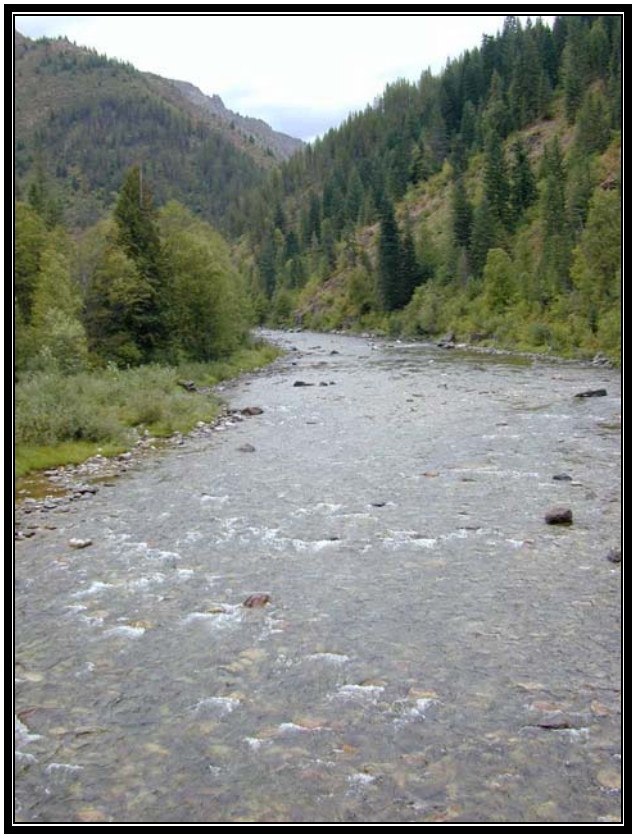
Upper North Fork Clearwater River Subbasin Assessment and Total Maximum Daily Loads



Department of Environmental Quality
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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
^{o}C	degrees Centigrade
^{o}F	degrees Fahrenheit
§	Section (usually a section of federal or state rules or statutes)
%	percent
#	number
BMP	best management practice
BURP	Beneficial Use Reconnaissance Program
CFR	Code of Federal Regulations (refers to citations in the federal administrative rules)
CE	cobble embeddedness
cfs	cubic feet per second
CNF	Clearwater National Forest
CWA	Clean Water Act
CWE	cumulative watershed effects
DEQ	Department of Environmental Quality
FPA	Idaho Forest Practices Act
ft	foot/feet
GIS	Geographical Information Systems
HI	habitat index
HUC	Hydrologic Unit Code
IDAPA	Refers to citations of Idaho administrative rules
IDL	Idaho Department of Lands
INFISH	The federal Inland Native Fish Strategy
JTU	Jackson turbidity units
LTIU	long-term intermittent use
MBI	macroinvertebrate biotic index
mm	millimeter
MWMT	maximum weekly maximum temperature
NA	not assessed
nd	no data (data not available)
NRCS	Natural Resources Conservation Service
NTU	nephlometric turbidity unit
ORV	off-road vehicle
RMS	root mean square
SNOTEL	Snow Telemetry Station

SPZ stream protection zone

TMDL total maximum daily load

UNFCRS Upper North Fork Clearwater River Subbasin

UNFCR Upper North Fork Clearwater River

U.S. United States

USEPA United States Environmental Protection Agency

USFS United States Forest Service

USFWS United States Fish and Wildlife Service

USGS United States Geological Survey

WATBAL Watershed Response Model for Forest Management

WBAG Waterbody Assessment Guidance

Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the 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 develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses the water bodies in the Upper North Fork Clearwater River Subbasin 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 Upper North Fork Clearwater River Subbasin 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 1998 303(d) list of water quality limited water bodies. Nineteen segments of the Upper North Fork Clearwater River Subbasin were listed on this list. The subbasin assessment portion of this document examines the current status of 303(d) listed waters, and defines the extent of impairment and causes of water quality limitation throughout the subbasin. 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

Water Quality at a Glance

Hydrologic Unit Code	17060307 Subbasin (Upper North Fork Clearwater River)
Subbasin Area	1,294 Square Miles (828,000 Acres)
303(d) Listed Water Bodies	Sneak Creek, Tumble Creek, Orogrande Creek, Tamarack Creek, Sylvan Creek, Hem Creek, Middle Creek, Marten Creek, Gravey Creek, China Creek, Sugar Creek, Swamp Creek, Osier Creek, Laundry Creek, Deception Gulch, Cold Springs Creek, Cool Creek, Grizzly Creek, Cougar Creek
Beneficial Uses Affected	Cold Water Aquatic Life, Salmonid Spawning (Federal Bull Trout Protection)
Pollutants of Concern	Sediment and Temperature as Non-Point Sources (No Point Source Pollutants)
Land Uses	Forestry, Roads, Recreation

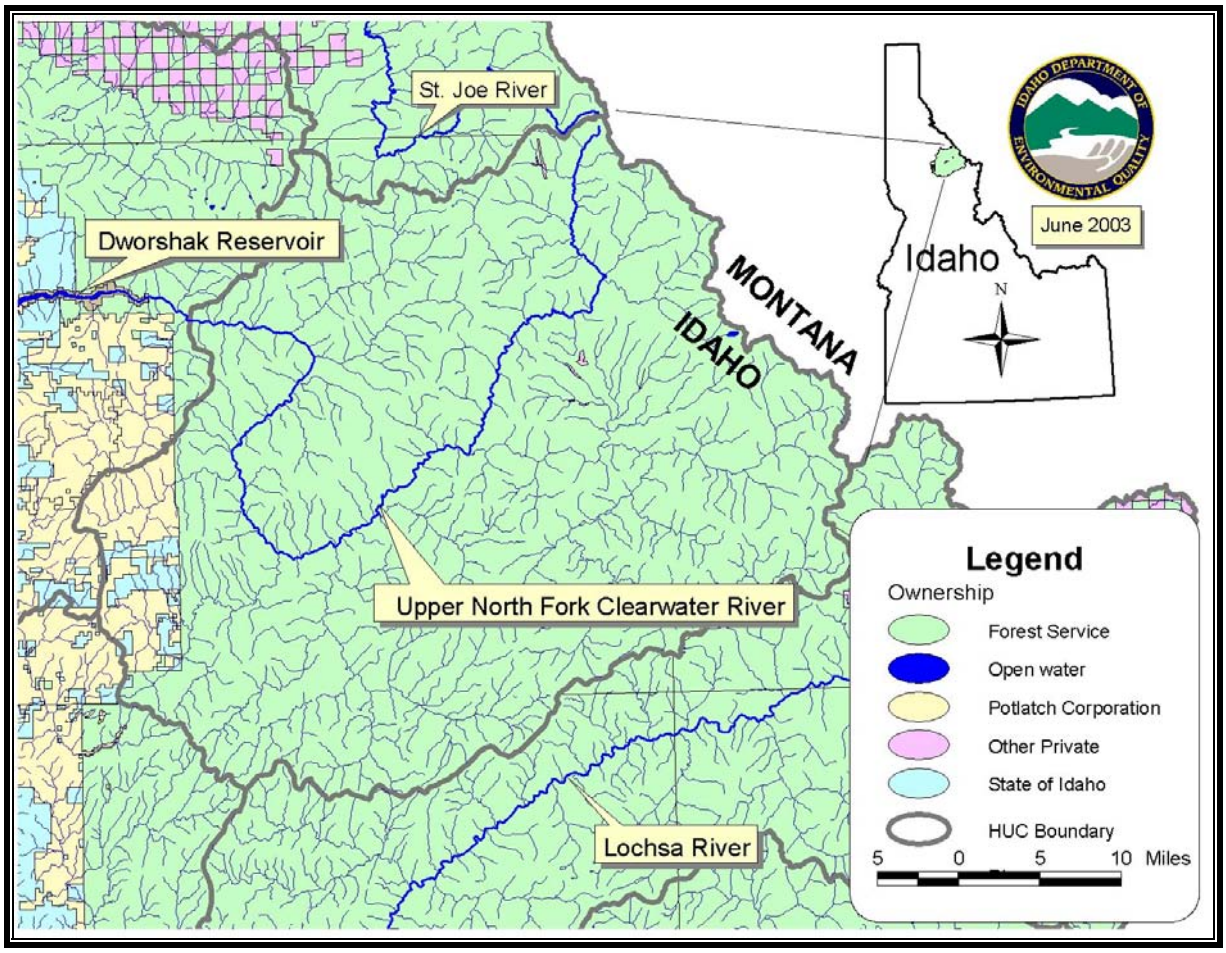


Figure A. Location in Idaho and Ownership of the Upper North Clearwater River Subbasin

The subbasin assessment evaluates the occurrence and effects of pollutants in each of the 303(d) listed water bodies, both in the context of the subbasin and with respect to the water quality of the individual streams. The Department of Environmental Quality *1996 Water Body Assessment Guidance* (WBAG) (DEQ 1996) is the primary tool used to assist in the evaluation of water quality. Water temperature is evaluated using results from continuous temperature recording stations established by the Clearwater National Forest. Such data are available for all of the 303(d) listed streams in this subbasin except Tumble, Sugar, and Marten Creeks. Water temperature is evaluated against the appropriate federal or state standard, depending on federal designation for bull trout protection, presence of cutthroat trout, presence of rainbow trout, and presence of brook trout. Sediment is evaluated using standardized data sets and procedures within the WBAG to determine whether beneficial uses are being supported. The designated beneficial uses for all the listed water bodies are cold water aquatic life and salmonid spawning. Finally, the results of the specific procedural analyses for both temperature and sediment are weighed against other data and information about the subbasin and a conclusion is reached whether or not a water body is impaired and, if so, by which pollutant.

Table A. 303(d) listed water bodies in the Upper North Fork Clearwater River Subbasin.

Stream Name	Boundaries[1]	WQL Seg. No.[2]	Channel Type[3]	Stream Miles	Listed Pollutant[4]
Sneak Creek	HW to NF Clearwater River	5178	B	3.5	Channel Stability
Tumble Creek	HW to Washington Creek	5200	B	4.6	Sed
Orogrande Creek	HW to NF Clearwater River	3215	B	19.5	Sed
Tamarack Creek	HW to Orogrande Creek	5193	B	3.9	Sed
Sylvan Creek	HW to French Creek	5192	B	4.3	Sed
Hem Creek	HW to Sylvan Creek	5093	B	5.0	Sed
Middle Creek	HW to Weitas Creek	5123	B	13.3	Sed
Marten Creek	HW to Gravey Creek	5119	B	4.5	Sed
Gravey Creek	HW to Cayuse Creek	3229	A	9.0	Sed
China Creek	HW to Osier Creek	5040	A	4.9	Sed
Sugar Creek	HW to Swamp Creek	5189	B	4.0	Sed
Swamp Creek	HW to Osier Creek	5190	B	5.4	Sed
Osier Creek	HW to Moose Creek	3225	A&B	8.1	Sed, Temp
Laundry Creek	HW to Osier Creek	5104	A	4.4	Sed
Deception Gulch	HW to NF Clearwater River	5059	B	4.7	Sed
Cold Springs Creek	HW to NF Clearwater River	5045	A	4.8	Sed
Cool Creek	HW to Cold Springs Creek	5047	A	3.3	Sed
Grizzly Creek	HW to Quartz Creek	5088	A	4.5	Sed
Cougar Creek	HW to Quartz Creek	5049	A	3.7	Sed

[1] HW = Headwaters, NF = North Fork
[2]WQL Seq No. = Water Quality Limited Segment Number
[3]A and B are Rosgen channel types (Rosgen 1994)
[4]Sed=Sediment; Temp=Temperature

