212	92
2025	557.20	7	2400	151	100	93	NS	17	212	92
2027	332.67	7	2400	151	100	93	EW	18	256	93
2028	871.78	7	2400	151	100	93	EW	18	256	93
2071	3238.59	7	2400	151	100	93	NWSE	18	234	93
2062	2732.73	84	2600	145	100	16	NS	17	51	66
1275	433.87	68	2600	145	100	32	NESW	18	92	81
1277	318.55	68	2600	145	100	32	NESW	18	92	81
1577	404.31	68	2600	145	100	32	NESW	18	92	81
1578	754.80	68	2600	145	100	32	NWSE	18	92	81
1580	1070.47	68	2600	145	100	32	NESW	18	92	81
2036	251.38	68	2600	145	100	32	NESW	18	92	81
2074	821.59	68	2600	145	100	32	NWSE	18	92	81
2075	2385.40	68	2600	145	100	32	NWSE	18	92	81
1579	586.70	38	2600	145	100	62	NWSE	18	162	89

Table D-2., Elk Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
1585	2360.73	38	2600	145	100	62	NWSE	18	162	89
2037	588.75	23	2600	145	100	77	NESW	18	197	91
2065	3290.78	23	2600	145	100	77	NESW	18	197	91
1346	2160.02	7	2600	145	100	93	NWSE	18	234	93
1370	1687.99	7	2600	145	100	93	NWSE	18	234	93
1372	784.05	7	2600	145	100	93	NWSE	18	234	93
1449	828.04	7	2600	145	100	93	NS	17	212	92
1450	913.93	7	2600	145	100	93	NS	17	212	92
1451	706.10	7	2600	145	100	93	NS	17	212	92
1452	249.62	7	2600	145	100	93	NS	17	212	92
1453	1551.41	7	2600	145	100	93	NS	17	212	92
1881	525.58	7	2600	145	100	93	NS	17	212	92
1882	286.52	7	2600	145	100	93	NS	17	212	92
1883	2397.04	7	2600	145	100	93	NS	17	212	92
1884	1860.35	7	2600	145	100	93	NWSE	18	234	93
1885	1970.80	7	2600	145	100	93	NS	17	212	92
1886	283.74	7	2600	145	100	93	NS	17	212	92
1887	1559.92	7	2600	145	100	93	NWSE	18	234	93
1888	1389.17	7	2600	145	100	93	NS	17	212	92

Table D-2., Elk Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
1889	399.98	7	2600	145	100	93	NS	17	212	92
1890	1761.82	7	2600	145	100	93	EW	18	256	93
1891	318.42	7	2600	145	100	93	NESW	18	234	93
2004	241.00	7	2600	145	100	93	NS	17	212	92
2005	1104.25	7	2600	145	100	93	NS	17	212	92
2026	594.94	7	2600	145	100	93	NESW	18	234	93
2063	746.66	7	2600	145	100	93	NESW	18	234	93
2072	970.86	7	2600	145	100	93	NWSE	18	234	93
2047	518.27	95	2800	139	100	5	NESW	18	29	40
2043	2960.76	84	2800	139	100	16	NESW	18	55	68
2058	1587.21	84	2800	139	100	16	NESW	18	55	68
2076	1667.83	68	2800	139	100	32	NWSE	18	92	81
2046	373.60	53	2800	139	100	47	NESW	18	127	86
1583	31.13	38	2800	139	100	62	NESW	18	162	89
1930	1445.02	38	2800	139	100	62	NESW	18	162	89
2041	2223.20	38	2800	139	100	62	NESW	18	162	89
1809	1131.29	23	2800	139	100	77	NESW	18	197	91
1818	2429.41	23	2800	139	100	77	NESW	18	197	91
1819	102.12	23	2800	139	100	77	NESW	18	197	91

Table D-2., Elk Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
2038	380.45	23	2800	139	100	77	NESW	18	197	91
2039	1542.01	23	2800	139	100	77	NESW	18	197	91
2066	2685.23	23	2800	139	100	77	NESW	18	197	91
1350	1312.52	7	2800	139	100	93	NWSE	18	234	93
2044	924.02	7	2800	139	100	93	NESW	18	234	93
2064	546.82	7	2800	139	100	93	NESW	18	234	93
2067	3999.79	7	2800	139	100	93	NWSE	18	234	93
1570	1444.59	53	3000	132	100	47	NESW	18	127	86
2042	1610.45	53	3000	132	100	47	NESW	18	127	86
2068	1329.52	7	3000	132	100	93	NESW	18	234	93

Table D-3. Long Meadow Creek temperature TMDL.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
173-H	359.91	90	2800	139	100	10	NS	17	38	55
186-H	535.03	90	2800	139	100	10	NS	17	38	55
856-H	1109.16	95	2600	145	100	5	NESW	18	29	40
857-H	276.45	95	2600	145	100	5	NESW	18	29	40
858-H	966.14	95	2600	145	100	5	NESW	18	29	40
859-H	300.16	95	2600	145	100	5	NS	17	28	38
860-H	160.68	95	2600	145	100	5	NS	17	28	38
861-H	674.02	95	2600	145	100	5	NS	17	28	38
862-H	389.17	60	2600	145	100	40	NWSE	18	111	84
863-H	311.84	60	2600	145	100	40	NWSE	18	111	84
864-H	339.10	60	2600	145	100	40	NWSE	18	111	84
865-H	339.01	60	2600	145	100	40	NWSE	18	111	84
866-H	282.47	60	2600	145	100	40	NWSE	18	111	84
867-H	408.07	60	2600	145	100	40	NWSE	18	111	84
868-H	345.66	60	2600	145	100	40	NWSE	18	111	84
869-H	375.17	60	2600	145	100	40	NWSE	18	111	84
870-H	474.04	60	2600	145	100	40	NWSE	18	111	84
871-H	219.20	60	2600	145	100	40	NWSE	18	111	84
872-H	111.48	60	2600	145	100	40	NWSE	18	111	84

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
873-H	537.26	60	2600	145	100	40	NWSE	18	111	84
874-H	402.23	60	2600	145	100	40	NWSE	18	111	84
875-H	415.23	60	2600	145	100	40	NWSE	18	111	84
876-H	304.56	60	2600	145	100	40	NWSE	18	111	84
877-H	355.92	60	2600	145	100	40	NWSE	18	111	84
878-H	354.83	60	2600	145	100	40	NWSE	18	111	84
879-H	479.79	60	2600	145	100	40	NWSE	18	111	84
880-H	293.07	60	2600	145	100	40	NWSE	18	111	84
881-H	379.06	60	2600	145	100	40	NWSE	18	111	84
882-H	792.90	60	2600	145	100	40	NESW	18	111	84
883-H	353.64	40	2800	139	100	60	EW	18	172	90
884-H	320.51	40	2800	139	100	60	EW	18	172	90
885-H	403.91	40	2800	139	100	60	EW	18	172	90
886-H	453.91	40	2800	139	100	60	EW	18	172	90
887-H	91.42	40	2800	139	100	60	EW	18	172	90
888-H	468.39	40	2800	139	100	60	EW	18	172	90
889-H	275.94	40	2600	145	100	60	EW	18	172	90
890-H	198.93	60	2800	139	100	40	NWSE	18	111	84

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
891-H	128.42	60	2800	139	100	40	NWSE	18	111	84
892-H	249.76	60	2800	139	100	40	NWSE	18	111	84
893-H	566.00	60	2800	139	100	40	NWSE	18	111	84
894-H	371.42	60	2800	139	100	40	NWSE	18	111	84
895-H	259.25	60	2800	139	100	40	NWSE	18	111	84
896-H	559.84	60	2800	139	100	40	NWSE	18	111	84
897-H	376.55	60	2800	139	100	40	NWSE	18	111	84
898-H	553.03	60	2800	139	100	40	NWSE	18	111	84
899-H	508.59	60	2800	139	100	40	NWSE	18	111	84
900-H	63.11	60	2800	139	100	40	NWSE	18	111	84
901-H	319.59	60	2800	139	100	40	NWSE	18	111	84
902-H	166.44	60	2800	139	100	40	NWSE	18	111	84
903-H	497.18	60	2600	145	100	40	NWSE	18	111	84
904-H	443.80	60	2600	145	100	40	NWSE	18	111	84
905-H	126.94	60	2600	145	100	40	NWSE	18	111	84
906-H	730.79	60	2600	145	100	40	NWSE	18	111	84
907-H	173.30	60	2600	145	100	40	NWSE	18	111	84
908-H	203.24	60	2800	139	100	40	NWSE	18	111	84
909-H	568.55	60	2800	139	100	40	NESW	18	111	84

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
910-H	2043.06	60	2800	139	100	40	NWSE	18	111	84
911-H	291.20	10	2800	139	100	90	EW	18	248	93
912-H	553.12	10	2800	139	100	90	NESW	18	227	92
913-H	66.67	10	2800	139	100	90	EW	18	248	93
914-H	448.92	10	2800	139	100	90	EW	18	248	93
915-H	498.75	10	2800	139	100	90	EW	18	248	93
916-H	81.16	10	2800	139	100	90	EW	18	248	93
917-H	605.40	10	2800	139	100	90	EW	18	248	93
918-H	225.18	10	2800	139	100	90	EW	18	248	93
919-H	91.07	10	2800	139	100	90	EW	18	248	93
920-H	412.89	10	2800	139	100	90	EW	18	248	93
921-H	860.65	10	2800	139	100	90	EW	18	248	93
922-H	282.20	10	2800	139	100	90	EW	18	248	93
923-H	621.12	10	2800	139	100	90	EW	18	248	93
924-H	462.50	10	2800	139	100	90	EW	18	248	93
925-H	217.54	0	2800	139	100	100	EW	18	274	93
926-H	544.09	0	2800	139	100	100	EW	18	274	93
927-H	557.72	50	2800	139	100	50	EW	18	146	88
928-H	441.56	50	2800	139	100	50	EW	18	146	88