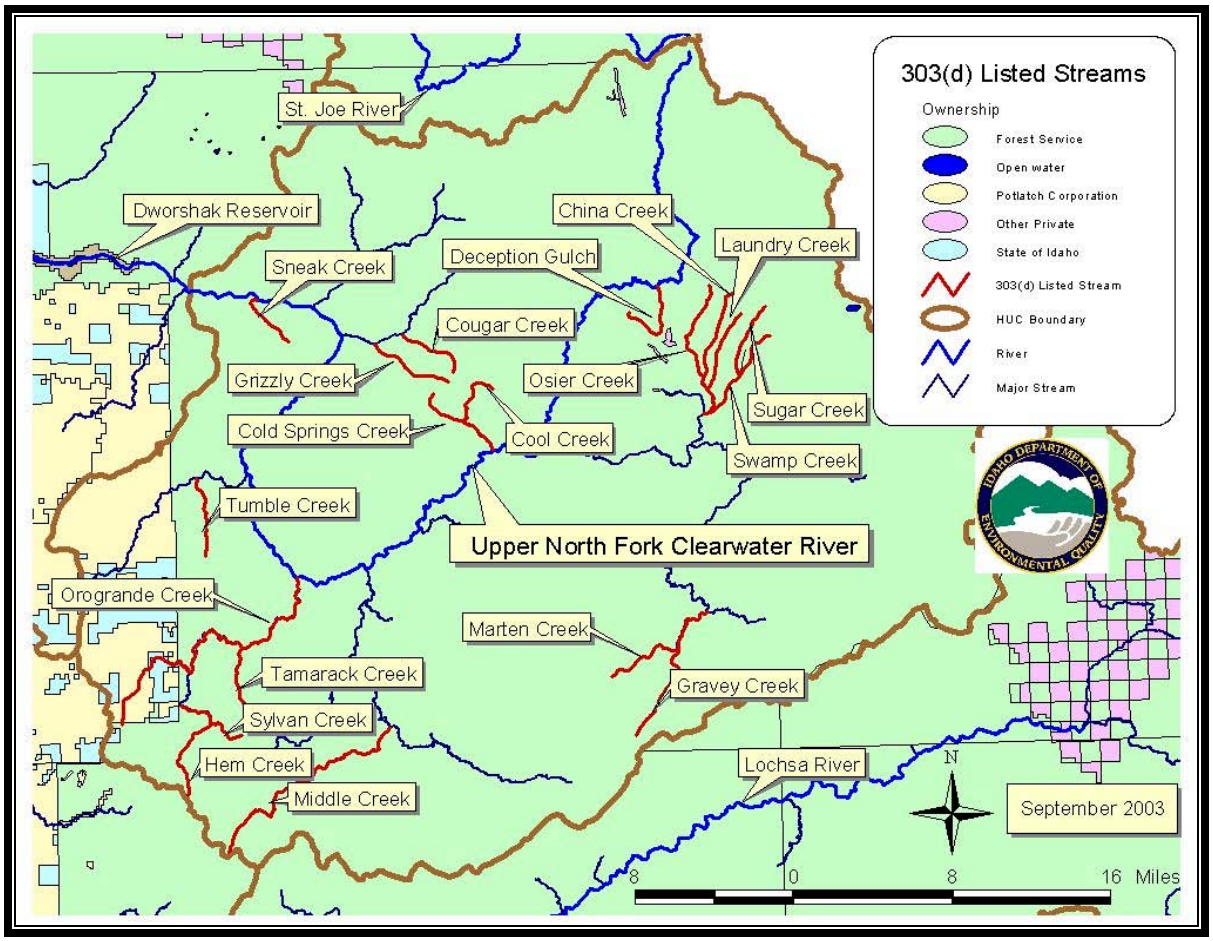


Figure B. 303(d) Listed Streams of the Upper North Fork Clearwater River Subbasin

Eleven of the water bodies (Cold Springs and Cool, Cougar, Grizzly, Gravey, Marten, Middle, Laundry, Osier, Sugar, and Swamp Creeks) are federally protected as bull trout watersheds. Based on the available data, none of these water bodies meets the federal bull trout water temperature standard. Orogrande, Tamarack, Hem, Sylvan, Sneak, and China Creeks have populations of cutthroat trout but do not meet the state's water temperature standard for this species. Hem Creek, however, is in near pristine condition and it is concluded that the temperature regime in this creek is natural. Deception Gulch has rainbow trout but does not meet the state's water temperature standard for rainbow trout. Tumble Creek has a population of brook trout and it is concluded that the state's water temperature standard for salmonid spawning is being met during the brook trout spawning season. Temperature TMDLs are written for every 303(d) listed water body except Hem Creek and Tumble Creek.

Key Findings

All the water bodies are 303(d) listed for sediment (only Osier Creek is listed for temperature). However, analysis of the data indicates that only one of the listed water

bodies, Deception Gulch, is water quality limited as the result of sediment. Except for Deception Gulch, we recommend that all the water bodies be removed from the 303(d) list for sediment. A sediment TMDL is written for Deception Gulch.

Temperature TMDLs are developed for 18 water bodies using percent stream canopy closure increase by stream segment as the target, based on the appropriate water temperature standard as the load capacity. The TMDL section discusses how the percent canopy closure target relates to heat as a pollutant. In order to meet the stream temperature targets in the various water bodies, 75-100 percent of the stream miles require increased stream canopy closure.

A sediment TMDL is developed for Deception Gulch based on sediment mass balance. Most of the excess sediment is coming from roads on high hazard landtypes and mass failures associated with these roads – the total required load reduction is assigned to these nonpoint sources. A sediment target is set at 390 tons/year, while total loading to the stream is on the order of 770 tons/year. The load reduction target is 380 tons/year, or about a 50 percent sediment loading reduction. To achieve this target, we recommend that the Clearwater National Forest obliterate approximately 50 percent of the roads in the watershed, especially those on high hazard landtypes.

Table B. Summary of conclusions and recommended actions.

Stream Name	Boundaries[1]	Listed Pollutant	TMDLs Completed	Recommend-ations
China Creek	HW to Osier Creek	Sediment	Temperature	Delist for Sediment
Cold Springs Creek	HW to NF Clearwater River	Sediment	Temperature	Delist for Sediment
Cool Creek	HW to Cold Springs Creek	Sediment	Temperature	Delist for Sediment
Cougar Creek	HW to Quartz Creek	Sediment	Temperature	Delist for Sediment
Deception Gulch	HW to NF Clearwater River	Sediment	Temperature Sediment	None
Gravey Creek	HW to Cayuse Creek	Sediment	Temperature	Delist for Sediment
Grizzly Creek	HW to Quartz Creek	Sediment	Temperature	Delist for Sediment
Hem Creek	HW to Sylvan Creek	Sediment	None	Delist for Sediment
Laundry Creek	HW to Osier Creek	Sediment	Temperature	Delist for Sediment
Marten Creek	HW to Gravey Creek	Sediment	Temperature	Delist for Sediment
Middle Creek	HW to Weitas Creek	Sediment	Temperature	Delist for Sediment
Upper Orogrande Creek	HW to French Creek	Sediment	Temperature	Delist for Sediment
Lower Orogrande Creek	French Creek to NF Clearwater River	Sediment	Temperature	Delist for Sediment
Osier Creek	HW to Moose Creek	Sediment Temperature	Temperature	Delist for Sediment
Sneak Creek	HW to NF Clearwater River	Channel Stability	Temperature	Delist for Channel Stability
Sugar Creek	HW to Swamp Creek	Sediment	Temperature	Delist for Sediment
Swamp Creek	HW to Osier Creek	Sediment	Temperature	Delist for Sediment
Sylvan Creek	HW to French Creek	Sediment	Temperature	Delist for Sediment
Tamarack Creek	HW to Orogrande Creek	Sediment	Temperature	Delist for Sediment
Tumble Creek	HW to Washington Creek	Sediment	None	Delist for Sediment

[1] HW = Headwaters, NF = North Fork

Appendix 1 presents a table that correlates the 303(d) listed streams addressed in this TMDL to the "assessment units" being developed by the state and the U.S. Environmental Protection Agency for the purposes of tracking water quality status.

1. Subbasin Assessment – Watershed Characterization

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the 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 develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses the water bodies in the Upper North Fork Clearwater Subbasin (UNFCRS) that have been placed on what is known as the "303(d) list."

The overall purpose of this subbasin assessment and TMDLs is to characterize and document pollutant loads within the UNFCRS. 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 is then summarized for each water body in Chapter 5 and used to develop TMDLs for each pollutant of concern for the UNFCRS in Chapter 6.

1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water 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 (USEPA), 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 USEPA oversees Idaho water pollution control activities and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt, with USEPA 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 a TMDL for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses. These requirements result in a list of impaired waters, called the "303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. A subbasin assessment and subsequent TMDLs provide a summary of the water quality status and allowable TMDL for water bodies on the 303(d) list. This document, *Upper North Fork Clearwater River Subbasin Assessment and Total Maximum Daily Loads,* provides this summary for the currently listed waters in the UNFCRS.

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 UNFCRS to date. While this assessment is not a requirement of the TMDLs, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDLs are plans to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (Water quality planning and management, 40 CFR 130). Consequently, a TMDL is water body and pollutant specific. The TMDL also includes individual pollutant allocations among various sources discharging the pollutant. The USEPA 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 not by specific pollutants. A TMDL is only required when a pollutant can be identified and in some way quantified. 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 use support – cold water, seasonal cold water, warm water, salmonid spawning, modified
- Contact recreation – primary (swimming), secondary (boating)
- Water supply – domestic, agricultural, industrial
- Wildlife habitat, 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.

Methodology

This subbasin assessment for the UNFCRS examines the water quality for each of the 20 303(d) listed water bodies in the subbasin. They are assessed to determine whether or not their water quality meets the standards of Idaho State Code Section 58.01.02 (Water Quality Standards and Wastewater Treatment Requirements). If it is determined that the water quality does not meet the state's standards as the result of an identified pollutant, then a TMDL for that pollutant for that water body is developed. In addition, streams designated by the USEPA as protected for bull trout spawning and rearing are assessed using the USEPA temperature standards (40 CFR Part 131.33(a)), and if they do not meet the standards, a TMDL for temperature is developed.

This report describes the setting of the UNFCRS (Chapter 1), including physiographic, biological, and human cultural characteristics. Next, in Chapter 2, we discuss the applicable state and federal water quality standards in relation to the water pollution issues within the UNFCRS. The two major pollutants of concern are sediment and heat. Also in Chapter 2, we present the assessment techniques we have available to help determine the extent of the impact of the pollutants on water quality. The primary data sets and analyses are those contained in DEQ's Beneficial Use Reconnaissance Program (BURP) and its associated *1996 Water Body Assessment Guidance* (WBAG) (DEQ 1996). Additional data that relate to water quality are also identified in Chapter 2.

In Chapter 3, we discuss current knowledge about the sources and effects of the pollutants, past and current efforts to control the pollutants, and gaps in our knowledge base about the pollutants in the UNFCRS. In Chapter 4, we discuss efforts to improve water quality that have already been implemented. In Chapter 5, the data from Chapters 2, 3, and 4 are

summarized water body–by-water body, and conclusions are drawn as to water quality status and the need for TMDLs. Finally, in Chapter 6, a loading analysis is completed and a TMDL is developed for each water body identified as water quality impaired in Chapter 5.

As an initial step in the UNFCRS assessment, we divided the Orogrande Creek stream segment into two water bodies. This division is consistent with Idaho's water quality standards wherein Orogrande Creek is divided into two water body units (IDAPA 58.01.02.120.09) even though, on the 303(d) list, the whole of Orogrande Creek is 303(d) listed for sediment. The upper part of Orogrande Creek, above the confluence with French Creek, is primarily managed by Potlatch Corporation and the Idaho Department of Lands (IDL). The lower part of the Orogrande Creek watershed and all the other listed watersheds in the UNFCRS are managed by the Clearwater National Forest (CNF). Data collected by the CNF are significantly different from those of the state and private forestland mangers. While 19 individual streams are being analyzed, the division of Orogrande Creek results in 20 stream segments being analyzed for water quality problems.

At the outset of this investigation, we discussed how to assess Sneak Creek, which is listed for channel stability. We assessed this stream specifically for channel stability as measured by percent of raw banks. In addition, since the most likely pollutant affecting beneficial uses as a result of channel instability would be sediment, we assessed Sneak Creek for sediment in the same manner as all the other sediment listed streams in the UNFCRS.

We first analyzed each of the 20 streams using DEQ's BURP data following the 1996 WBAG (DEQ 1996). The BURP procedure is a rapid assessment method of collecting data from one or a few representative sites within a water body. The WBAG specifies the procedures for analyzing that data to determine whether beneficial uses are being supported or not. The streams were assessed using BURP protocols in 1997 and 1998. In a process known as "WBAG plus," additional information about the water quality from various other sources was considered in relation to the WBAG results. A final water quality status determination was made based on the weight of evidence of whether a given pollutant exceeds state or federal water quality standards and is limiting the designated beneficial uses.

The first step in the WBAG process is to assess whether any numeric criteria are exceeded. In the case of water bodies in this subbasin, we know that temperature exceedances exist for most of the streams. Stream temperature data from the CNF were evaluated against the USEPA designated standards for bull trout protected streams and against Idaho water quality standards for other water bodies supporting other salmonids. Outside the bull trout protected water bodies, the other 303(d) streams, except Cougar, Grizzly, Deception, and Tumble Creeks, have populations of cutthroat trout, so they were evaluated against the cutthroat trout temperature standards. Tumble Creek supports only brook trout and was evaluated against that criterion.

It was determined that temperature standard exceedances occur in every 303(d) listed water body in this subbasin except Tumble Creek. Since most of the water bodies in the subbasin are listed for sediment, rather than temperature, we continued to follow the WBAG plus process to determine whether sediment is also limiting water quality beyond the state

standards. We conducted the sediment assessments as though the temperature exceedances did not exist.
For the sediment assessment in Chapter 3 we identified the major sources of sediment in the subbasin. We then considered the BURP data and WBAG conclusions in relation to other available data about potential sediment sources on a water body by water body basis.

In a geographic information systems (GIS) program we delineated the watershed surrounding each listed water body as the area for consideration, resulting in a sixth field hydrologic unit (HUC) delineation. We looked at the characteristics listed below as potentially impacting sediment loading. To a degree, these characteristics were chosen because similar types of data exist for them in both the CNF and the state of Idaho forest practices (IDL 2000) data sets. A high ranking for any given characteristic triggered further analysis in relation to the WBAG conclusion.

Road Density. We used either the Potlatch Corporation or CNF digital roads GIS layer to determine the number of miles of roads per square mile of the watershed. All things being equal, the higher the road density, the greater the potential for sediment being delivered to a stream. However, road design and maintenance can greatly influence this relationship.

Mass Failures. Potlatch Corporation, IDL, and the CNF collected extensive mass failure location data after the 1995-96 rain-on-snow events (McClelland et al. 1997). Since then, these data have been partially updated by the CNF and Cumulative Watershed Effects (CWE) assessments. The mass failure data were sorted by watershed in GIS. For each watershed, the total number of mass failures and the mass failure density is presented. These data are dated and many of the sites have been restored.