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
929-H	387.38	50	2800	139	100	50	EW	18	146	88
930-H	54.09	50	2800	139	100	50	EW	18	146	88
931-H	318.02	50	2800	139	100	50	EW	18	146	88
932-H	268.61	50	2800	139	100	50	EW	18	146	88
933-H	499.29	50	2800	139	100	50	EW	18	146	88
934-H	369.24	50	2800	139	100	50	EW	18	146	88
935-H	435.36	50	2800	139	100	50	EW	18	146	88
936-H	693.44	50	2800	139	100	50	EW	18	146	88
937-H	388.42	50	2800	139	100	50	EW	18	146	88
938-H	1014.09	5	2800	139	100	95	NESW	18	239	93
939-H	320.79	5	2800	139	100	95	NS	17	217	92
940-H	203.67	5	2800	139	100	95	NS	17	217	92
941-H	1272.23	5	2800	139	100	95	NS	17	217	92
942-H	729.56	5	2800	139	100	95	NS	17	217	92
943-H	104.95	5	2800	139	100	95	NS	17	217	92
944-H	403.54	5	2800	139	100	95	NS	17	217	92
945-H	514.91	5	2800	139	100	95	NS	17	217	92
946-H	605.76	5	2800	139	100	95	NESW	18	239	93
947-H	654.00	45	3000	132	100	55	NESW	18	146	88

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
948-H	527.33	45	3000	132	100	55	NESW	18	146	88
949-H	157.30	45	3000	132	100	55	NESW	18	146	88
950-H	246.27	45	3000	132	100	55	NESW	18	146	88
951-H	127.12	45	3000	132	100	55	NESW	18	146	88
952-H	729.61	45	2800	139	100	55	NESW	18	146	88
953-H	266.19	45	2800	139	100	55	NESW	18	146	88
954-H	438.32	45	2800	139	100	55	NESW	18	146	88
955-H	759.07	60	3200	126	100	40	NWSE	18	111	84
956-H	375.17	60	3200	126	100	40	NWSE	18	111	84
957-H	87.59	60	3000	132	100	40	NESW	18	111	84
958-H	284.35	60	3000	132	100	40	NESW	18	111	84
959-H	500.79	60	3000	132	100	40	NESW	18	111	84
960-H	50.68	60	3200	126	100	40	NWSE	18	111	84
962-H	376.12	75	3400	120	100	25	NWSE	18	76	77
963-H	712.41	75	3400	120	100	25	NWSE	18	76	77
964-H	370.40	75	3200	126	100	25	NWSE	18	76	77
965-H	520.22	75	3200	126	100	25	NWSE	18	76	77
966-H	569.72	75	3000	132	100	25	NWSE	18	76	77
967-H	171.21	75	3000	132	100	25	NWSE	18	76	77

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
968-H	718.29	75	3000	132	100	25	NWSE	18	76	77
969-H	418.10	75	3000	132	100	25	NWSE	18	76	77
970-H	269.64	75	3000	132	100	25	NWSE	18	76	77
971-H	293.19	75	3000	132	100	25	NWSE	18	76	77
972-H	903.01	75	2800	139	100	25	NWSE	18	76	77
973-H	703.52	75	2800	139	100	25	NWSE	18	76	77
974-H	1072.45	75	2800	139	100	25	NWSE	18	76	77
975-H	106.17	75	2800	139	100	25	NWSE	18	76	77
977-H	1194.50	75	2800	139	100	25	NS	17	70	76
978-H	269.93	75	2800	139	100	25	NS	17	70	76
979-H	228.31	75	2800	139	100	25	NS	17	70	76
980-H	299.22	75	2800	139	100	25	NS	17	70	76
981-H	447.08	75	2800	139	100	25	NS	17	70	76
982-H	1070.86	75	2800	139	100	25	NS	17	70	76
983-H	447.22	15	2800	139	100	85	NS	17	196	91
984-H	916.56	15	2800	139	100	85	NS	17	196	91
985-H	419.12	25	3000	132	100	75	NS	17	175	90
986-H	426.62	25	3000	132	100	75	NS	17	175	90
987-H	501.19	25	3000	132	100	75	NS	17	175	90

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
988-H	493.99	25	3000	132	100	75	NS	17	175	90
989-H	191.41	25	3000	132	100	75	NS	17	175	90
990-H	203.18	25	3000	132	100	75	NS	17	175	90
991-H	2174.90	25	2800	139	100	75	NS	17	175	90
992-H	510.36	25	2800	139	100	75	NS	17	175	90
993-H	1337.38	25	2800	139	100	75	NS	17	175	90
994-H	784.68	25	2800	139	100	75	NWSE	18	192	91
995-H	498.12	75	2800	139	100	25	NS	17	70	76
996-H	197.51	75	2800	139	100	25	NS	17	70	76
997-H	384.79	75	2800	139	100	25	NS	17	70	76
998-H	540.67	0	2800	139	100	100	NS	17	227	93
999-H	328.28	0	2800	139	100	100	NS	17	227	93
1000-H	611.12	0	2800	139	100	100	NS	17	227	93
1001-H	1206.40	0	2800	139	100	100	NS	17	227	93
1002-H	327.98	0	2800	139	100	100	NS	17	227	93
1003-H	309.43	0	2800	139	100	100	NS	17	227	93
1004-H	520.31	0	2800	139	100	100	NESW	18	251	93
1005-H	475.60	0	2800	139	100	100	NESW	18	251	93
1006-H	521.47	50	2800	139	100	50	NESW	18	134	87

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
1007-H	1050.30	50	2800	139	100	50	NESW	18	134	87
1008-H	729.43	50	2800	139	100	50	NS	17	122	86
1009-H	742.44	10	2800	139	100	90	NWSE	18	227	92
1010-H	302.32	10	2800	139	100	90	NWSE	18	227	92
1011-H	156.77	10	2800	139	100	90	NWSE	18	227	92
1012-H	77.68	10	2800	139	100	90	NWSE	18	227	92
1013-H	272.07	10	2800	139	100	90	NWSE	18	227	92
1014-H	988.05	10	2800	139	100	90	NWSE	18	227	92
1015-H	841.47	25	2800	139	100	75	NWSE	18	192	91
1016-H	301.74	25	2800	139	100	75	NWSE	18	192	91
1017-H	71.68	25	2800	139	100	75	NWSE	18	192	91
1018-H	1061.97	25	2800	139	100	75	NESW	18	192	91
1019-H	666.87	80	3000	132	100	20	NWSE	18	64	73
1020-H	693.76	80	3000	132	100	20	NWSE	18	64	73
1021-H	220.22	80	3000	132	100	20	NWSE	18	64	73
1022-H	623.69	80	3000	132	100	20	NWSE	18	64	73
1023-H	367.64	80	3000	132	100	20	NWSE	18	64	73
1024-H	349.07	60	3400	120	100	40	NWSE	18	111	84
1025-H	783.90	60	3200	126	100	40	NWSE	18	111	84

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
1026-H	561.72	60	3200	126	100	40	NWSE	18	111	84
1027-H	300.23	90	3000	132	100	10	NS	17	38	55
1028-H	436.67	90	3000	132	100	10	NS	17	38	55
1029-H	364.25	90	3000	132	100	10	NS	17	38	55
1030-H	544.08	90	3000	132	100	10	NS	17	38	55
1031-H	270.45	90	3000	132	100	10	NS	17	38	55
1032-H	309.64	90	3000	132	100	10	NS	17	38	55
1033-H	660.79	90	3000	132	100	10	NS	17	38	55
1034-H	560.15	90	2800	139	100	10	NS	17	38	55
1035-H	1169.15	50	3600	114	100	50	NESW	18	134	87
1036-H	325.99	50	3400	120	100	50	NESW	18	134	87
1037-H	64.27	50	3200	126	100	50	NESW	18	134	87
1038-H	218.23	50	3200	126	100	50	NESW	18	134	87
1039-H	286.38	50	3200	126	100	50	NESW	18	134	87
1040-H	555.84	50	3200	126	100	50	NESW	18	134	87
1041-H	474.27	50	3000	132	100	50	NESW	18	134	87
1042-H	193.70	50	3000	132	100	50	NWSE	18	134	87
1043-H	446.03	50	3000	132	100	50	NWSE	18	134	87
1044-H	158.15	50	3000	132	100	50	NWSE	18	134	87

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
1045-H	226.15	50	3000	132	100	50	NWSE	18	134	87
1047-H	971.88	60	3600	114	100	40	NESW	18	111	84
1048-H	541.47	60	3400	120	100	40	NESW	18	111	84
1049-H	387.33	60	3400	120	100	40	NESW	18	111	84
1050-H	268.58	60	3400	120	100	40	NESW	18	111	84
1051-H	270.83	60	3200	126	100	40	NESW	18	111	84
1052-H	426.29	60	3200	126	100	40	NESW	18	111	84
1053-H	316.65	60	3200	126	100	40	NESW	18	111	84
1054-H	650.41	60	3200	126	100	40	NESW	18	111	84
1055-H	902.55	60	3200	126	100	40	NESW	18	111	84
1056-H	220.74	60	3200	126	100	40	NESW	18	111	84
1057-H	96.24	60	3200	126	100	40	NESW	18	111	84
1058-H	134.13	60	3200	126	100	40	NESW	18	111	84
1059-H	1168.77	60	3000	132	100	40	NESW	18	111	84
1060-H	579.98	60	3000	132	100	40	NESW	18	111	84
1061-H	442.12	60	3000	132	100	40	NESW	18	111	84
1062-H	262.70	60	3000	132	100	40	NESW	18	111	84
1063-H	273.52	60	3000	132	100	40	NESW	18	111	84
1064-H	458.14	60	2800	139	100	40	NESW	18	111	84

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
1065-H	948.65	50	3200	126	100	50	NESW	18	134	87
1066-H	474.47	50	3000	132	100	50	NESW	18	134	87
1067-H	327.12	50	3400	120	100	50	NESW	18	134	87
1068-H	339.21	50	3200	126	100	50	NESW	18	134	87
1069-H	454.48	60	3000	132	100	40	NESW	18	111	84
1070-H	129.88	60	2800	139	100	40	NESW	18	111	84
1071-H	208.46	90	3000	132	100	10	NS	17	38	55
1072-H	686.48	90	2800	139	100	10	NS	17	38	55
1073-H	565.34	60	3400	120	100	40	NWSE	18	111	84
1074-H	385.99	60	3200	126	100	40	NWSE	18	111	84
1075-H	404.99	60	3600	114	100	40	NWSE	18	111	84
1076-H	843.28	60	3400	120	100	40	NWSE	18	111	84
1077-H	1168.93	60	3800	108	100	40	NWSE	18	111	84
1078-H	573.74	60	4200	95	95	35	NWSE	28	111	74
1079-H	539.55	60	4000	101	100	40	NWSE	18	111	84
1080-H	268.77	75	2800	139	100	25	NS	17	70	76
1081-H	328.72	75	2600	145	100	25	NS	17	70	76
1082-H	541.49	60	3800	108	100	40	NWSE	18	111	84
1083-H	1345.46	60	4000	101	100	40	NWSE	18	111	84

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
1084-H	738.23	60	3200	126	100	40	NESW	18	111	84
1085-H	218.71	60	3000	132	100	40	NESW	18	111	84
1086-H	490.89	60	3800	108	100	40	NWSE	18	111	84
1087-H	688.35	60	3400	120	100	40	NWSE	18	111	84
1088-H	211.58	75	3200	126	100	25	NWSE	18	76	77
1089-H	234.29	75	3400	120	100	25	NWSE	18	76	77
1090-H	693.28	75	3200	126	100	25	NWSE	18	76	77
1091-H	410.80	75	3000	132	100	25	NWSE	18	76	77
533-O	140.01	95	2600	145	100	5	NWSE	18	29	40
543-O	456.61	95	2600	145	100	5	NWSE	18	29	40
546-O	366.49	95	2400	151	100	5	NWSE	18	29	40
567-O	1004.56	95	2400	151	100	5	NWSE	18	29	40
630-O	389.69	100	2000	163	100	0	NESW	18	18	0
631-O	533.45	100	2000	163	100	0	NESW	18	18	0
632-O	376.28	100	2000	163	100	0	NESW	18	18	0
633-O	80.72	100	2000	163	100	0	NESW	18	18	0
634-O	588.78	100	2000	163	100	0	NESW	18	18	0
635-O	610.76	100	2000	163	100	0	NESW	18	18	0
636-O	539.96	95	2400	151	100	5	NWSE	18	29	40

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
637-O	286.05	95	2400	151	100	5	NWSE	18	29	40
638-O	582.59	95	2200	157	100	5	NWSE	18	29	40
639-O	508.97	95	2200	157	100	5	NWSE	18	29	40
640-O	463.47	95	2000	163	100	5	NWSE	18	29	40
641-O	337.81	95	2000	163	100	5	NWSE	18	29	40
642-O	240.48	60	2400	151	100	40	NESW	18	111	84
643-O	669.31	60	2200	157	100	40	NESW	18	111	84
644-O	525.49	60	2000	163	100	40	NESW	18	111	84
645-O	569.58	90	2800	139	100	10	NS	17	38	55
646-O	542.04	90	2800	139	100	10	NESW	18	41	57
647-O	263.03	90	2800	139	100	10	NESW	18	41	57
648-O	691.05	90	2800	139	100	10	NESW	18	41	57
649-O	74.60	90	2600	145	100	10	NESW	18	41	57
650-O	844.75	90	2600	145	100	10	NESW	18	41	57
651-O	80.18	90	2600	145	100	10	NESW	18	41	57
652-O	504.99	90	2600	145	100	10	NESW	18	41	57
653-O	479.61	95	2800	139	100	5	NWSE	18	29	40
654-O	677.96	95	2800	139	100	5	NWSE	18	29	40
655-O	243.82	95	2800	139	100	5	NWSE	18	29	40

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
656-O	445.17	95	2800	139	100	5	NWSE	18	29	40
657-O	276.71	95	2800	139	100	5	NWSE	18	29	40
658-O	68.57	95	2800	139	100	5	NWSE	18	29	40
659-O	438.98	95	2800	139	100	5	NWSE	18	29	40
660-O	72.07	95	2800	139	100	5	NWSE	18	29	40
661-O	810.50	95	2800	139	100	5	NS	17	28	38
662-O	935.06	95	2600	145	100	5	NWSE	18	29	40
663-O	796.10	95	2600	145	100	5	NWSE	18	29	40
664-O	1242.11	95	2600	145	100	5	NESW	18	29	40
665-O	343.93	80	2800	139	100	20	NWSE	18	64	73
666-O	804.88	80	2800	139	100	20	NWSE	18	64	73
667-O	588.02	80	2800	139	100	20	NWSE	18	64	73
668-O	121.98	80	2800	139	100	20	NWSE	18	64	73
669-O	307.22	80	2800	139	100	20	NWSE	18	64	73
670-O	154.54	80	2800	139	100	20	NWSE	18	64	73
671-O	608.63	80	2800	139	100	20	NWSE	18	64	73
672-O	208.22	80	2800	139	100	20	NWSE	18	64	73
673-O	714.46	80	2800	139	100	20	NWSE	18	64	73
674-O	242.49	80	2800	139	100	20	NWSE	18	64	73

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
675-O	838.75	80	2800	139	100	20	NWSE	18	64	73
676-O	110.30	60	2800	139	100	40	NESW	18	111	84
677-O	758.35	60	2800	139	100	40	NS	17	101	83
678-O	639.62	60	2800	139	100	40	NS	17	101	83
679-O	754.33	60	2800	139	100	40	NS	17	101	83
680-O	368.51	60	2800	139	100	40	NS	17	101	83
681-O	220.70	60	2800	139	100	40	NS	17	101	83
682-O	1101.44	60	2800	139	100	40	NWSE	18	111	84
684-O	269.77	65	3000	132	100	35	NS	17	91	81
685-O	293.97	65	3000	132	100	35	NS	17	91	81
686-O	353.36	65	3000	132	100	35	NS	17	91	81
687-O	354.74	65	3000	132	100	35	NESW	18	99	82
688-O	273.54	65	3000	132	100	35	NESW	18	99	82
689-O	102.77	65	3000	132	100	35	NESW	18	99	82
690-O	807.27	65	3000	132	100	35	NESW	18	99	82
691-O	381.40	65	3000	132	100	35	NESW	18	99	82
692-O	574.63	65	2800	139	100	35	NESW	18	99	82
693-O	345.96	65	2800	139	100	35	NESW	18	99	82
694-O	182.42	65	2800	139	100	35	NESW	18	99	82

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
695-O	227.70	65	2800	139	100	35	NESW	18	99	82
696-O	148.97	60	3200	126	100	40	NS	17	101	83
697-O	534.50	60	3200	126	100	40	NS	17	101	83
698-O	120.36	60	3200	126	100	40	NS	17	101	83
699-O	206.85	60	3200	126	100	40	NS	17	101	83
700-O	425.05	60	3200	126	100	40	NS	17	101	83
701-O	198.00	60	3200	126	100	40	NS	17	101	83
702-O	203.49	60	3200	126	100	40	NS	17	101	83
703-O	416.01	60	3200	126	100	40	NS	17	101	83
704-O	105.96	60	3000	132	100	40	NS	17	101	83
705-O	181.77	60	3000	132	100	40	NWSE	18	111	84
706-O	184.30	60	3000	132	100	40	NWSE	18	111	84
707-O	437.24	60	3000	132	100	40	NWSE	18	111	84
708-O	308.59	60	3000	132	100	40	NWSE	18	111	84
709-O	105.85	60	3000	132	100	40	NWSE	18	111	84
710-O	346.01	60	3000	132	100	40	NWSE	18	111	84
711-O	79.37	60	3000	132	100	40	NWSE	18	111	84
712-O	671.73	60	3000	132	100	40	NWSE	18	111	84
713-O	282.26	60	3000	132	100	40	NWSE	18	111	84

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
714-O	526.44	60	3000	132	100	40	NWSE	18	111	84
715-O	243.98	60	3000	132	100	40	NWSE	18	111	84
716-O	423.49	60	3000	132	100	40	NWSE	18	111	84
717-O	405.68	60	3000	132	100	40	NWSE	18	111	84
718-O	196.69	60	3000	132	100	40	NWSE	18	111	84
719-O	529.96	60	3000	132	100	40	NWSE	18	111	84
720-O	506.00	75	2800	139	100	25	NS	17	70	76
721-O	187.22	75	2800	139	100	25	NS	17	70	76
722-O	513.46	75	2800	139	100	25	NS	17	70	76
723-O	232.84	75	2800	139	100	25	NESW	18	76	77
724-O	169.82	75	2800	139	100	25	NESW	18	76	77
725-O	110.90	75	2800	139	100	25	NESW	18	76	77
726-O	506.11	75	2800	139	100	25	NESW	18	76	77
727-O	468.38	75	2800	139	100	25	NESW	18	76	77
728-O	269.20	35	2800	139	100	65	NS	17	154	89
729-O	821.47	35	2800	139	100	65	NS	17	154	89
730-O	99.16	35	2800	139	100	65	NS	17	154	89
731-O	1235.16	35	2800	139	100	65	NS	17	154	89
732-O	1132.13	30	2800	139	100	70	NS	17	164	90

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
733-O	216.20	30	2800	139	100	70	NS	17	164	90
734-O	1111.70	30	2800	139	100	70	NS	17	164	90
735-O	296.33	50	3000	132	100	50	NS	17	122	86
736-O	653.19	50	2800	139	100	50	NWSE	18	134	87
737-O	196.57	50	2800	139	100	50	NWSE	18	134	87
738-O	735.13	50	2800	139	100	50	NWSE	18	134	87
739-O	266.09	50	2800	139	100	50	NWSE	18	134	87
740-O	110.42	50	2800	139	100	50	NWSE	18	134	87
741-O	635.39	50	2800	139	100	50	NWSE	18	134	87
742-O	347.19	50	2800	139	100	50	NWSE	18	134	87
743-O	927.46	50	2800	139	100	50	NWSE	18	134	87
744-O	729.09	50	2800	139	100	50	NWSE	18	134	87
745-O	701.55	50	2800	139	100	50	NWSE	18	134	87
746-O	406.06	70	3000	132	100	30	NS	17	80	79
747-O	400.97	70	3000	132	100	30	NS	17	80	79
748-O	834.00	70	3000	132	100	30	NS	17	80	79
749-O	75.95	70	3000	132	100	30	NS	17	80	79
750-O	571.55	75	3200	126	100	25	NWSE	18	76	77
751-O	69.79	75	3000	132	100	25	NWSE	18	76	77