Channel Stability. The CNF has conducted bio-physical studies of most of the watersheds being assessed herein, the methodologies of which are discussed in Chapter 3. One of the indices developed is a bank stability index ranging from 0 to 5 based on the percentage of raw banks (0 indicates >50% raw banks and 5 indicates 0% raw banks).

The CWE process includes a channel stability assessment based on the Pfankuch method (Pfankuch 1978). In those watersheds where CWE data are available, the CWE channel stability scores are presented.

Road Erosion. The CNF uses the *Watershed Response Model for Forest Management* (WATBAL) to predict the amount of sediment being delivered in a watershed (Patten 1989). A background sediment delivery rate is calculated for each watershed based on the landtypes in the watershed. Then additional sediment delivery is calculated based on the lengths, types, and ages of roads; timber harvest; and other activities. A figure is generated for the amount of sediment being delivered over background amounts.

The CWE roads module assesses on the ground the amount of sediment being produced and delivered to a water channel. The CWE road sediment delivery scores are presented in Chapter 3. As part of this assessment, we conducted preliminary CWE road assessments as we visited the watersheds to compare to the WATBAL results.

Roads Close to Streams. Using GIS, a number was calculated for the number of miles of road in each 303(d) listed watershed that are within 100 feet of a stream. Proximity to a stream is only a *potential* sediment problem—many roads within 100 feet of a stream do not deliver any sediment to the stream channel.

Roads in High Mass Failure Hazard Zones. A number was calculated in GIS for the number of miles of road in each 303(d) listed watershed that are on landtypes with high or very high mass failure hazard ratings. Road design and maintenance greatly affect the potential impacts these roads might have.

Logged Areas. The CNF tree stand database was used to identify the total number of acres per watershed that have been entered for logging. No adjustment was made for partial canopy removal at the time of entry or for the canopy recovery since.

On state and private lands, a canopy removal index was generated using the CWE database. This is an estimate of current canopy condition in relation to the natural condition.

Generally, for the water bodies 303(d) listed as sediment impaired, the results were considered in light of any high-ranking potential sediment source characteristic. The final decision about any water quality impairment beyond the limits of the state standards, however, was largely driven by the beneficial use status of the water body. Specific to the water bodies in the UNFCRS, if it was clear that salmonid spawning as determined by the WBAG is occurring, then water quality is considered to be meeting the state standards.

For the assessment of channel stability impairment of Sneak Creek, we observed portions of the water body in the field and used the data from the CNF's *Habitat Conditions and Salmonid Abundance in the Sheep and Sneak Creek Drainages* (Clearwater BioStudies, Inc. 1995b) report for the stream.

The subbasin assessment resulted in one of two conclusions for each of the pollutants for each water body. If it was concluded that a water body is not impaired by the pollutant, then the proposal was made that the water body be removed from the 303(d) list for that pollutant. If it was concluded that a water body is indeed impaired by a pollutant, then a TMDL was developed for that water body and pollutant.

TMDLs were developed for 18 water bodies in the UNFCRS; these appear in Chapter 5. Temperature TMDLs were developed for 18 water bodies, and a sediment TMDL was developed for one water body (Deception Gulch). Of the 303(d) listed water bodies, only Tumble and Hem Creeks were found to be fully supporting their beneficial uses and do not have TMDLs developed for them.

For temperature TMDLs, we used the stream temperature to percent canopy closure and elevation relationship developed under the Idaho Forest Practices Act Cumulative Watershed Effects process (IDL 2000). The model estimates needed percent canopy closure to protect a stream for any selected maximum weekly maximum temperature (MWMT). The selected MWMT was the temperature standard for the species requiring the coldest water. For

example, the percent stream canopy closure needed to protect stream temperatures for bull trout at a given elevation is greater than the percent stream canopy closure needed to protect temperatures for general salmonid spawning because bull trout water quality standards require colder water. The model is dependent on elevation and was run at 200-foot elevation intervals, resulting in the designation of 860 stream segments for which temperature loading analyses were run. The model-estimated percent canopy closure needed to protect stream temperatures was compared to existing percent canopy closure. If the model-estimated percent canopy closure needed to protect stream temperatures was greater than the existing percent canopy closure, a percent canopy closure target was set based on the model estimate, and a TMDL requiring increased shade was developed. If the model-estimated percent canopy closure needed to protect stream temperature was less than or equal to the existing percent canopy closure, then the existing percent canopy closure was set as the target. We identified stream segments throughout the 303(d)-listed watersheds that lacked adequate stream shading for the most temperature sensitive salmonid species and developed TMDLs for them on a stream segment by stream segment basis.

For the sediment TMDL, we used a sediment balance approach. We used a standard figure of 25 tons per square mile for background sediment developed by the CNF (Wilson et al. 1982). Significant additional sediment was considered to be coming only from roads and mass failures. We used a GIS coverage of mass failures coupled with an estimate of their size and percent delivery to calculate the amount of sediment being delivered from mass failures. We then used both the CWE road assessment module and the CNF WATBAL calculations to develop a figure for sediment being delivered from roads. For total allowable loading, we used a CNF-developed figure for the percent sediment delivery over background that would allow a viable population of salmonids (Jones and Murphy 1997). The targeted load is that amount over background that would still result in salmonid spawning. The targeted load reduction amount is allocated to roads in the watershed and calculations were made for the number of miles of roads that need to be obliterated to meet the TMDL targets.

1.2 Physical and Biological Characteristics

This section of the report summarizes the physical and biological characteristics of the UNFCRS. Extensive physical and biological data are available because the subbasin is almost entirely public land managed by the U.S. Department of Agriculture, Forest Service (USFS), Clearwater National Forest. This summary focuses on those data that are most useful to understanding threats to the subbasin's surface water quality.

The North Fork of the Clearwater River is located in north-central Idaho, running 130 miles from the divide on the Montana-Idaho border westward towards Orofino, Idaho. The UNFCRS is that portion of the North Fork of the Clearwater River watershed above the U.S. Geological Survey (USGS) gauging station immediately above the confluence of Beaver Creek with the North Fork Clearwater River. Within the USGS hydrologic unit classification system (Seaber et al. 1984), the UNFCRS is identified by the fourth order HUC 17060307. (The Lower North Fork Clearwater River Subbasin is the remainder of the watershed, most of which drains directly into Dworshak Reservoir and is identified as HUC 17060308.) The Upper North Fork Clearwater River (UNFCR) is a 75-mile long, eighth order water body

(based on 1:24,000 scale hydrography), draining 1,294 square miles (828,000 acres). The vast majority of the UNFCRS is managed by the CNF, with much smaller areas managed by IDL, Potlatch Corporation, and small private owners. Figure 1 shows the UNFCRS, its ownership, the river, and major tributary streams.

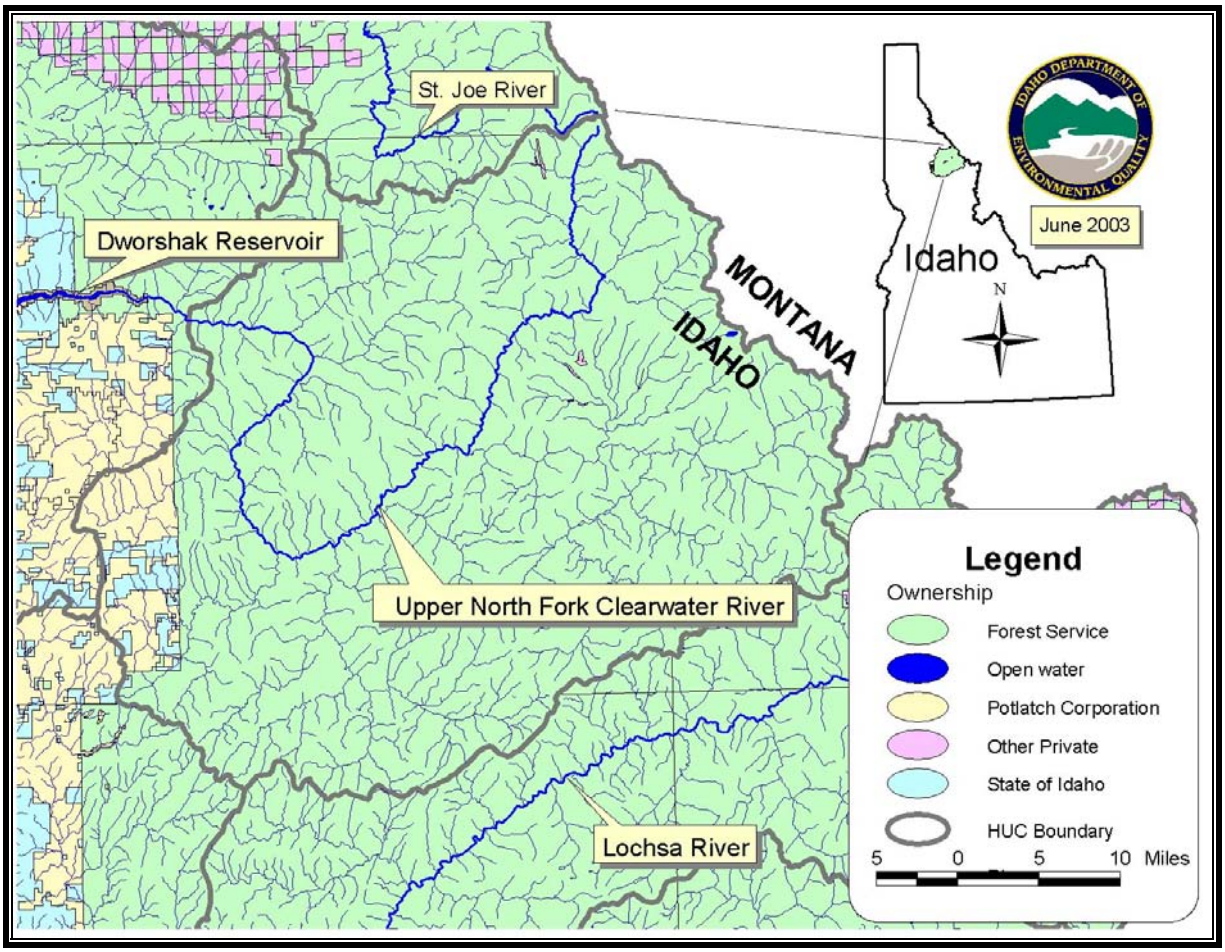


Figure 1. Location in Idaho and Ownership of the UNFCRS

Climate

North Idaho's climate is dominated by Pacific Ocean maritime air masses and prevailing westerly winds. Precipitation in the UNFCRS ranges from about 30 inches to over 70 inches per year (Figure 2), with over 90 percent of the annual precipitation occurring during the fall, winter, and spring months. Cyclonic storms consisting of a series of frontal systems moving west to east produce long duration, low intensity precipitation from fall through spring. A seasonal snowpack generally covers the area from November to May. High intensity electric storms occur during the summer months, frequently causing wildfires.

At lower elevations, along the mainstem UNFCR, the subbasin climate has mild wet winters and hot dry summers. At elevations above about 4,000 feet, most of the winter precipitation falls as snow. The winter snowpack water content usually peaks in early April and snowmelt

contributes much of the summer stream flow. Generally, there is very little precipitation from July through September. Summer high temperatures regularly exceed 90 °F in the river valleys, such that mid-July through August is generally the critical period for stream high temperatures.