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
752-O	424.90	75	3000	132	100	25	NWSE	18	76	77
753-O	304.08	75	3000	132	100	25	NWSE	18	76	77
754-O	370.92	75	3000	132	100	25	NWSE	18	76	77
755-O	366.97	75	3000	132	100	25	NWSE	18	76	77
756-O	192.11	75	3000	132	100	25	NWSE	18	76	77
757-O	221.39	75	3000	132	100	25	NWSE	18	76	77
758-O	144.43	75	3000	132	100	25	NWSE	18	76	77
759-O	331.61	75	3000	132	100	25	NWSE	18	76	77
760-O	170.89	75	3000	132	100	25	NWSE	18	76	77
761-O	269.51	75	3000	132	100	25	NWSE	18	76	77
762-O	254.00	75	3000	132	100	25	NWSE	18	76	77
763-O	392.97	75	3000	132	100	25	NWSE	18	76	77
764-O	389.89	75	3000	132	100	25	NWSE	18	76	77
765-O	506.84	75	3000	132	100	25	NS	17	70	76
766-O	110.18	75	3000	132	100	25	NS	17	70	76
767-O	1216.63	80	3000	132	100	20	NS	17	59	71
768-O	1201.74	80	3000	132	100	20	NS	17	59	71
769-O	1440.36	80	3000	132	100	20	NESW	18	64	73
770-O	250.60	80	2800	139	100	20	NESW	18	64	73

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
771-O	658.79	80	2800	139	100	20	NESW	18	64	73
772-O	241.10	80	2800	139	100	20	NESW	18	64	73
773-O	212.41	80	2800	139	100	20	NESW	18	64	73
777-O	353.23	80	3000	132	100	20	NESW	18	64	73
778-O	538.88	60	2600	145	100	40	NESW	18	111	84
779-O	748.49	60	2400	151	100	40	NESW	18	111	84
782-O	497.91	60	2400	151	100	40	NESW	18	111	84
783-O	502.59	60	2200	157	100	40	NESW	18	111	84
786-O	335.82	95	2400	151	100	5	NWSE	18	29	40
787-O	955.86	95	2200	157	100	5	NWSE	18	29	40
459-S	386.35	100	1800	169	100	0	NWSE	18	18	0
460-S	723.26	100	1800	169	100	0	NWSE	18	18	0
461-S	635.62	100	1800	169	100	0	NWSE	18	18	0
462-S	357.12	100	1600	176	100	0	NWSE	18	18	0
463-S	1339.37	100	1600	176	100	0	NWSE	18	18	0
464-S	472.81	100	1600	176	100	0	NWSE	18	18	0
465-S	766.01	100	1600	176	100	0	NWSE	18	18	0
466-S	261.81	100	1600	176	100	0	NWSE	18	18	0
467-S	523.12	100	1600	176	100	0	NWSE	18	18	0

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
468-S	345.10	100	1600	176	100	0	NWSE	18	18	0
469-S	420.06	100	1600	176	100	0	NWSE	18	18	0
470-S	306.65	100	2200	157	100	0	NESW	18	18	0
471-S	207.64	100	2200	157	100	0	NESW	18	18	0
472-S	277.25	100	2200	157	100	0	NESW	18	18	0
473-S	251.61	100	2200	157	100	0	NESW	18	18	0
474-S	625.61	100	2400	151	100	0	NESW	18	18	0
475-S	106.98	100	2400	151	100	0	NESW	18	18	0
476-S	910.41	100	2400	151	100	0	NESW	18	18	0
477-S	175.54	100	2000	163	100	0	NWSE	18	18	0
478-S	285.01	100	2000	163	100	0	NWSE	18	18	0
479-S	580.25	100	2000	163	100	0	NWSE	18	18	0
480-S	622.73	100	1800	169	100	0	NWSE	18	18	0
481-S	313.65	100	1800	169	100	0	NS	17	17	0
482-S	123.10	100	1800	169	100	0	NS	17	17	0
483-S	443.72	100	1800	169	100	0	NS	17	17	0
484-S	368.40	100	1800	169	100	0	NS	17	17	0
485-S	478.99	100	1800	169	100	0	NS	17	17	0
486-S	294.27	100	1800	169	100	0	NS	17	17	0

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
487-S	606.41	100	1800	169	100	0	NS	17	17	0
488-S	628.20	100	1800	169	100	0	NS	17	17	0
489-S	439.34	80	2000	163	100	20	NESW	18	64	73
490-S	118.77	80	2000	163	100	20	NESW	18	64	73
491-S	465.29	80	2000	163	100	20	NESW	18	64	73
492-S	764.87	80	2200	157	100	20	NESW	18	64	73
493-S	490.95	80	2000	163	100	20	NWSE	18	64	73
494-S	100.61	80	2000	163	100	20	EW	18	69	74
495-S	335.13	80	2000	163	100	20	EW	18	69	74
496-S	345.50	80	2000	163	100	20	EW	18	69	74
497-S	434.49	80	2000	163	100	20	NWSE	18	64	73
498-S	579.24	80	2000	163	100	20	EW	18	69	74
499-S	571.86	80	2000	163	100	20	EW	18	69	74
500-S	840.01	60	2200	157	100	40	NESW	18	111	84
501-S	281.98	60	2200	157	100	40	NESW	18	111	84
502-S	425.84	60	2200	157	100	40	NESW	18	111	84
503-S	337.43	60	2200	157	100	40	NESW	18	111	84
504-S	799.79	60	2200	157	100	40	NESW	18	111	84
505-S	298.22	60	2200	157	100	40	NESW	18	111	84

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
506-S	186.51	60	2200	157	100	40	NESW	18	111	84
507-S	236.18	60	2200	157	100	40	NESW	18	111	84
508-S	153.59	60	2200	157	100	40	NESW	18	111	84
509-S	409.99	60	2200	157	100	40	NESW	18	111	84
510-S	792.72	60	2200	157	100	40	NESW	18	111	84
511-S	550.21	100	2200	157	100	0	NESW	18	18	0
512-S	382.75	100	2400	151	100	0	NESW	18	18	0
513-S	172.19	100	2400	151	100	0	NESW	18	18	0
514-S	329.17	90	2400	151	100	10	NWSE	18	41	57
515-S	379.79	90	2400	151	100	10	NWSE	18	41	57
516-S	277.55	90	2400	151	100	10	NWSE	18	41	57
517-S	335.47	90	2200	157	100	10	NWSE	18	41	57
518-S	534.99	90	2200	157	100	10	NWSE	18	41	57
519-S	465.27	90	2200	157	100	10	NESW	18	41	57
520-S	340.02	90	2200	157	100	10	NWSE	18	41	57
521-S	178.22	90	2200	157	100	10	NWSE	18	41	57
522-S	328.03	90	2200	157	100	10	NWSE	18	41	57
523-S	70.86	90	2200	157	100	10	NWSE	18	41	57
524-S	603.61	100	2400	151	100	0	NESW	18	18	0

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
525-S	547.16	100	2600	145	100	0	NESW	18	18	0
526-S	650.36	100	2600	145	100	0	NESW	18	18	0
527-S	181.06	100	2600	145	100	0	NESW	18	18	0
528-S	587.30	100	2400	151	100	0	NWSE	18	18	0
529-S	287.70	100	2400	151	100	0	NWSE	18	18	0
530-S	224.09	100	2400	151	100	0	NWSE	18	18	0
531-S	354.81	100	2400	151	100	0	NWSE	18	18	0
532-S	289.23	100	2600	145	100	0	NWSE	18	18	0
533-S	695.19	100	2600	145	100	0	NWSE	18	18	0
534-S	221.19	100	2600	145	100	0	NWSE	18	18	0
535-S	584.33	100	2600	145	100	0	NESW	18	18	0
536-S	593.10	100	2400	151	100	0	NESW	18	18	0
537-S	422.73	100	2600	145	100	0	NESW	18	18	0
538-S	321.44	100	2600	145	100	0	NESW	18	18	0
539-S	529.17	100	2600	145	100	0	NESW	18	18	0
540-S	136.79	100	2600	145	100	0	NESW	18	18	0
541-S	288.05	100	2600	145	100	0	NESW	18	18	0
542-S	351.61	100	2600	145	100	0	NESW	18	18	0
543-S	591.81	100	2600	145	100	0	NESW	18	18	0

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
544-S	972.00	100	2800	139	100	0	NESW	18	18	0
545-S	436.24	100	2800	139	100	0	NESW	18	18	0
546-S	166.69	100	2800	139	100	0	NESW	18	18	0
547-S	224.72	100	2800	139	100	0	NESW	18	18	0
548-S	435.49	100	2800	139	100	0	NESW	18	18	0
549-S	335.35	85	2400	151	100	15	NWSE	18	52	67
550-S	550.06	85	2400	151	100	15	NWSE	18	52	67
551-S	123.42	85	2400	151	100	15	NWSE	18	52	67
552-S	693.57	85	2400	151	100	15	NWSE	18	52	67
553-S	224.33	85	2400	151	100	15	NWSE	18	52	67
554-S	738.12	85	2400	151	100	15	NWSE	18	52	67
555-S	437.88	85	2400	151	100	15	NWSE	18	52	67
556-S	393.47	85	2400	151	100	15	NWSE	18	52	67
557-S	299.29	85	2400	151	100	15	NWSE	18	52	67
558-S	848.72	100	2200	157	100	0	NWSE	18	18	0
559-S	496.24	30	2800	139	100	70	NS	17	164	90
560-S	1050.76	30	2400	151	100	70	NS	17	164	90
561-S	65.13	30	2400	151	100	70	NS	17	164	90
562-S	789.65	30	2400	151	100	70	NWSE	18	181	90