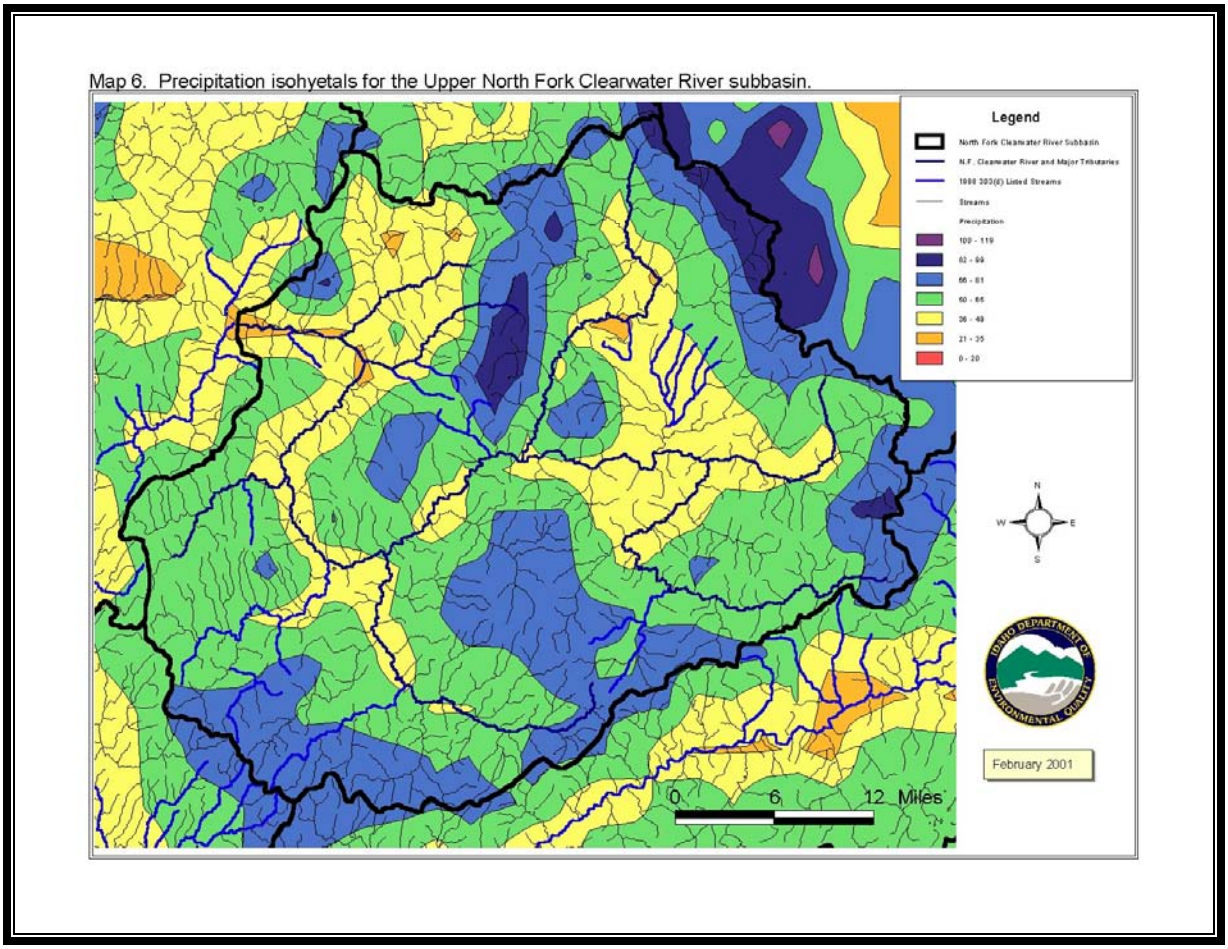


Figure 2. Precipitation Zones of the UNFCRS

Data from three weather stations (located at Powell, Fenn, and Pierce) and six snow telemetry (SNOTEL) stations (SNOTEL Website) are presented in Table 1. Powell, located on the Lochsa River at an elevation of 3,409 feet, is considered representative of mid-elevation canyon sites at the upper end of the UNFCRS with a strong continental influence. Fenn, on the Selway River at 1,480 feet elevation, is considered representative of the lower canyon lands (e.g., around Canyon Ranger Station) with a strong maritime influence. Pierce, located at 3,079 feet elevation, represents mid-elevation upland sites on the western, more maritime influenced side of the subbasin. The SNOTEL data from Shanghai Summit, Hemlock Butte, and Elk Butte reflect high elevation conditions on the western edge of the basin, while those from Cool Creek, Crater Meadows, and Lolo Pass reflect high elevation conditions on the eastern end of the basin.

Table 1. Weather data from selected stations in and around the UNFCRS.

Type[1]	Station Name	Elevation (feet)	Latitude	Longitude	Record Dates	Mean Annual Temperature (°F)	Average Monthly Temperature (°F)	Mean Annual Precipitation (inches)	Average Number of Days Above 90 °F per Year[2]
NWS	Fenn	1480	46.00	115.55	1948 to pres.	49.2	48.9	38.03	32.0*
NWS	Pierce	3079	46.50	115.80	1963 to pres.	42.2	42.2	41.38	15.1***
NWS	Powell	3409	46.52	114.70	1962 to pres.	42.7	42.6	39.59	10.6**
SNOTEL	Shangai Summit	4600	46.32	115.45	1993 to 1999	39.5	40.6	56.08	6.25
SNOTEL	Lolo Pass	5240	46.38	114.35	1993 to pres.	34.7	35.9	48.88	1.67
SNOTEL	Elk Butte	5420	46.50	116.07	1993 to pres.	36.8	38.1	60.89	0
SNOTEL	Hemlock Butte	5810	46.29	115.38	1993 to pres.	37.0	38.3	70.21	0
SNOTEL	Crater Meadows	5960	46.34	115.17	1993 to 1999	34.9	35.7	67.84*	0
SNOTEL	Cool Creek	6280	46.46	115.18	1993 to pres.	35.7	36.7	72.96*	0

[1]NWS = National Weather Service station (National Climatic Data Center Website) SNOTEL = Snow Telemetry station (SNOTEL Website)
[2] Years of Record: * 1983 – 1999 ** 1993 – 1997 *** 1990 - 2000

Appendix 2, Figures 2-1 through 2-8 show the average monthly means, maximums, and minimums for temperature and precipitation for Powell, Fenn, Pierce, and Hemlock Butte. Looking at the temperature and precipitation patterns, one can immediately see that the months with the highest temperatures are also those with the lowest precipitation, and vice versa. (Note that the y-axis scales are not the same on all the figures.)

For the period of record, Powell's and Pierce's mean annual temperatures were very similar (42.7 °F and 42.2 °F, respectively). However, the mean annual temperature at Fenn, located at a much lower elevation, was 49.2 °F. The subbasin temperatures ranged from mean January minimums of approximately 23.3 °F, 15.6 °F, 15.9 °F, and 7.1 °F to mean July/August maximums of approximately 88.5 °F, 82.4 °F, 80.9 °F, and 72.1 °F at the Fenn, Powell, Pierce, and Hemlock Butte stations, respectively.

Hot summer temperatures occur regularly in the subbasin and are a major factor influencing stream temperatures. Table 1 summarizes the number of days with temperatures above 90 °F at each of the weather stations. At Pierce and Powell, temperatures of greater than 90 °F occur on about 15 to 25 percent of the July and August days. On average, the Fenn station exceeds 90 °F on about 50 percent of the July and August days. As a point of reference, since water temperatures over time equilibrate to air temperatures, note that at Fenn the average monthly air temperature exceeds Idaho's 13 °C (55.4 °F) salmonid spawning instantaneous water temperature criterion from May through September. Thus it might be expected that water temperatures naturally exceed the state's numeric criteria.

Precipitation at Fenn has averaged 38 inches annually, with 53 inches of snowfall. Annual precipitation at Powell averages about an inch more, but with cooler temperatures, snowfall more than triples to 178 inches. About 45 percent of the annual precipitation falls as snow at Powell. At the Fenn station, only 14 percent of the annual total comes as snow; even in the winter most of the precipitation is rain. Figures 2-2, 2-4, 2-6, and 2-8 in Appendix 2 show that the maximum precipitation at all sites occurs during the winter.

Precipitation increases markedly with elevation in the mountains. Higher peaks, especially in the northeast corner of the subbasin, may receive as much as 100 inches per year, making them among the wettest of any areas in Idaho (NRCS website). The winter snowpack is vital to sustaining summer flows in the subbasin.

Occasionally, 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 and huge amounts of runoff 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 events in the subbasin, since above 4,000 feet it is cold enough that most of the precipitation still falls as snow. Two major rain-on-snow events have occurred in recent history – one in the winter of 1975-76 and the other in winter of 1995-96. Both events caused flooding and landslides in UNFCRS below about 4,000 feet (McClelland et al. 1997). These events are likely the most significant contributors of sediment to the water bodies in the UNFCRS. While these are natural climatic events, the question that needs to be answered is to what degree human activity, especially road building, exacerbates the effects of these events on the landscape.

Subbasin Characteristics

This section summarizes the area's hydrology, geomorphology, geology, soils, climate, and landscape hazards with emphasis on how these characteristics relate to sediment and temperature, the pollutants of concern in the subbasin.

Hydrology

The UNFCRS, the main river, major tributaries, 303(d) listed stream segments, and surrounding hydrologic features are shown in Figure 3.

The UNFCR flows almost 74 miles from its headwaters to where it empties into Dworshak Reservoir. The USGS calculates the mean annual flow for the UNFCR from 1967 to present at its Canyon Ranger Station just upstream from the reservoir to be 3,511 cubic feet per second (Brennan et al. 1999). Figures 2-9 and2-10 in Appendix 2 show flow for 1998-99, mean daily flow for the period of record, and the daily flow for the period of record. Flow has ranged from a daily mean of 34,200 cubic feet per second on November 30, 1995, to 252 cubic feet per second on December 5, 1972. Peak flows generally occurred during spring run-off between April 18 and June 17 for the period of record, with May 23 as the median date for peak flow. The extreme peak flows shown in Appendix 2, Figure 2-10, represent

rain-on-snow events. Low flows occur from August through mid- to late-winter. Low flows in late July and August, when air temperatures are high, can lead to high water temperatures.

Figures 2-11 through 2-15 in Appendix 2 show flow data collected by the CNF for five watersheds in the UNFCRS – the North Fork at Kelly Creek, Cold Springs Creek, Swamp Creek, Quartz Creek, and Gravey Creek. Since each site only has a few years of record, we have selected specific years to plot that show normal and extreme flows. Years 1983 and 1984 have records at the most sites. The same general trend can be seen in this data as in the USGS data. High runoff occurs from late April through early June, with some mid-winter peaks representing rain-on-snow events. Low flow begins in late July and August and continues on into late winter.

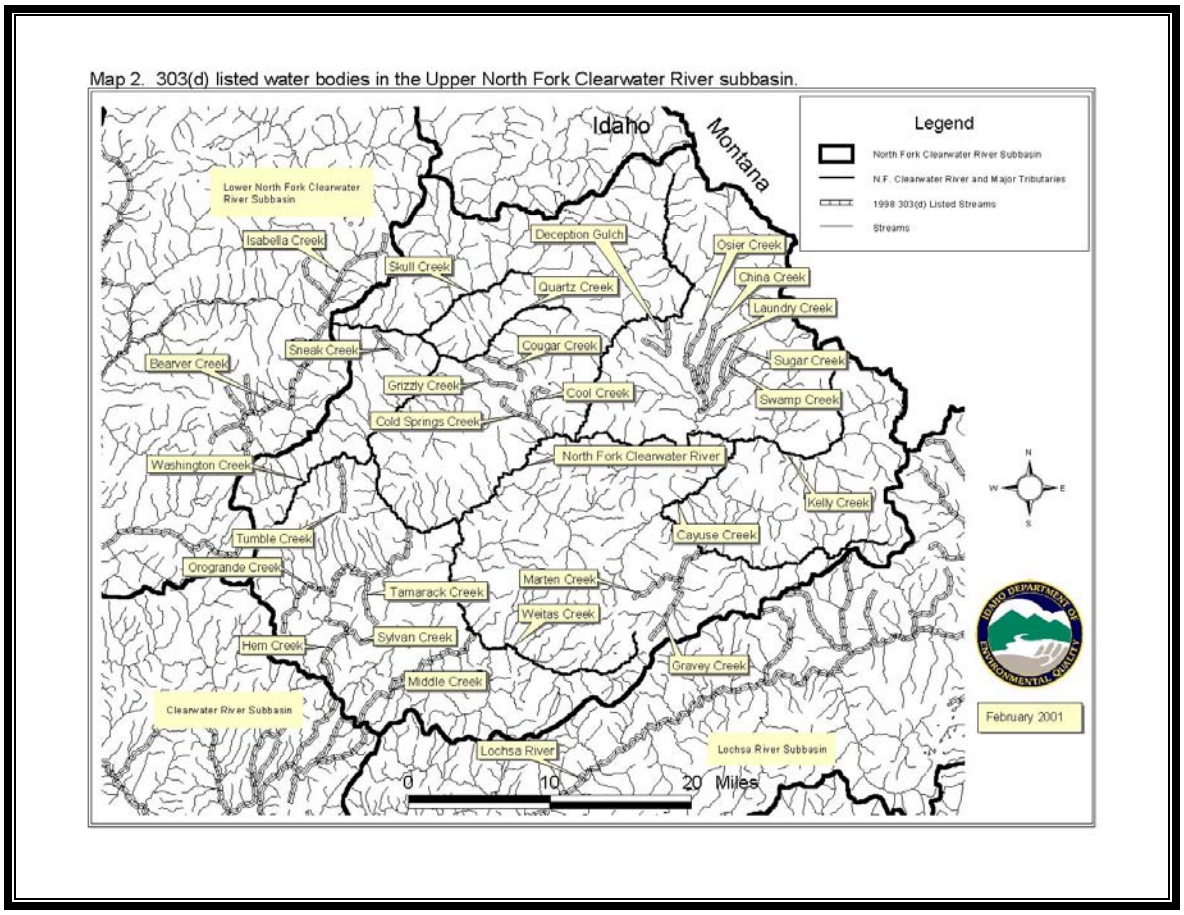


Figure 3. Major Hydrologic Features and 303(d) Listed Stream Segments of the UNFCRS Area

Geomorphology

The UNFCRS is a mature, deeply dissected upland forming part of the Clearwater Mountains of the Bitterroot Range in the northern Rocky Mountains. Elevations range from about 1,660 feet at the USGS gauging station near the Canyon Work Station to nearly 8,000 feet on Rhodes Peak on the Bitterroot Divide. The southern, eastern, and northern boundaries of the watershed, as well as the divide between Kelly Creek and the North Fork above Black Canyon, generally have elevations of 5,000 feet or more.

The CNF utilizes a land classification system that categorizes the landscape into landform units. Table 2 lists the various landform types and their percentages within the subbasin (USFS 1999b), and Figure 4 shows their distribution.

Table 2. Landform types within the UNFCRS.