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
563-S	417.86	100	1600	176	100	0	NWSE	18	18	0
564-S	160.98	100	1600	176	100	0	NWSE	18	18	0
565-S	438.91	100	1600	176	100	0	NWSE	18	18	0
566-S	396.38	100	1600	176	100	0	NWSE	18	18	0
567-S	387.99	100	2000	163	100	0	NESW	18	18	0
568-S	756.98	100	1800	169	100	0	NESW	18	18	0
569-S	367.68	100	2000	163	100	0	NESW	18	18	0
570-S	520.73	100	1800	169	100	0	NS	17	17	0
571-S	646.19	100	1800	169	100	0	NS	17	17	0
572-S	527.23	85	2400	151	100	15	EW	18	56	68
573-S	299.39	85	2400	151	100	15	EW	18	56	68
574-S	193.65	85	2400	151	100	15	EW	18	56	68
575-S	512.23	100	2000	163	100	0	NWSE	18	18	0
576-S	206.53	80	2000	163	100	20	NWSE	18	64	73
74-3B	762.66	85	3000	132	100	15	NWSE	18	52	67
89-3B	546.90	85	2800	139	100	15	NWSE	18	52	67
93-3B	524.22	85	3000	132	100	15	NWSE	18	52	67
104-3B	274.79	85	3000	132	100	15	NWSE	18	52	67
112-3B	599.50	85	3000	132	100	15	NWSE	18	52	67

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
123-3B	259.72	85	3000	132	100	15	NWSE	18	52	67
152-3B	1198.93	85	2800	139	100	15	NWSE	18	52	67
159-3B	191.17	90	2800	139	100	10	NWSE	18	41	57
163-3B	242.27	90	2800	139	100	10	NWSE	18	41	57
175-3B	527.79	90	2800	139	100	10	NWSE	18	41	57
191-3B	571.07	70	2600	145	100	30	NESW	18	87	80
203-3B	292.24	70	2600	145	100	30	NESW	18	87	80
206-3B	522.90	90	2800	139	100	10	NWSE	18	41	57
212-3B	301.40	90	2600	145	100	10	NWSE	18	41	57
213-3B	887.90	90	2600	145	100	10	NWSE	18	41	57
215-3B	358.88	90	2600	145	100	10	NWSE	18	41	57
216-3B	331.67	90	2600	145	100	10	NWSE	18	41	57
223-3B	311.62	90	2800	139	100	10	NWSE	18	41	57
226-3B	395.67	70	2600	145	100	30	NESW	18	87	80
228-3B	644.40	90	2600	145	100	10	NWSE	18	41	57
229-3B	134.64	70	2600	145	100	30	NESW	18	87	80
234-3B	143.35	70	2600	145	100	30	NESW	18	87	80
235-3B	305.34	70	2600	145	100	30	NESW	18	87	80
244-3B	387.44	90	2800	139	100	10	NWSE	18	41	57

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
245-3B	876.83	90	2800	139	100	10	NWSE	18	41	57
250-3B	276.00	90	2800	139	100	10	NWSE	18	41	57
255-3B	824.13	90	2600	145	100	10	NWSE	18	41	57
258-3B	157.84	85	3200	126	100	15	NWSE	18	52	67
278-3B	658.15	80	2600	145	100	20	NESW	18	64	73
282-3B	138.94	85	3200	126	100	15	NWSE	18	52	67
286-3B	459.74	85	3200	126	100	15	NWSE	18	52	67
288-3B	484.93	85	3200	126	100	15	NWSE	18	52	67
291-3B	321.50	80	2600	145	100	20	NESW	18	64	73
294-3B	179.86	85	3200	126	100	15	NWSE	18	52	67
296-3B	147.31	85	3200	126	100	15	NWSE	18	52	67
297-3B	301.82	85	3200	126	100	15	NWSE	18	52	67
299-3B	478.13	85	3200	126	100	15	NWSE	18	52	67
300-3B	399.55	85	3200	126	100	15	NWSE	18	52	67
312-3B	908.01	80	2600	145	100	20	NESW	18	64	73
316-3B	530.78	85	3200	126	100	15	NWSE	18	52	67
319-3B	1092.07	80	2600	145	100	20	NESW	18	64	73
329-3B	387.75	85	3200	126	100	15	NWSE	18	52	67
336-3B	321.52	85	3000	132	100	15	NWSE	18	52	67

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
339-3B	365.80	85	3000	132	100	15	NWSE	18	52	67
344-3B	493.33	80	2600	145	100	20	NESW	18	64	73
350-3B	728.82	80	2600	145	100	20	NESW	18	64	73
361-3B	97.49	85	3000	132	100	15	NWSE	18	52	67
362-3B	532.94	85	3000	132	100	15	NWSE	18	52	67
365-3B	251.93	80	2600	145	100	20	NESW	18	64	73
368-3B	346.64	85	3000	132	100	15	NWSE	18	52	67
383-3B	621.16	80	2600	145	100	20	NESW	18	64	73
390-3B	406.08	70	2800	139	100	30	NWSE	18	87	80
393-3B	695.95	85	3000	132	100	15	NWSE	18	52	67
394-3B	210.87	80	2600	145	100	20	NESW	18	64	73
401-3B	255.53	70	2800	139	100	30	NWSE	18	87	80
403-3B	439.96	70	2800	139	100	30	NWSE	18	87	80
409-3B	284.79	85	2800	139	100	15	NWSE	18	52	67
411-3B	225.42	70	2800	139	100	30	NWSE	18	87	80
415-3B	376.33	70	2800	139	100	30	NWSE	18	87	80
418-3B	269.60	80	2600	145	100	20	NESW	18	64	73
421-3B	82.02	70	2800	139	100	30	NWSE	18	87	80
423-3B	183.67	70	2800	139	100	30	NWSE	18	87	80

Table D-3., **Long Meadow Creek temperature TMDL, cont.**

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
425-3B	464.32	70	2800	139	100	30	NWSE	18	87	80
429-3B	72.24	85	2800	139	100	15	NWSE	18	52	67
431-3B	256.27	80	2600	145	100	20	NESW	18	64	73
433-3B	357.49	85	2800	139	100	15	NWSE	18	52	67
436-3B	72.52	85	2800	139	100	15	NWSE	18	52	67
437-3B	655.98	85	2800	139	100	15	NWSE	18	52	67
438-3B	423.56	85	2800	139	100	15	NWSE	18	52	67
439-3B	103.00	80	2600	145	100	20	NESW	18	64	73
441-3B	281.58	85	2800	139	100	15	NWSE	18	52	67
450-3B	386.59	70	2800	139	100	30	NWSE	18	87	80
452-3B	104.02	95	2800	139	100	5	NWSE	18	29	40
458-3B	259.50	80	2600	145	100	20	NESW	18	64	73
464-3B	522.14	95	2800	139	100	5	NWSE	18	29	40
475-3B	489.29	95	2800	139	100	5	NWSE	18	29	40
478-3B	396.16	80	2600	145	100	20	NESW	18	64	73
499-3B	399.57	80	2600	145	100	20	NESW	18	64	73
509-3B	542.53	80	2600	145	100	20	NESW	18	64	73
515-3B	467.36	80	2600	145	100	20	NESW	18	64	73
529-3B	627.38	80	2600	145	100	20	NESW	18	64	73

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
547-3B	430.18	80	2600	145	100	20	NESW	18	64	73
588-3B	577.71	80	2600	145	100	20	NWSE	18	64	73
589-3B	64.56	80	2800	139	100	20	NWSE	18	64	73
600-3B	683.45	80	2800	139	100	20	NWSE	18	64	73
616-3B	790.58	90	2600	145	100	10	NESW	18	41	57
619-3B	212.83	90	2800	139	100	10	NESW	18	41	57
621-3B	316.95	90	2800	139	100	10	NESW	18	41	57
622-3B	303.42	90	2800	139	100	10	NESW	18	41	57
626-3B	1024.80	80	2800	139	100	20	NWSE	18	64	73
629-3B	424.96	90	2800	139	100	10	NESW	18	41	57
636-3B	188.44	90	2800	139	100	10	NESW	18	41	57
640-3B	161.30	90	2800	139	100	10	NESW	18	41	57
643-3B	966.68	80	2800	139	100	20	NWSE	18	64	73
653-3B	573.94	90	2800	139	100	10	NESW	18	41	57
655-3B	259.38	80	2800	139	100	20	NWSE	18	64	73
656-3B	115.13	80	2800	139	100	20	NWSE	18	64	73
668-3B	354.04	90	2800	139	100	10	NESW	18	41	57
695-3B	455.11	90	2800	139	100	10	NESW	18	41	57
698-3B	74.17	80	2800	139	100	20	NESW	18	64	73

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
699-3B	245.62	80	2800	139	100	20	NESW	18	64	73
705-3B	427.58	80	2800	139	100	20	NESW	18	64	73
711-3B	276.48	80	2800	139	100	20	NESW	18	64	73
715-3B	556.83	80	2800	139	100	20	NESW	18	64	73
721-3B	606.79	80	2800	139	100	20	NESW	18	64	73
735-3B	485.10	80	2800	139	100	20	NESW	18	64	73
740-3B	451.63	80	2800	139	100	20	NESW	18	64	73
744-3B	200.71	80	2800	139	100	20	NESW	18	64	73
760-3B	309.86	80	2800	139	100	20	NESW	18	64	73
767-3B	101.90	80	2800	139	100	20	NESW	18	64	73
770-3B	127.11	80	3200	126	100	20	NWSE	18	64	73
779-3B	308.70	80	2800	139	100	20	NESW	18	64	73
790-3B	258.81	80	2800	139	100	20	NESW	18	64	73
805-3B	819.18	80	3000	132	100	20	NWSE	18	64	73
818-3B	415.09	80	2800	139	100	20	NESW	18	64	73
826-3B	106.63	80	2800	139	100	20	NESW	18	64	73
831-3B	366.60	80	3000	132	100	20	NWSE	18	64	73
844-3B	249.75	80	2800	139	100	20	NESW	18	64	73
851-3B	357.46	80	3000	132	100	20	NWSE	18	64	73

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
858-3B	72.30	80	3000	132	100	20	NWSE	18	64	73
859-3B	203.65	80	2800	139	100	20	NESW	18	64	73
873-3B	275.46	80	3000	132	100	20	NWSE	18	64	73
890-3B	389.94	80	3000	132	100	20	NWSE	18	64	73
894-3B	449.81	80	2800	139	100	20	NESW	18	64	73
899-3B	148.31	80	3000	132	100	20	NWSE	18	64	73
904-3B	155.38	80	3000	132	100	20	NWSE	18	64	73
907-3B	298.37	80	2800	139	100	20	NESW	18	64	73
910-3B	199.68	80	2800	139	100	20	NWSE	18	64	73
916-3B	330.99	80	2800	139	100	20	NESW	18	64	73
922-3B	141.80	80	2800	139	100	20	NESW	18	64	73
924-3B	608.74	80	2800	139	100	20	NESW	18	64	73
929-3B	450.91	80	2800	139	100	20	NESW	18	64	73
930-3B	312.06	80	2800	139	100	20	NWSE	18	64	73
936-3B	54.29	80	2800	139	100	20	NESW	18	64	73
943-3B	522.07	80	2800	139	100	20	NESW	18	64	73
946-3B	410.57	80	2800	139	100	20	NESW	18	64	73
948-3B	57.89	80	2800	139	100	20	NESW	18	64	73
950-3B	105.41	80	2800	139	100	20	NESW	18	64	73

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
956-3B	319.68	80	2800	139	100	20	NESW	18	64	73
957-3B	302.22	80	2800	139	100	20	NESW	18	64	73
967-3B	479.86	80	2800	139	100	20	NESW	18	64	73
979-3B	183.36	80	2800	139	100	20	NESW	18	64	73
998-3B	493.96	80	2800	139	100	20	NESW	18	64	73
1001-3B	116.82	80	2800	139	100	20	NESW	18	64	73
1003-3B	69.69	80	2800	139	100	20	NESW	18	64	73
1008-3B	578.17	80	3000	132	100	20	NWSE	18	64	73
1012-3B	140.41	80	3000	132	100	20	NWSE	18	64	73
1016-3B	171.65	80	2800	139	100	20	NESW	18	64	73
1024-3B	415.81	80	2800	139	100	20	NWSE	18	64	73
1025-3B	102.65	80	2800	139	100	20	NWSE	18	64	73
1027-3B	377.61	80	3000	132	100	20	NWSE	18	64	73
1028-3B	233.04	80	2800	139	100	20	NWSE	18	64	73
1031-3B	97.38	80	3000	132	100	20	NWSE	18	64	73
1038-3B	520.91	80	2800	139	100	20	NWSE	18	64	73
1041-3B	639.20	80	3000	132	100	20	NWSE	18	64	73
1042-3B	419.65	80	3000	132	100	20	NWSE	18	64	73
1045-3B	327.52	80	3000	132	100	20	NWSE	18	64	73

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
1047-3B	180.37	80	3000	132	100	20	NWSE	18	64	73
1048-3B	307.91	80	3000	132	100	20	NWSE	18	64	73
1050-3B	74.10	80	3000	132	100	20	NWSE	18	64	73
1055-3B	314.37	80	3000	132	100	20	NWSE	18	64	73
1057-3B	732.56	80	3000	132	100	20	NWSE	18	64	73
1069-3B	868.25	85	2800	139	100	15	NESW	18	52	67
1072-3B	103.12	85	3000	132	100	15	NESW	18	52	67
1077-3B	195.44	85	3000	132	100	15	NESW	18	52	67
1093-3B	406.63	85	3000	132	100	15	NESW	18	52	67
1102-3B	96.62	85	3000	132	100	15	NESW	18	52	67
1119-3B	276.88	85	3000	132	100	15	NESW	18	52	67
1127-3B	197.35	85	3000	132	100	15	NESW	18	52	67
1273-3B	370.44	70	2600	145	100	30	NESW	18	87	80
1274-3B	454.30	70	2600	145	100	30	NESW	18	87	80
1275-3B	636.53	70	2600	145	100	30	NESW	18	87	80
1276-3B	191.22	70	2600	145	100	30	NESW	18	87	80
1277-3B	425.36	85	3000	132	100	15	NWSE	18	52	67
1278-3B	1045.82	85	2800	139	100	15	NWSE	18	52	67
1279-3B	1043.67	85	3000	132	100	15	NWSE	18	52	67

Table D-3., Long Meadow Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
1280-3B	387.45	90	2600	145	100	10	NESW	18	41	57
1281-3B	225.32	90	2600	145	100	10	NESW	18	41	57
1282-3B	404.94	90	2600	145	100	10	NESW	18	41	57
1283-3B	185.34	95	2800	139	100	5	NWSE	18	29	40
1284-3B	512.09	95	2800	139	100	5	NWSE	18	29	40
1285-3B	283.29	95	2600	145	100	5	NWSE	18	29	40
1286-3B	331.22	95	2600	145	100	5	NWSE	18	29	40
1287-3B	613.51	95	2800	139	100	5	NWSE	18	29	40
1288-3B	1035.40	100	3000	132	100	0	NWSE	18	18	0
1289-3B	1121.31	100	2800	139	100	0	NWSE	18	18	0

Table D-4. Swamp Creek temperature TMDL.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
572	499.93	100	1600	176	100	0	NWSE	18	18	0
573	652.39	100	1600	176	100	0	NWSE	18	18	0
574	97.38	100	1600	176	100	0	NWSE	18	18	0
575	2448.20	100	1600	176	100	0	NWSE	18	18	0
576	741.70	100	1800	169	100	0	NWSE	18	18	0
577	972.15	100	2000	163	100	0	NWSE	18	18	0
578	156.45	100	2000	163	100	0	EW	18	18	0
579	637.88	100	2000	163	100	0	EW	18	18	0
580	702.66	100	2000	163	100	0	EW	18	18	0
581	1074.33	100	2200	157	100	0	EW	18	18	0
582	451.54	100	2400	151	100	0	NWSE	18	18	0
583	583.38	100	2400	151	100	0	NWSE	18	18	0
584	251.04	100	2400	151	100	0	NWSE	18	18	0
585	716.90	100	2400	151	100	0	NWSE	18	18	0
586	558.49	100	2200	157	100	0	EW	18	18	0
587	1095.57	100	2200	157	100	0	NWSE	18	18	0
588	44.16	100	2200	157	100	0	EW	18	18	0
589	548.02	95	2600	145	100	5	NS	17	28	38
590	271.54	95	2600	145	100	5	NS	17	28	38

Table D.4., Swamp Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
591	723.63	95	2600	145	100	5	NS	17	28	38
592	186.07	95	2600	145	100	5	NS	17	28	38
593	107.75	95	2400	151	100	5	NS	17	28	38
594	1348.12	95	2400	151	100	5	NS	17	28	38
595	146.62	95	2400	151	100	5	EW	18	31	42
596	756.66	95	2400	151	100	5	EW	18	31	42
597	215.77	95	2400	151	100	5	EW	18	31	42
598	455.04	95	2400	151	100	5	EW	18	31	42
599	66.13	95	2400	151	100	5	EW	18	31	42
600	199.36	95	2400	151	100	5	EW	18	31	42
601	295.01	95	2800	139	100	5	NWSE	18	29	40
602	705.30	95	2600	145	100	5	NWSE	18	29	40
603	879.18	95	2600	145	100	5	NWSE	18	29	40
604	344.82	95	2600	145	100	5	NWSE	18	29	40
605	248.00	95	2600	145	100	5	NS	17	28	38
606	625.13	95	2800	139	100	5	NWSE	18	29	40
607	23.21	90	2800	139	100	10	NWSE	18	41	57
608	47.41	90	2800	139	100	10	NWSE	18	41	57

Table D.4., Swamp Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
609	536.32	90	2800	139	100	10	NWSE	18	41	57
610	909.13	85	3200	126	100	15	NWSE	18	52	67
611	424.97	85	3000	132	100	15	NWSE	18	52	67
612	143.61	85	3000	132	100	15	NWSE	18	52	67
613	566.93	85	3000	132	100	15	NWSE	18	52	67
614	63.62	85	3000	132	100	15	NWSE	18	52	67
615	674.07	85	3000	132	100	15	NWSE	18	52	67
616	297.97	85	3000	132	100	15	NWSE	18	52	67
617	326.35	85	3000	132	100	15	NWSE	18	52	67
618	237.85	85	3000	132	100	15	EW	18	56	68
619	403.47	85	3000	132	100	15	EW	18	56	68
620	488.82	25	3200	126	100	75	NWSE	18	192	91
621	656.43	25	3200	126	100	75	NWSE	18	192	91
622	345.67	25	3200	126	100	75	NWSE	18	192	91
623	1315.91	25	3200	126	100	75	NWSE	18	192	91
624	280.17	25	3200	126	100	75	NWSE	18	192	91
625	206.15	25	3200	126	100	75	NWSE	18	192	91
626	290.66	50	3200	126	100	50	NS	17	122	86
627	337.78	50	3200	126	100	50	NS	17	122	86

Table D.4., Swamp Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
628	657.48	50	3200	126	100	50	NS	17	122	86
629	475.18	50	3200	126	100	50	NS	17	122	86
630	458.44	50	3200	126	100	50	NS	17	122	86
631	199.55	50	3200	126	100	50	NS	17	122	86
632	428.23	50	3200	126	100	50	NS	17	122	86
633	75.19	50	3200	126	100	50	NS	17	122	86
634	302.47	50	3200	126	100	50	NS	17	122	86
635	247.15	50	3200	126	100	50	NWSE	18	134	87
636	201.55	40	3200	126	100	60	NS	17	143	88
637	1027.66	40	3200	126	100	60	NS	17	143	88
638	897.48	40	3200	126	100	60	NS	17	143	88
639	1005.16	40	3200	126	100	60	NS	17	143	88
640	187.78	40	3200	126	100	60	NS	17	143	88
641	516.02	40	3200	126	100	60	NS	17	143	88
642	701.49	20	3200	126	100	80	NS	17	185	91
643	713.85	20	3200	126	100	80	NS	17	185	91
644	31.36	80	3400	120	100	20	NS	17	59	71
645	106.22	80	3400	120	100	20	NS	17	59	71
646	142.39	80	3400	120	100	20	NS	17	59	71