Landform Type	Percentage
Valley bottoms and recent alluvium	0.2
Breaklands (>60% slopes)	28.3
Alpine glaciated ridges, headlands, and troughs	8.4
Colluvial midslopes (generally 30 - 60% slopes)	15.2
Frost-churned ridges (moderate slopes)	26.7
Low relief hills (<30% slopes)	19.9
Mass wasted areas	1.3

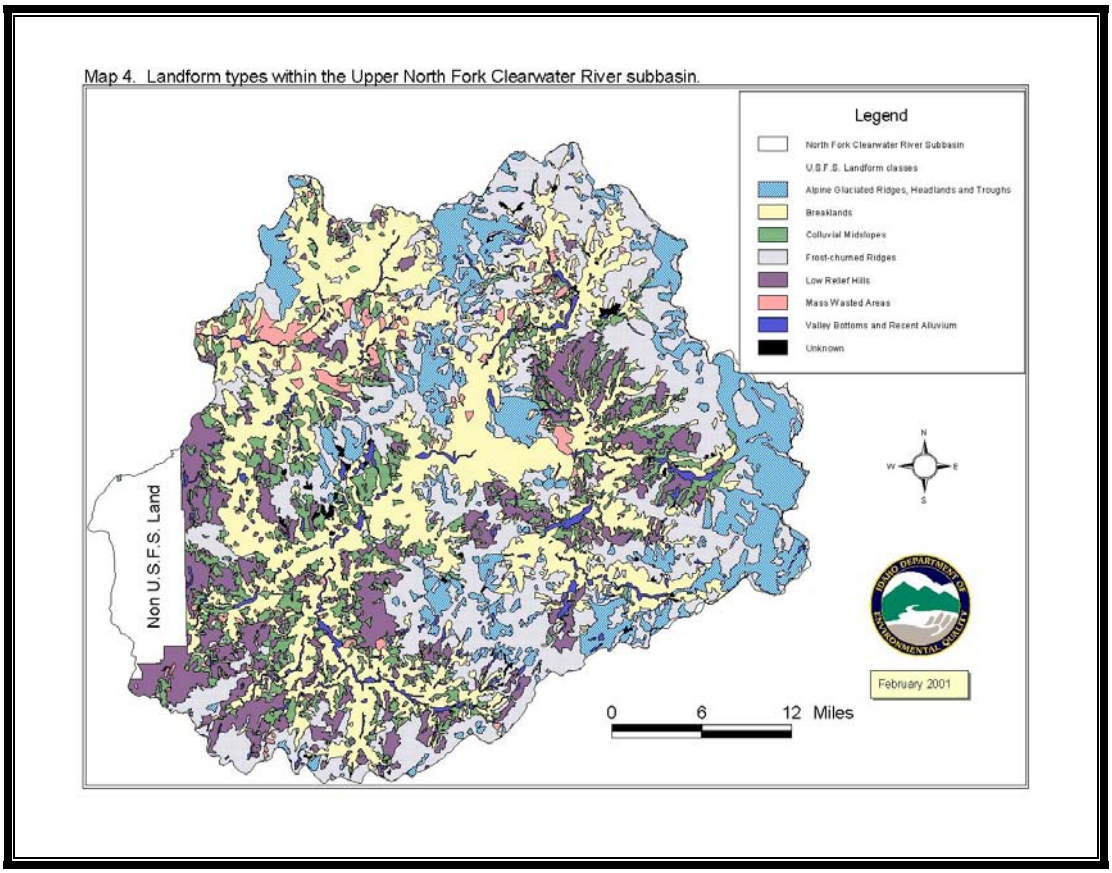


Figure 4. Landform Types of the UNFCRS

Alpine glaciation created some broad U-shaped valleys and extensive alpine meadows in the upper reaches of many drainages. Middle elevations in the Clearwater Mountains are characterized by more gentle terrain with broadly rounded ridges as result of frost churning. Lower elevations display deeply dissected breaklands with oversteepened slopes that are susceptible to erosion and mass failure. The abundance of breaklands (28% of the landscape) suggests the UNFCR is rapidly (in geologic time) entrenching its bed (Alt and Hyndman 1989). The angulate stream pattern suggests joint and/or fault control. Exploitation of more erosive rock along the contact zone between different bedrock types (see geology discussion below) may be one reason for the UNFCR's rapid incision and landscape oversteepening. A little over one percent of the total area is mass wasted, which is a concern for water quality.

In addition to the general landform types, the CNF has developed a detailed classification of the various landforms based on their bedrock and soils and the vegetation they support (Wilson et al. 1983), resulting in several hundred "landtypes" being identified in the CNF. Many of the CNF's management decisions and hazard ratings are based on the landtypes. Much of the CNF data presented below in this report is related to landtypes.

Geology

The general surface geology is represented in Figure 5 (derived from Lewis et al. 1992). The mapped geology for the subbasin does not correlate well with the geology described for many of the landtypes. Much of this is because the landtypes were mapped before the geology was well understood and mapped in the UNFCRS. Reed Lewis (personal communication 2000) confirms that he recognized this situation while mapping the subbasin in the late 1980s and paid particular attention to confirming his bedrock mapping in areas that disagree with the landtype mapping. In the summary assessments for each water body in Chapter 5 of this report, the reader may note discrepancies between the geology described for the landtypes and that described as the mapped geology. Our field work confirms that the mapped geology is likely correct.

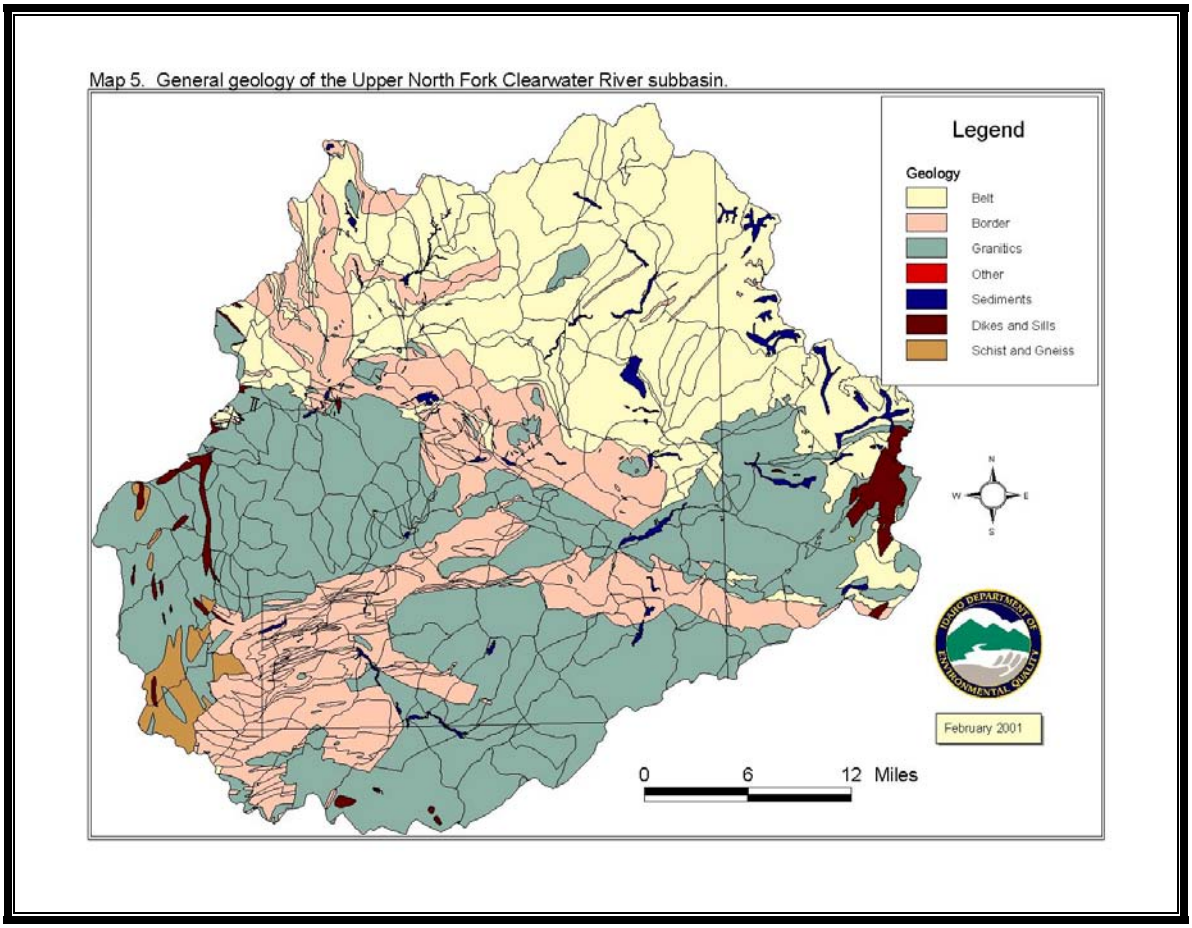


Figure 5. General Geology of the UNFCRS

The subbasin is located on the northern edge of the Idaho Batholith. Upper Jurassic to Cretaceous age plutonic rocks intrude and are bordered by Precambrian-aged metasedimentary rocks. The intrusive igneous rocks of granitic to granodioritic composition are the dominant lithology in the southern half of the subbasin. They are generally considered to be associated with the Idaho Batholith, which underlies most of central Idaho (Alt and Hyndman 1989), although they are highly altered and variable on this extreme edge

of the batholith. The north-northeast portion of the subbasin is dominated by Precambrian-aged Belt Supergroup interlaminated metasediments ranging from argillite to quartzite.

Running in a southeast to northwest direction is a contact zone between plutonic and metasedimentary rocks that has resulted in high grade metamorphic schist and gneiss. Another zone of highly metamorphosed schist and gneiss occurs in the southwest of the subbasin. These contact zones have been called "border zones" or the "western Idaho suture zones." The border zone schist and gneiss areas of the subbasin are highly variable in rock structure and composition. The mixed and highly variable nature of the contact zone between the metasedimentary and granitic lithologies exhibits considerable structural and weathering variability and results in an associated high mass failure hazard.

Of particular interest is a body of Tertiary-aged deposits in the Moose Creek and adjacent watersheds. These deposits have been the object of extensive placer mining in the past and are susceptible to erosion. Their presence leads to speculation that these particular surfaces have been exposed to weathering for a long period of time such that bedrock in the vicinity is deeply weathered, incompetent, and relatively erodible.

Soils

The granodiorite that underlies the southern portion of the subbasin weathers rapidly to grus, a sandy material with the structure of the original rock. The soils derived from the grus tend to be sandy, excessively well drained, and cohesionless. The metasediments that occur in the northern part of the subbasin generally weather to finer textured soils with varying amounts of coarse fragments. Quartzite tends to weather to the coarsest texture, with large amounts of coarse fragments. Siltite and argillite weather to finer textured soils with fewer coarse fragments. Soil depth tends to decrease and the amount of coarse fragments tends to increase on steeper and more convex slopes. Soils derived from bedrock in the suture zone are highly variable, reflecting the complexity of the bedrock. Soils derived from the Tertiary sediments tend to be fine-textured and fairly dense. When exposed during road building or other earth disturbing practices, these soils are highly erodible and difficult to stabilize.

Most soils include a layer of Mazama volcanic ash up to 20 inches thick on the surface. This layer of volcanic ash contributes substantially to the water and nutrient holding capacity of the soils and is the primary reason for the high productivity and stability of the soils in the UNFCRS. The volcanic ash has been eroded away in places, primarily on very steep south to west facing slopes and in areas seriously denuded by fire.

Terrestrial Vegetation

The subbasin is dominated by coniferous forest vegetation. Western red cedar (*Thuja plicata*), Douglas fir (*Pseudotsuga menziesii*), and grand fir (*Abies grandis*) are common tree species. Other tree species of commercial value are western white pine (*Pinus monticola*), ponderosa pine (*Pinus ponderosa*), lodgepole pine (*Pinus contorta*), western hemlock (*Tsuga hetophylla*), western larch (*Larix occidentales*), and Englemann spruce (*Picea Englemanii*). Higher elevation subalpine zones are dominated by Englemann 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 reforested some areas subjected to severe forest fires. The subbasin contains some of the most productive tree growing sites in north Idaho.

The forests in the UNFCRS are thought to contain some 1,200 to 1,500 plant species, only a few of which are trees. The forest understory in the UNFCRS ranges from nearly pure grasslands to nearly pure shrublands, with all gradations in between. More interestingly, the understory vegetation communities range from very drought tolerant (primarily grasslands), to communities associated with mild, moist Pacific maritime climates. These more maritime communities are dominated by evergreen species when protected by cedar and hemlock tree canopies. Many logging and other events that remove the tree canopy often result in dense stands of shrubby species with diverse composition crowding these productive sites.

Vegetation of the subbasin has been significantly altered since 1900. White pine blister rust 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 less than two percent today. The large fires of 1910, 1919, and 1934 significantly reduced the tree canopy in the subbasin. These, coupled with the fire suppression and logging practices, have changed the forest composition from being dominated by long-lived, shade-intolerant species to forests dominated by short-lived, shade-tolerant species.

Forest fires have 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). The CNF estimates that 63 percent of the entire subbasin has been burned since the 1910 fire (USFS 1999b).

Similarly, logging and road building over the last half century have significantly altered the forests. In a 1999 report of 14 selected watersheds in the UNFCRS, the CNF identified equivalent clearcut acres ranging from two to 15 percent, meaning that that the percentage of the canopy in those watersheds had been reduced by that amount (USFS 1999a). It is probable that the equivalent clearcut acres for many of the watersheds being considered in this assessment is greater than 15 percent. In addition, logging has changed the species composition of the forest, as noted above.