Table D.4., Swamp Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
647	446.97	80	3200	126	100	20	NS	17	59	71
648	59.57	80	3200	126	100	20	NS	17	59	71
649	121.09	80	3200	126	100	20	NS	17	59	71
650	217.79	80	3200	126	100	20	NS	17	59	71
651	178.89	80	3200	126	100	20	NS	17	59	71
652	339.94	80	3200	126	100	20	NS	17	59	71
653	72.86	80	3200	126	100	20	NS	17	59	71
654	237.37	80	3200	126	100	20	NS	17	59	71
655	637.08	80	3200	126	100	20	NS	17	59	71
656	239.19	80	3200	126	100	20	NS	17	59	71
657	101.16	80	3200	126	100	20	NS	17	59	71
658	355.89	80	3200	126	100	20	NS	17	59	71
659	731.91	80	3200	126	100	20	NS	17	59	71
660	241.60	80	3200	126	100	20	NS	17	59	71
661	614.04	80	3200	126	100	20	NS	17	59	71
662	562.66	80	3200	126	100	20	NS	17	59	71
663	358.18	80	3200	126	100	20	NS	17	59	71
664	518.44	80	3200	126	100	20	NS	17	59	71
665	781.95	80	3000	132	100	20	NWSE	18	64	73

Table D.4., Swamp Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
666	1431.39	80	3000	132	100	20	NS	17	59	71
667	669.79	80	3000	132	100	20	NWSE	18	64	73
668	368.16	80	3000	132	100	20	NESW	18	64	73
669	959.24	80	3000	132	100	20	NESW	18	64	73
670	69.35	85	3200	126	100	15	NESW	18	52	67
671	304.08	85	3200	126	100	15	NESW	18	52	67
672	471.87	85	3200	126	100	15	NESW	18	52	67
673	508.99	85	3000	132	100	15	EW	18	56	68
674	659.49	90	3200	126	100	10	NS	17	38	55
675	397.14	90	3200	126	100	10	NS	17	38	55
676	581.96	90	3200	126	100	10	NS	17	38	55
677	550.31	90	3000	132	100	10	NS	17	38	55
678	1699.35	90	3000	132	100	10	NS	17	38	55
679	527.27	45	2800	139	100	55	EW	18	159	89
680	335.39	45	2800	139	100	55	EW	18	159	89
681	502.18	45	2800	139	100	55	EW	18	159	89
682	842.80	45	2600	145	100	55	NWSE	18	146	88
683	645.39	45	2600	145	100	55	NWSE	18	146	88
684	263.64	45	2600	145	100	55	NWSE	18	146	88

Table D.4., Swamp Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
685	462.42	45	2600	145	100	55	NWSE	18	146	88
686	1526.87	40	3400	120	100	60	NS	17	143	88
687	294.64	40	3200	126	100	60	NS	17	143	88
688	50.73	40	3200	126	100	60	NS	17	143	88
689	445.50	40	3200	126	100	60	NS	17	143	88
690	32.76	40	3200	126	100	60	NS	17	143	88
691	315.94	40	3000	132	100	60	NS	17	143	88
692	179.07	40	3000	132	100	60	NS	17	143	88
693	432.13	40	3000	132	100	60	NS	17	143	88
694	592.49	40	3000	132	100	60	NS	17	143	88
695	128.27	40	3000	132	100	60	NS	17	143	88
696	118.00	40	3000	132	100	60	NS	17	143	88
697	488.93	40	3000	132	100	60	NS	17	143	88
698	208.28	40	3000	132	100	60	NS	17	143	88
699	743.64	40	3000	132	100	60	NS	17	143	88
700	486.12	40	3000	132	100	60	NS	17	143	88
701	688.56	40	3000	132	100	60	NS	17	143	88
702	141.89	40	2800	139	100	60	NS	17	143	88
703	98.21	40	2800	139	100	60	NWSE	18	157	89

Table D.4., Swamp Creek temperature TMDL, cont.

Segment ID	Segment Length (ft)	Current Canopy (%)	Elevation (ft)	Predicted CWE (%)	Target Canopy (%)	Target Canopy Increase (%)	Orientation	Heat Load Capacity (W/M^2)	Current Heat Loading (W/M^2)	Target Heat Load Reduction (%)
704	991.75	100	1600	176	100	0	NWSE	18	18	0
705	322.33	90	2800	139	100	10	NWSE	18	41	57
706	726.09	90	2800	139	100	10	NWSE	18	41	57
707	259.67	90	2800	139	100	10	NWSE	18	41	57
708	454.12	100	2800	139	100	0	EW	18	18	0
709	1027.13	100	3000	132	100	0	EW	18	18	0
710	328.36	100	3000	132	100	0	EW	18	18	0
711	314.86	100	3000	132	100	0	EW	18	18	0
712	242.05	100	3000	132	100	0	EW	18	18	0
713	683.36	100	2400	151	100	0	NWSE	18	18	0
714	664.46	100	2400	151	100	0	NS	17	17	0
715	339.66	100	2000	163	100	0	NS	17	17	0
716	917.29	45	2600	145	100	55	NWSE	18	146	88
717	854.81	45	2400	151	100	55	NWSE	18	146	88
718	336.83	80	3000	132	100	20	NWSE	18	64	73
719	433.39	80	2800	139	100	20	NWSE	18	64	73
720	298.05	40	3200	126	100	60	NS	17	143	88
721	578.95	40	3400	120	100	60	NS	17	143	88

Appendix E. Unit Conversion Chart

Table E-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 (g) Cubic Feet (ft^3)	Liters (l) Cubic Meters (m^3)	1 g = 3.78 l 1 l = 0.26 g 1 ft^3 = 0.03 m^3 1 m^3 = 35.32 ft^3	3 g = 11.35 l 3 l = 0.79 g 3 ft^3 = 0.09 m^3 3 m^3 = 105.94 ft^3
Flow Rate	Cubic Feet per Second (ft^3/sec)[a]	Cubic Meters per Second (m^3/sec)	1 ft^3/sec = 0.03 m^3/sec 1 m^3/sec = ft^3/sec	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 kg
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 ft^3/sec = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 ft^3/sec.
[b] The ratio of 1 ppm = 1 mg/l is approximate and is only accurate for water.

Appendix F. Distribution List

Department of Environmental Quality – Lewiston Regional Office 1118 F St, Lewiston, ID 83501
Department of Environmental Quality – Grangeville Office, 300 W. Main St. Grangeville, ID 83530
Clearwater Basin Advisory Group (CBAG) members
Lower North Fork Clearwater River Watershed Advisory Group (WAG) members
Lewiston City Library – Tsceminicum Branch, 428 Thain Road, Lewiston, ID 83501
University of Idaho Library, Government Documents, University of Idaho, Moscow ID 83844
Lewis Clark State College Library, Lewis Clark State College, Lewiston ID 83501
Clearwater Memorial Public Library, 402 Michigan Avenue, Orofino, ID 83544
Pierce City Library, 208 South Main Street, Pierce, ID 83546
Weippe City Library 208-435-4529
Kamiah Community Library, P.O. Box 846, Kamiah, ID 83536
Palouse Clearwater Environmental Institute, P.O Box 8596, Moscow, ID 83843
Clearwater Potlatch Timber Protection Agency, 10250 Hwy 12, Orofino ID 83544
Clearwater Basin Advisory Group (CBAG) members
Lower North Fork Clearwater River Watershed Advisory Group (WAG) members
Marti Bridges DEQ- State Office 1410 N. Hilton Boise, ID 83706
Bill Stewart – EPA 1435 N. Orchard, Boise, ID 83706
Richard Jones, Clearwater National Forest, 12730 Hwy 12, Orofino, ID 83544
Douglas Fitting and Jim Colla, Idaho Department of Lands, 3780 Industrial Ave. South, Coeur d'Alene, ID 83815
Rick Patten, US Forest Service, 3815 Schrieber Way, Coeur d' Alene, ID 83815

Appendix G. Public Comments

Table G-1 summaries the public comments received. The public comment period was announced by advertisements in three local newspapers- Lewiston Morning Tribune, Moscow-Pullman Daily News, and the Clearwater Tribune; and was posted on the following websites:

http://www2.state.id.us/deq/news/september_02/september24_02b.htm

http://www2.state.id.us/deq/water/tmdls/clearwater river/clearwater river.htm.

The official public comment period ran from September 24, 2002 to October 25, 2002. A copy of the TMDL was sent to the following locations, groups and individuals for public review:

Department of Environmental Quality – Lewiston Regional Office
Department of Environmental Quality – Grangeville Office
Clearwater Basin Advisory Group (CBAG) members
Lower North Fork Clearwater River Watershed Advisory Group (WAG) members
Lewiston City Library-Tsceminicum Branch
University of Idaho Library, Government Documents, University of Idaho
Lewis Clark State College Library, Lewis Clark State College
Clearwater Memorial Public Library
Pierce City Library
Weippe City Library
Kamiah Community Library
Palouse Clearwater Environmental Institute
Clearwater Potlatch Timber Protection Agency
Marti Bridges-DEQ-State Office
Bill Stewart-EPA
Richard Jones-Clearwater National Forest
Douglas Fitting and Jim Colla-Idaho Department of Lands
Rick Patten-US Forest Service

Four commentators submitted approximately 50 written comments. These comments were grouped for appropriate responses into technical, social and legal, and text comments.

Table G-1. Summary of Public Comments.

Commentator	Type of Comment	Date of Comment
Meg Foltz Hydrologist Palouse Ranger District Clearwater National Forest 1770 Hwy 6 Potlatch, ID 83855	E-mail	October 1, 2002
William C. Stewart Environmental Protection Specialist EPA-Region 10 Idaho Operations Office 1435 N. Orchard St. Boise, ID 83706	Letter	October 21, 2002
Mark Solomon CBAG member msolomon@turbonet.com	E-mail	October 23, 2002
Ann Storar Water Resources Division Nez Perce Tribe anns@nezperce.org	E-mail	October 25, 2002

Technical Comments

Comment 1: Comments were received concerning the effect Elk Creek Reservoir water temperature has on the water temperature in Elk Creek-lower. Elk Creek Reservoir meets its beneficial uses, but is identified as a heat source because it raises the water temperature 5 degrees as it proceeds to Elk Creek-lower. Since the dam is identified as a source of heat, a load allocation is required for the dam for warm weather periods.

Response 1: Although temperature is not a concern in the reservoir, a load allocation of 5ºC has been applied during the summer months to augment the temperature for Elk Creek-lower.

Comment 2: Throughout the document the labels used to describe pathogen loads vs. concentrations are unclear.