Aquatic Life

The following game fish may be found in the subbasin:

Common Name	**Taxonomic Nomenclature**
Brook trout	(*Salvelinus fontinalis*)
Bull trout	(*Salvelinus confluentus*)
Golden trout	(*Oncorhynchus aguabonita*)
Mountain whitefish	(*Prosopium williamsoni*)

Rainbow trout	(*Oncorhynchus mykiss*)
Steelhead	(*Oncorhynchus mykiss*)
Kokanee salmon	(*Oncorhynchus nerka*)
Westslope cutthroat trout	(*Oncorhynchus clarki lewisi*)

The following non-game fish species may be found in the subbasin:

Common Name	**Taxonomic Nomenclature**
Mottled sculpin	(*Cottus bairdi*)
Paiute sculpin	(*Cottus beldingi*)
Shorthead sculpin	(*Cottus confusus*)
Torrent sculpin	(*Cottus rhotheus*)
Redside shiner	(*Richardsonius balteatus*)
Longnose dace	(*Rhinichthys cataractae*)
Speckled dace	(*Rhinichthys osculus*)
Largescale sucker	(*Catostomus macrocheilus*)
Bridgelip sucker	(*Catostomus columbianus*)
Mountain whitefish	(*Prosopium williamsoni*)
Chiselmouth	(*Acrocheilus alutaceus*)

The UNFCR drainage currently has two fish populations that are species of concern – bull trout and westslope cutthroat trout. Bull trout were listed as a threatened species within the Columbia River Basin under the Endangered Species Act by the U.S. Fish and Wildlife Service (USFWS) on July 10, 1998.

Bull trout populations are currently considered depressed in most of the tributaries within the UNFCR drainage. Focal populations occur in the Upper North Fork Clearwater River, North Fork Kelly Creek, Meadow Creek, Vanderbilt Creek, Lake Creek, Long Creek, Hidden Creek, Elizabeth Creek, Skull Creek, upper Quartz Creek, Johnny Creek, upper Weitas Creek, Fourth of July Creek, Cayuse Creek, and upper Kelly Creek above Cayuse Creek (USFS 1999b).

Westslope cutthroat trout were recently proposed to be listed under the Endangered Species Act; however, the USFWS decided not to list the species at this time. Fish data show cutthroat trout populations are present in most drainages of the UNFCRS. The UNFCRS is considered to support one of the last strong westslope cutthroat trout populations in Idaho. The CNF determined that 23 out of 54 subwatersheds showed strong populations, 11 showed depressed populations, 14 had populations of unknown strength, and data were unavailable for 6. Overall, the CNF concluded that populations are well-distributed and in strong condition in 36 of the 54 subwatersheds (USFS 1999b).

Several varieties of herptofauna are known or suspected to inhabit the subbasin, including the long-toed salamander, Coeur d'Alene salamander, Idaho giant salamander, tiger salamander, garter snake, western toad, Pacific chorus frog, bull frog, and tailed frog (Clearwater Basin Bull Trout Technical Advisory Team 1998).

The macroinvertebrate assemblage includes Ephemeroptera, Plectoptera, Trichoptera, Coleoptera, and Diptera. The 1996 BURP data suggest that most of the macroinvertebrates sampled basin-wide are Ephemeroptera, Plectoptera, and Trichoptera (DEQ 1996). These genera are generally indicators of good water quality.

Landscape Hazards to Water Quality

Mass Failures: Landslides, debris avalanches, and other forms of mass wasting are the dominant erosional processes in the subbasin (USFS 1999b). Landslides are natural events across much of this landscape, but the risk has increased due to road construction and timber harvest over the past 40 years. Some 370 landslides were reported in the watershed resulting from the storm events in the winter of 1995-1996, with the majority initiated from forest roads. Using the CNF's landtype hazards ratings, approximately 30 percent of the total subbasin acreage has a high or very high mass failure hazard rating (Figure 6), and about 13 percent of the area has a high debris avalanche hazard rating.

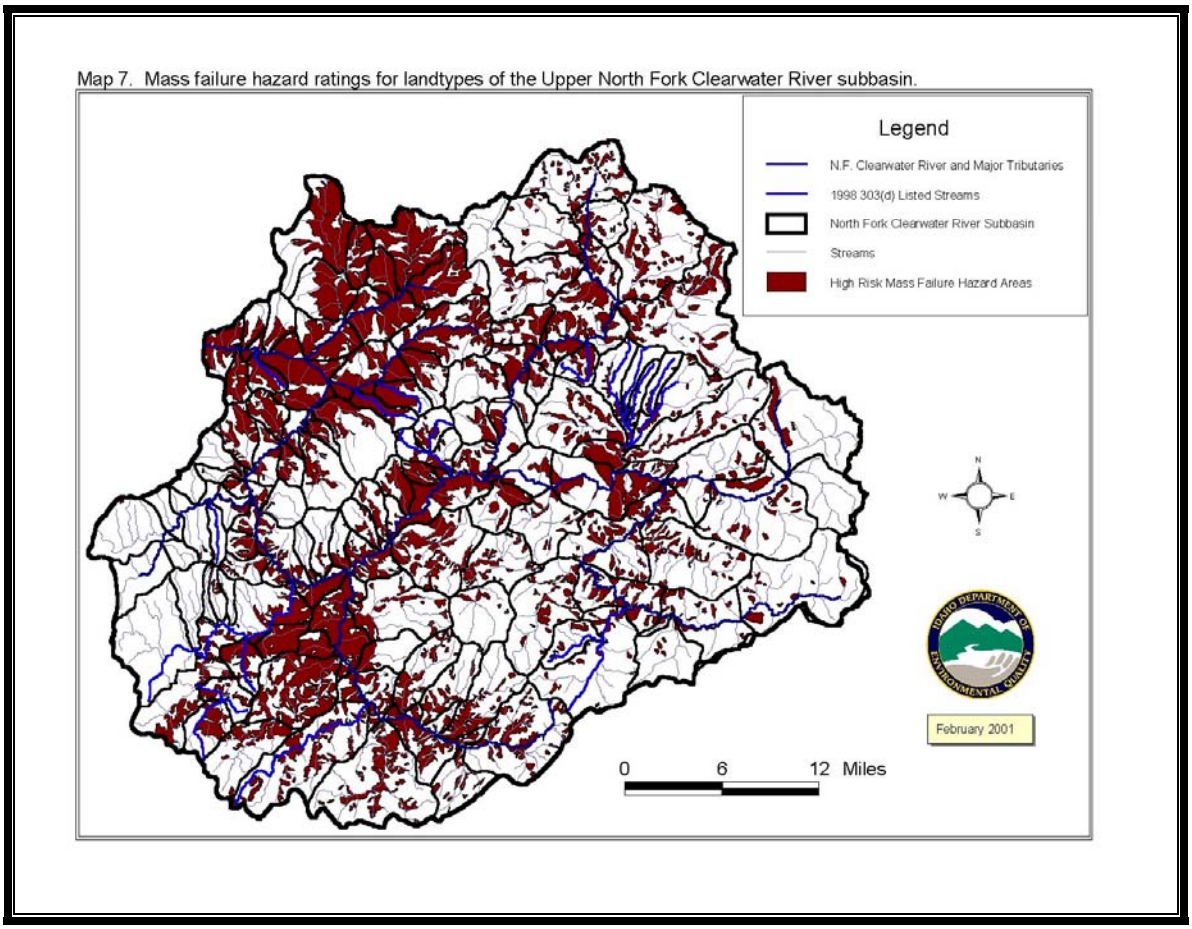


Figure 6. High Mass Failure Hazard Areas of the UNFCRS

Surface Erosion: About 20 percent of the UNFCRS watershed has a high surface erosion hazard rating. High surface erosion landtypes tend to be on south- to west-facing steep slopes that have for one reason or another lost their surface layer of volcanic ash. Surface

erosion has, in fact, occurred on many steep landforms in the UNFCRS since historic times, particularly after wildfires (USFS 1999b).

Subsurface Erosion Hazard: Idaho's CWE process identifies erosion from roads as one of the major sources of sediment being delivered to water bodies (IDL 2000). In most cases, significant road erosion occurs where road prism construction removes the topsoil and sediment-retaining roots, exposing subsoils with little structure or internal coherence. Approximately six percent of the subbasin is classified as having a high subsurface erosion hazard.

In-Stream Erosion Hazard: Current stream conditions are largely a function of channel gradient and stream energy (i.e., the stream's ability to move sediment). When bed material is cobble-size and smaller, stability decreases, and the channels react quickly to changes in sediment and flow regime. Lower gradient channels have a higher sensitivity to sediment input, with less transport capacity. Disturbances in a low-gradient stream channel with a fine sediment or an erodible geologic material bed and bank system can easily lead to in-stream erosion. Very few sensitive stream systems occur in the UNFCRS. Known streams with relatively high sensitivity occur in the Orogrande Creek and Moose Creek watersheds – areas of old surfaces exposed to weathering.

Nearly 80 percent of the streams in the subbasin are first- and second-order, steep, Rosgen (1994) A-type channels, which are predominantly stable when the streambed material is bedrock or boulder. Some of the watersheds in the UNFCRS have high road densities and have been intensively managed, yet are resilient and capable of handling large amounts of sediment without adverse impacts to their hydrologic integrity (USFS 1999b).

Channel form and function, although variable across the subbasin, are for the most part stable and within dynamic equilibrium. Notable exceptions are heavily roaded and harvested watersheds that suffered numerous landslides and road failures during the 1975-76 and 1995-96 rain-on-snow events. In particular, the colluvial midslopes contain over 50% of the sensitive channel types in the UNFCRS, yet comprise only 15 percent of the area (USFS 1999b).

The majority of the 303(d) listed stream segments being addressed in this subbasin assessment have lower gradient, Rosgen (1994) B type channels, which have an intermediate in-stream erosion hazard. The fact that the 303(d) listed streams have lower gradients than average in the UNFCRS probably reflects the fact that historic logging activities have centered on the more gentle terrain. Additional information about stream characteristics of the 303(d) listed streams in the subbasin can be found in Chapter 2.

Fire Hazard: The hazards to water quality of a burned landscape are two-fold: the denuded landscape is more susceptible to erosion and the denuded stream banks increase heat loading/stream temperatures. Areas with higher hazards for fire tend to be south- to west-facing slopes. The fact that many of these slopes no longer have a surface layer of volcanic ash probably reflects the fact that these slopes have burned several times in the last 8,000 years. Slopes lower in the canyons with lower effective precipitation are most susceptible to

fire. These slopes are more susceptible to drought, and thus to fire; therefore, increasing their erosion potential which starts a negative cycle of fire and erosion. The CNF data indicate that about 15 percent of the subbasin has strong south- to west-facing slopes with high fire frequencies of 26 to 100 years (USFS 1999b).

Removal by fire of the coniferous canopy that shades streams often leads to significant, long-term effects on stream temperatures. Large, catastrophic fires are the most likely to destroy streamside vegetation. Once the tall tree canopy is removed, it may require centuries for trees to reestablish in swampy and cold-air-drainage areas. Smaller, shrubby species do not provide the same quality of shade and environmental buffering. Further, the destruction of large trees removes potential large woody debris and its consequent stream structure. Other areas with higher than expected fire hazards are those adjacent to and associated with human activities. For the most part, these correlate fairly well to roaded areas of the subbasin.

1.3 Cultural Characteristics

This section describes present land ownership and principal land uses in the UNFCRS.

Land Ownership

The UNFCRS is predominantly owned by the federal government and managed by the CNF. The state of Idaho, Potlatch Corporation, and private individuals also own small portions of the UNFCRS (Figure 1).

Total Subbasin Acreage	**828,460 Acres**
U.S. federal lands managed by CNF	787,133
Potlatch Corporation	29,792
State of Idaho	10,208
Other private holdings	680
Open water	647

Land Use

The UNFCRS is largely a forested landscape dominated by forestry and associated recreational activities.

Native American Traditional Uses

The Nez Perce people have been residents in the study area for over 8,000 years. The UNFCRS is within the Nez Perce Tribe's ceded territories. The Treaty of 1855 reserved fishing and hunting rights in these areas, and it established a responsibility for the management of fish and wildlife resources. The Nez Perce Tribe's treaty-reserved interest in maintaining and utilizing natural resources is important to its sense of community. The fishery and the waters supporting it are revered by the Nez Perce for the life and sustenance these resources have given and continue to provide to tribal members.

Forestry

Logging began in the UNFCRS in 1935 with western white pine salvage logging and logging of western red cedar for power poles. Initially, log flumes were built down major drainages to the North Fork 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 with a maximum of 800-foot road spacing, skylines with longer cable reaches, and, most recently, helicopters. Logging activity and the associated road construction was at its greatest in the 1960s and 1970s, and has tapered off considerably since (Table 3). According to CNF stand data, about 10 percent of the subbasin has been logged. Figure 7 shows the harvested areas of the UNFCRS.

Table 3. Timber harvested by decade in millions of board feet from CNF land.

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

Logging still plays an important role in the economies of the communities surrounding the subbasin (USFS 1999a), including Orofino, Pierce, Weippe, Kamiah, Headquarters, Cardiff, and Lewiston, Idaho; and Superior, Montana.

Mining

Mining in the subbasin began in the last half of the 19th century and has continued to the present, with the amount of activity varying greatly over time. The majority of the mining has been placer mining occurring in the streams and stream valleys. Some upland mining for precious metals occurred in the late 1800s in Cayuse and Kelly Creeks. Aggregate mining, primarily for road construction, continues to the present, and is usually located on uplands away from the streams and riparian areas.

Habitat conditions within most of the Orogrande Creek, Moose Creek, and upper North Fork drainages have most likely improved substantially since the gold mining era of the 1860s through the early 1900s. The majority of these streams and most, if not all, of their tributaries were placer-mined by hand, dredge, and large machinery. Riparian areas and stream channels were probably altered numerous times (USFS 1999b).

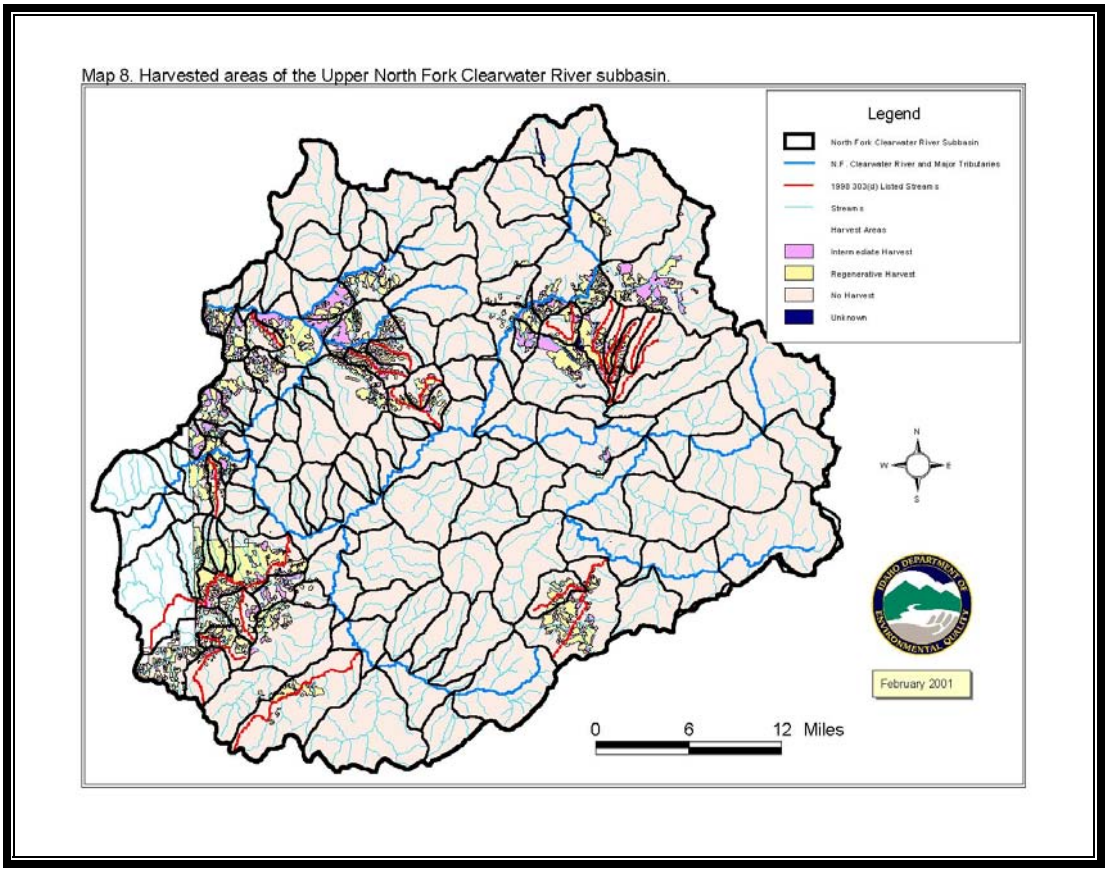


Figure 7. Timber Harvested Areas in Relation to the 303(d) Listed Streams

Currently, there are approximately 16 registered recreational suction dredges in the basin that operate during the summer, primarily in the Moose and Orogrande watersheds. There are six patented mining claims in the Moose and Bostonian Creek watersheds. There are 15 additional unpatented placer mining claims within the basin. The total recorded production in the North Fork of the Clearwater in 1990 was estimated to be 197 ounces of gold and 44 ounces of silver (U.S. Bureau of Mines et al. 1993).

Grazing

Grazing allotments were established in Cayuse and Kelly Creeks in the early 1900s following a series of wildfires that reduced the tree canopy cover and allowed considerable undergrowth. Large numbers of sheep were grazed until natural succession reduced the understory, making grazing infeasible. Currently, grazing on the CNF land is limited to pack animals and saddle stock. On state and private land in Orogrande Creek, limited grazing is permitted after timber harvest.

Recreation

Recreational activities include fishing, kayaking, canoeing, rafting, swimming, hunting, camping, mountain biking, wildlife and scenery viewing, skiing, trapping, 4-wheeling,

motorcycling, hiking, and driving the historic trail systems. Some of these activities also provide economic benefits. The CNF maintains several campgrounds along the main stem rivers in the area.

The Lolo trail system attracts visitors who are interested in its prehistoric and historic trails. The trail known to the Nez Perce as *Kushahna Ishkit*, the buffalo trail, is potentially thousands of years old. The Lolo Motorway generally follows the Nez Perce *Nee-Me-Poo* trail, which 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.

Transportation

The CNF GIS roads layer identifies 1,951 miles of roads in the 1,294 square mile subbasin, yielding an average road density of 1.6 road miles per square mile. Major drainages affected by road construction include Washington, Orogrande, Quartz, Cold Springs, and Moose Creeks (Figure 8) (USFS 1999b). Of particular interest to water quality issues are those roads that are close to streams. There are 352 miles of roads (18% of total roads) in the UNFCRS within 100 feet of a mapped waterway.

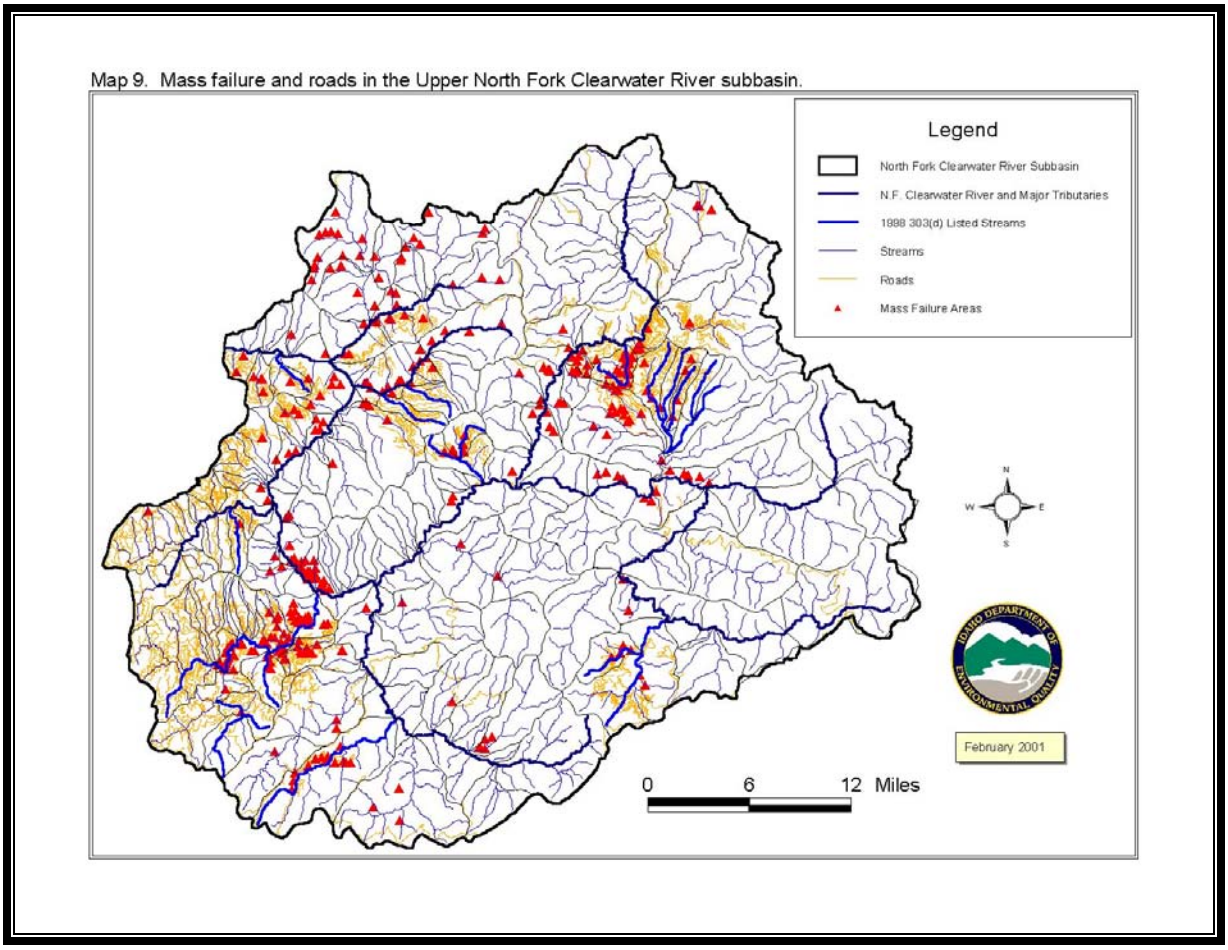


Figure 8. Roaded Areas of the UNFCRS

2. Subbasin Assessment – Water Quality Concerns and Status

This section discusses the reasons that stream segments were placed on the 303(d) list, describes the applicable water quality standards, and presents available water quality data that relate to the water quality status.

2.1 Water Quality Limited Segments Occurring in the Subbasin

Within the UNFCRS, 18 tributary stream segments were placed on the state of Idaho's 1996 303(d) list because of concerns that sediment may be impacting the streams' beneficial uses (Table 4). One of these streams, Osier Creek, was also listed for temperature concerns. One other stream, Sneak Creek, was listed for concerns about channel stability affecting beneficial uses. Figure 9 shows the distribution of the listed water bodies within the UNFCRS. Appendix 1 shows the correlation between the water bodies assessed and the newer "assessment units" that the state of Idaho and USEPA are currently using to track water quality limited waters. The 1996 303(d) list was a carryover of a 1994 list prepared in large part by the USEPA under court order. All of the water bodies were retained on Idaho's 1998 303(d) list (DEQ 1999) for lack of any data or assessment to the contrary.

Flow and habitat alteration are also identified on the 303(d) list as potentially impairing beneficial uses of Osier Creek. The USEPA does not believe that flow alteration (or lack of flow) or habitat alteration are pollutants as defined by CWA Section 502(6). Since TMDLs are required to be established only for water bodies impaired by identifiable pollutants, further assessment of Osier Creek for habitat or flow alteration was not conducted.

Beneficial uses for all of the 303(d) listed water bodies are cold water aquatic life and salmonid spawning. The salmonid species of particular interest are bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhynchus clarki*). The *North Fork Clearwater River Basin Bull Trout Problem Assessment* (Clearwater Basin Bull Trout Technical Advisory Committee 1998) identifies watersheds containing the following 303(d) listed streams in the UNFCRS as moderate or high priority for bull trout recovery: Middle, Gravey, Cougar, Grizzly, and Cold Springs Creeks. The USEPA designated Cold Springs, Cool, Cougar, Gravey, Grizzly, Laundry, Marten, Middle, Osier, Sugar, and Swamp Creeks as streams protected for bull trout spawning and rearing (40 CFR Part 131.33(a)(2)). The USEPA rule establishes a maximum weekly maximum temperature (MWMT) criterion of 10 ^{o}C (50 ^{o}F) for the months of June, July, August, and September for the protection of bull trout spawning and juvenile rearing in natal streams (40 CFR Part 131.33(a)(1)). Most of the 303(d) listed streams have populations of westslope cutthroat trout. The spawning season for cutthroat is April through July. This spawning season is the general spawning season for the species – specific spawning seasons may vary by location and elevation and are addressed as needed for each stream 303(d) listed as temperature limited.

This subbasin assessment addresses the question of whether the pollutants identified on the 303(d) list are of a nature and degree that the beneficial uses are not being fully supported in the water body.

Table 4. 303(d) listed water bodies in the UNFCRS.