Response 2: The labeling units for bacteria were changed to make them more readable. Under IDAPA 58.01.02, the bacteria state standards are in organisms per 100 m, and to be consistent, are presented as such in this document. In the glossary of this document, organisms per 100ml is defined as the total number of colonies or colony forming units of E-coli bacteria per 100 ml of solution.

Comment 3: The use of lower Elk Creek as a baseline for “similar" subbasin watersheds for sediment has not been adequately justified. Nowhere in the document does it determine that the current sediment loading to Lower Elk Creek is appropriate to support the creek's beneficial uses.

Response 3: A paired watershed approach was used to determine sediment load capacity. Beneficial uses in Elk Creek-lower are not impaired by sediment, while beneficial uses are impaired by sediment in Cranberry, Swamp, Long Meadow and Reeds Creeks. Elk Creek Reservoir may act as a sediment sink; therefore, Elk Creek may flush sediment more effectively because of stream energy. This has been addressed by the MOS.

Comment 4: Subbasin assessments utilizes Waterbody Assessment Guidance II (WBAGII). as one of the major tools to make significant determinations, including the decision to de-list several streams for sediment.

Response 4: WBAG II has provided good information for the LNFCRS. Other data was also used to help determine if a waterbody was truly impaired. Based on the information presented, waterbodies found to be meeting beneficial uses and state standards are not impaired, and are therefore recommended for removal from the 303(d) list.

Comment 5: Sediment load modeling by WATBAL has been invariably underestimated. Use of the model should be carefully reconsidered understanding the limitations in the model.

Response 5: The limitations of WATBAL were considered in this assessment and TMDL. The model was only one of many factors used to determine beneficial use status.

Comment 6: A commentator suggested that that DEQ employ the "Matrix of Pathways and Indicators of Watershed Condition for Chinook, Steelhead and Bull Trout" (Matrix) (National Marine Fisheries Service (NMFS)). The above document incorporates the Endangered Species Act, and any assessment that does not adequately consider fish habitat is incomplete and erroneous.

Response 6: Most of the indicators in the NMFS document were considered when determining whether a TMDL was necessary. The NMFS document is a checklist to document environmental baseline indicators, not a TMDL document.

Comment 7: Recreational dredge mining ought to be addressed in the assessment.

Response 7: Recreational dredge mining was addressed in Section 3.1 under "Sediment."

Comment 8: The rating process using Idaho's Cumulative Watershed Effects (CWE) process is subject to great individual interpretation, so its limitations ought to be considered.

Response 8: The CWE temperature analysis utilizes some interpretation; however, in all of the temperature TMDLs the surrogate temperature target is 100% canopy cover for the entire length of the stream (refer to Appendix D). The CWE road sediment evaluation, which was used for the road portion of the sediment TMDLs, has clear categories to select the conditions on the ground.

Comment 9: The presence of fish is not evidence that sediment is not a pollutant. Surrogate targets such as TSS, percent fines, cobble embeddedness, and residual pool volume should be added. A tons/year target is not adequate. There should be BMP effectiveness monitoring conducted to assure that sediment reduction targets are met, and this sampling design should be described in the implementation plan.

Response 9: Sediment is a water quality pollutant in the LNFCRS, and where appropriate, sediment TMDLs were completed. Considerable data and discussion of sediment is evident throughout the document. The assessment determined that sediment is degrading water quality below the state standards in Cranberry, Swamp, Long Meadow, Reeds, Partridge and Breakfast Creeks, but the remaining waterbodies are not being impaired by sediment as a pollutant. The Idaho State Water Quality Standards related to sediment are narrative. DEQ relies heavily upon bioassessment techniques, as codified in WBAG II, to gage sediment effects on beneficial uses. Sediment delivery data was analyzed and compared to in-stream effects in terms of beneficial uses. The presence of several age classes of salmonids in these streams indicates that the beneficial uses are still being supported and that sediment TMDLs are not necessary. Idaho uses aquatic life indicators to characterize water quality because they are most applicable across the broad range of conditions found in streams and rivers. A tons per year target is a direct measurement of sediment off of the landscape. In addition to BURP, BMP effectiveness monitoring will take place in the watershed to ensure the targets set forth in the TMDL are met.

Comment 10: We disagree with the decision to de-list streams for sediment.

Response 10: The analysis completed as part of this TMDL indicates that the beneficial uses are still being supported and that sediment TMDLs are not necessary. All de-listings are recommendations; de-listing issues will be addressed at the time the 2002 303(d) list is submitted to EPA.

Social and Legal Comments

Comment 1: How does the TMDL affect implementation?

Response 1: The TMDL guides the development of implementation activities by defining load reductions needed.

Comment 2: Concerns were raised over the nutrient levels and nuisance algae in Elk Creek Reservoir. Does continued monitoring need to occur in the reservoir?

Response 2: The data shows that nutrient levels are low in the reservoir, and nuisance algae is not problem. IDFG is committed to address the algae situation in the reservoir with annual treatment and monitoring (Shriever, 2002).

Comment 3: The document indicates a limited road system made access to collection sites a challenge. That seems to contradict the high road density numbers given for each of the subwatersheds.

Response 3**:** Although there is a high road density in some of the subwatershed, many of these roads are closed or not accessible. The sentence has been changed to reflect that the steep terrain and large sampling area were the main factors making collection of the data difficult. For example, the sites at the mouth of each stream sampled were accessed by boat and foot from Dworshak Reservoir in order to complete the fieldwork in a reasonable time frame.

Comment 4: The document is not clear with regard to seasonal variation of tributary loads. Since seasonal variation is an element of a TMDL that is required by statute, some discussion of how seasonal variation has been accounted for in the TMDL is needed.

Response 4: Discussion of season variation has been added to the document.

Comment 5: It appears as though DEQ has completed a TMDL that includes portions of the Lower North Fork of the Clearwater River that are within the exterior boundaries of the Nez Perce Reservation.

Response 5: No TMDLs were completed within the boundaries of the Nez Perce Reservation, and the water bodies that are within the reservation boundary were not analyzed or considered for TMDL development

Comment 6: There is no information regarding locations at which the cattle may have access to streams. The possible presence of nutrients and bacteria in those locations or where cattle graze nearby should be thoroughly investigated.

Response 6: The effects from cattle were thoroughly analyzed throughout the document. Section 1.3-Grazing, gives the locations of cattle. Specifically, the LNFCR subbasin has virtually no fences and an open range policy exists for cattle. In the watersheds where cattle are allowed, they have access to the entire stream, and occasionally cattle roam outside of the areas specifically managed for them.

Comment 7: Please note that the Nez Perce people continue to rely on the basin for both subsistence and traditional activities.

Response 7: Noted and changed accordingly.

Text Comments

Comment 1: page 2. “TMDLs are not required for water bodies impaired by pollution, but not specific pollutants.” This sentence is confusing.

Response 1: A typographical error, the new sentence now reads, "TMDLs are not required for water bodies impaired by pollution, but by specific pollutants."

Comment 2: page 9. Westslope cutthroat is not a proposed or candidate species.

Response 2: Westlope cutthroat has been removed from that sentence.

Comment 3: page 10. Misspelling of unincorporated.

Response 3: The typographical error has been corrected.

Comment 4: page 30. 1970's and precipitation are the correct spellings. WATBAL does not predict desired or current cobble embeddedness, but does predict the percent increase in sediment over natural levels.

Response 4: The typographical errors were corrected. The sentence about cobble embeddedness not being predicted by WATBAL was corrected.

Comment 5: page 36. Stray comma in the next sentence, after the words "sculpin and ,".

Response 5: The comma was deleted.

Comment 6: page 46. An awkward sentence construction might be improved: Road density is very high (7.14 miles per square mile), but there are no roads in high mass failure or high surface erosion areas.

Response 6: The sentence was changed to your suggested improvement.

Comment 7: page 54. Sentence says "WATBAL indicates the current cobble embeddedness of 20% is below the desired condition of 40-45%." If taken from Jones and Murphy, Watershed Condition, 1997, the 20% is an in-stream measurement as determined by Clearwater Biostudies, Inc. and not a WATBAL prediction. The conclusion that follows is correct – that lower Elk Creek is not sediment impaired.

Response 7: The correction has been made.

Comment 8: page 57. Awkward sentence-IDFG has been stocking rainbow trout on a consistent basis in the reservoir since 1968 and currently maintains the reservoir so the average catch rate is 0.5 fish/hour.

Response 8: The sentence has been re-worded for clarification.

Comment 9: page 92. Map reference should be to Map 20.

Response 9: The correction has been made.

Comment 10: page 119. Jones, not Jone.

Response 10: The typographical error has been corrected.

Comment 11: Appendix 3-Figures. Several, but not all graphs have indicators of standards and/or minimum detectable limits. Fig 17 and 18 show good comparisons to standards, but the phosphorus and nitrate graphs require going back to the discussion of standards to see how they compare. It's useful to have those on each chart, rather than needing to flip back to the description of standards to see what the standard is.

Response 11: The are no numeric standards for phosphorus. Where there is a numeric standard, it is displayed.

Comment 12: Table C. In the executive summary appears to be mixed up. Either the column headings are in the wrong place or the values for Cranberry Creek and Long Meadow Creek are in error.

Response 12: Table C. has been corrected, as the values in the current load column were not accurate.

Comment 13: On page 23, Table 6. under Salmonid Spawning, the bull trout section should read, "Bull Trout- water temperature shall not exceed 13°C…"

Response 13: The correction was made.

Comment 14: On page 23, Table 6. under Temperature at the bottom of the page, the federal bull trout standard should read, "a temperature criterion of 10°C expressed as an average of daily maximum temperatures over a seven-day period, applies…during the months of June, July, August, and September."

Response 14: The correction was made.

Comment 15: Presentation, interpretation of data in the document is inadequate or not explained. Tables and figures are difficult to read. The document states that there is a self-propagating fish population without presenting or referring to data to support that allegation.

Response 15: The data for each waterbody is found the tables and figures. Corrections were made to the figures and tables to provide a more readable document. Tables 8, 11, and 12 provide clear evidence of a self propagating fish population.

DEQ-287, TM85, 22064, 9/02, Cost Per Unit: $20.00

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