Stream Name	Boundaries[1]	WQL Seg. No.[2]	Channel Type[3]	Stream Miles	Pollutant[4]
Sneak Creek	HW to NF Clearwater	5178	B	3.5	Channel Stability
Tumble Creek	HW to Washington	5200	B	4.6	Sediment
Orogrande Creek	HW to NF Clearwater	3215	B	19.5	Sediment
Tamarack Creek	HW to Orogrande	5193	B	3.9	Sediment
Sylvan Creek	HW to French	5192	B	4.3	Sediment
Hem Creek	HW to Sylvan	5093	B	5.0	Sediment
Middle Creek	HW to Weitas	5123	B	13.3	Sediment
Marten Creek	HW to Gravey	5119	B	4.5	Sediment
Gravey Creek	HW to Cayuse	3229	A	9.0	Sediment
China Creek	HW to Osier	5040	A	4.9	Sediment
Sugar Creek	HW to Swamp	5189	B	4.0	Sediment
Swamp Creek	HW to Osier	5190	B	5.4	Sediment
Osier Creek	HW to Moose	3225	A & B	8.1	Sediment, Temperature
Laundry Creek	HW to Osier	5104	A	4.4	Sediment
Deception Gulch	HW to NF Clearwater	5059	B	4.7	Sediment
Cold Springs Creek	HW to NF Clearwater	5045	A	4.8	Sediment
Cool Creek	HW to Cold Springs	5047	A	3.3	Sediment
Grizzly Creek	HW to Quartz	5088	A	4.5	Sediment
Cougar Creek	HW to Quartz	5049	A	3.7	Sediment

[1] HW = Headwaters, NF = North Fork
[2]WQL Seq No. = Water Quality Limited Segment Number
[3]A and B are Rosgen channel types (Rosgen 1994)
[4]Sed=Sediment; Temp=Temperature

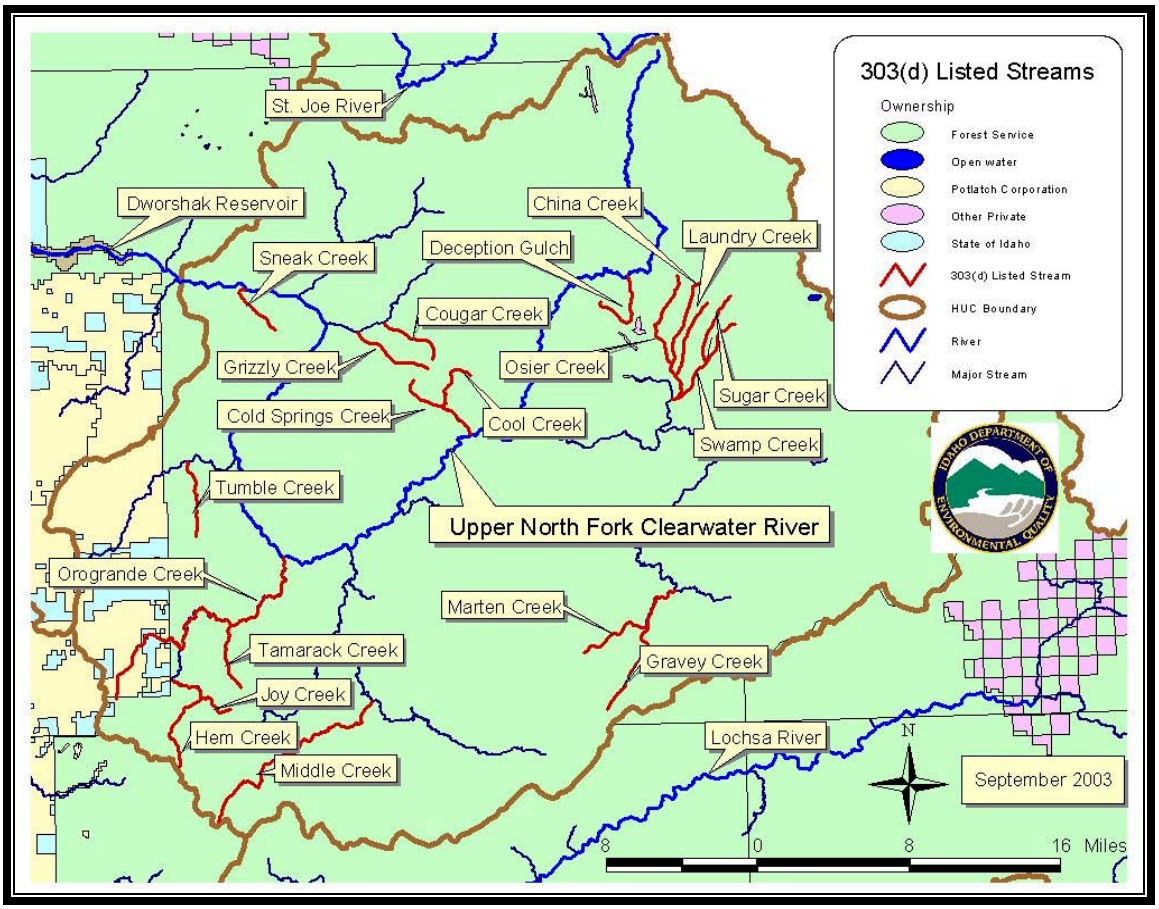


Figure 9. 303(d) Listed Water Bodies of the UNFCRS

2.2 Applicable Water Quality Standards

Application of the Idaho water quality standards depends on understanding the beneficial uses for which any give stream should be protected and the water quality standards in the Idaho code set to protect those beneficial uses. This section discusses the beneficial uses of the 303(d) listed streams in the UNFCRS and identifies the standards that must be met to protect those uses.

Beneficial Uses

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

Specifically, the beneficial use of primary concern in the UNFCRS is the cold water aquatic life use and the subcategory of salmonid spawning, defined as follows (IDAPA 58.01.02.100.02):

> cold water aquatic life: waters which are suitable or intended to be made suitable for protection and maintenance of viable communities of aquatic organisms and populations of significant aquatic species which have optimal growing temperatures below eighteen (18) degrees C.

and

> salmonid spawning: waters which provide or could provide a habitat for active self-propagating populations of salmonid fishes.

All water bodies in the UNFCRS considered in this assessment are assumed to "provide or could provide a habitat for active self-propagating populations of salmonid fishes." The data presented below support this assumption.

Existing Uses

Existing uses under the CWA are "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards." The existing in-stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.003.35, .050.02, and 051.01 and .053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. Practical application of this concept would be when a water body could support salmonid spawning, but salmonid spawning is not yet occurring.

Designated Uses

Designated uses under the CWA are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained." Designated uses are simply uses officially recognized by the state. In Idaho these include things like aquatic life support, recreation in and on the water, domestic water supply, and agricultural use. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.22 and .100, and IDAPA 58.01.02.109-160 in addition to citations for existing uses).

Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary

contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric criteria cold water and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel dissolved oxygen, temperature). However, if for example, cold water aquatic life is not found to be an existing use, an use designation to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria (IDAPA 58.01.02.101.01).

Sediment Water Quality Standards

The Idaho general surface water quality criterion for sediment (IDAPA 58.01.02.200.08) says:

> Sediment shall not exceed quantities specified in Section 250, 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.b. [Subsection 350.02.b. describes non-point source restrictions when water quality criteria are not being met, but does not add any specific sediment criteria.]
>
> Section 250.02.d specifies that "Turbidity … shall not exceed background turbidity by more than fifty (50) NTU instantaneously or more than twenty-five (25) NTU for more than ten (10) consecutive days."

Temperature Water Quality Standards

The Idaho general surface water quality criteria for temperature are shown in Table 5. For cold water aquatic life (IDAPA 158.01.02.250.02.b), "water temperatures shall be twenty-two (22 ^{o}C) degrees Celsius or less with a maximum daily average of no greater than nineteen (19 ^{o}C) degrees Celsius." For salmonid spawning (IDAPA 58.01.02.250.02.e.ii), "water temperatures shall be thirteen (13 ^{o}C) degrees Celsius or less with a maximum daily average no greater than nine (9 ^{o}C) degrees Celsius." For bull trout (IDAPA 58.01.02.250.02.f), "water temperatures shall not exceed twelve degrees Celsius (12 ^{o}C) daily average during June, July and August for juvenile bull trout rearing, and nine degrees Celsius (9 ^{o}C) daily average during September and October for bull trout spawning."

In addition to the Idaho water quality criteria, for streams that have been designated by the USEPA as protected for bull trout spawning and rearing, "a temperature criterion of 10 ^{o}C (50 ^{o}F) expressed as an average of daily maximum temperatures over a seven-day period applies…during the months of June, July, August, and September" (40 CFR Part 131.33(a)).

As a point of clarification of our use of the standards in the UNFCRS, for those water bodies designated by the USEPA as protected for bull trout, we use the federally promulgated bull trout temperature criterion because it is the most limiting. For all the other water bodies, we

use the salmonid spawning criteria for cutthroat, rainbow, and brook trout, in that order, depending on the species present.

Table 5. Idaho's water temperature criteria for beneficial uses in the UNFCRS.

Beneficial Use	IDAPA 58.01.02	Maximum Water Temp.	Daily Average Water Temp.	Effective Time Period
Cold Water Aquatic Life	250.02.b	≤22 °C (71.6 °F)	≤19 °C (66.2 °F)	Year Round
Salmonid Spawning	250.02.e.ii	≤13 °C (55.4 °F)	≤9 °C (48.2 °F)	Spawning and Incubation
Brook Trout Spawning	Specific to UNFCRS	≤13 °C (55.4 °F)	≤9 °C (48.2 °F)	Oct 1 – June 1
Cutthroat Spawning	Specific to UNFCRS	≤13 °C (55.4 °F)	≤9 °C (48.2 °F)	Apr 1 – Aug 1
Rainbow Spawning	Specific to UNFCRS	≤13 °C (55.4 °F)	≤9 °C (48.2 °F)	Jan 15 – July 15
Kokanee Spawning	Specific to UNFCRS	≤13 °C (55.4 °F)	≤9 °C (48.2 °F)	Aug 1 – June 1
Bull Trout Spawning	250.02.f		≤9 °C (48.2 °F)	Sept 1 – Oct 31
Bull Trout Rearing	250.02.f		≤12 °C (53.6 °F)	June 1 – Aug 31

For the purposes of measuring the state designated criteria, "the daily average shall be generated from a recording device with a minimum of six (6) evenly spaced measurements in a twenty-four (24) hour period" (IDAPA 58.01.02.250.02.f). "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 two standards do not apply to the federally promulgated bull trout streams or temperature criteria.

2.3 Summary and Analysis of Existing Water Quality Data

This section presents the various data sets used to evaluate water quality status compared with the state and federal sediment and temperature criteria. Sediment, in-stream temperature, biologic assessment, fish data, habitat data, and data gaps are discussed.

Flow Characteristics

The UNFCR flows almost 74 miles from its headwaters to where it empties into Dworshak Reservoir. The USGS calculates the mean annual flow for the UNFCR from 1967 to present at its Canyon Ranger Station just upstream from the reservoir to be 3,511 cubic feet per second (Brennan et al. 1999). Figures 2-9 and 2-10 in Appendix 2 show flow for 1998-99, mean daily flow for the period of record, and the daily flow for the period of record. Flow has ranged from a daily mean of 34,200 cubic feet per second on November 30, 1995, to 252

cubic feet per second on December 5, 1972. Peak flows generally occurred during spring run-off between April 18 and June 17 for the period of record, with May 23 as the median date for peak flow. The extreme peak flows shown on Appendix 2, Figure 2-10 represent rain-on-snow events. Low flows occur from August through mid- to late-winter. Low flows in late July and August, when air temperatures are high, can lead to high water temperatures.

Figures 2-11 through 2-15 in Appendix 2 show flow data collected by the CNF for five watersheds in the UNFCRS – the North Fork at Kelly Creek, Cold Springs Creek, Swamp Creek, Quartz Creek, and Gravey Creek. Since each site only has a few years of record, we have selected specific years to plot that show normal and extreme flows. Years 1983 and 1984 have records at the most sites. The same general trend can be seen in this data as in the USGS data. High runoff occurs from late April through early June, with some mid-winter peaks representing rain-on-snow events. Low flow begins in late July and August and continues on into late winter.

Water Column Data

The CNF has collected water column data at a number of sites around the forest, mostly associated with stream flow monitoring sites. We present the summary results for Cold Springs, Swamp, Gravey, Marten, and Quartz Creeks. All of these creeks except Quartz Creek are 303(d) listed for sediment. However, the Quartz Creek watershed contains Cougar and Grizzly Creeks that are 303(d) listed. The results of these data are presented in Appendix 2, Figures 2-16 through 2-20. The important thing to note about these data is that at no time do the peaks ever exceed 10 Jackson turbidity units (JTU) (JTUs are roughly equivalent to nephlometric turbidity units (NTUs) used in the state standards). The state water quality standard is a limit of 50 NTUs instantaneous.

Stream Temperature Data

Available stream temperature data collected by the CNF for the 303(d) listed streams are presented in Appendix 3, arranged alphabetically by stream. Stream temperature data are not available for Sugar, Marten, and Tumble Creeks. Both daily average and maximum weekly maximum temperatures are presented since the state standards are given in daily averages while the federal bull trout standard is based on the MWMT. The figures clearly show that the temperatures of these water bodies exceed the state and federal water quality standards for considerable parts of July and August.

Biological and Other Data

Available biological data consist of those collected by DEQ through BURP and extensive data collected by the CNF in their bio-physical assessment of streams.

Idaho's Water Body Assessment Guidance

Idaho rules (IDAPA 58.01.02.053) establish a procedure to determine whether a water body fully supports designated and existing beneficial uses, relying on physical, chemical, and biological parameters, as outlined in the *1996 Water Body Assessment Guidance* (DEQ,

1996). IDAPA 58.01.02.054 outlines procedures for identifying water quality limited waters that require TMDL development and establishes management restrictions that apply to water quality limited water bodies until TMDLs are developed.

The General Surface Water Quality Criteria (IDAPA 58.01.02.200) for Idaho set forth general guidance for surface water quality. The Surface Water Quality Criteria for Aquatic Use Designations (IDAPA 58.01.02.250) set forth specific numeric criteria to be met for particular beneficial uses. The WBAG sets forth a specific methodology whereby a water body is first assessed using the numeric criteria for a particular beneficial use, then identifies indices and methods for "narrative" assessments of pollutants for which numeric criteria do not apply or are not available. Sediment is the primary pollutant addressed by narrative means in the WBAG.

DEQ conducted BURP surveys on the water quality limited water bodies of the UNFCRS during July and August 1997 and in July 1998. The BURP surveys collected data on fish, macroinvertebrates, and stream habitat to determine whether a water body is supporting its designated beneficial uses. The WBAG results of the analysis of these BURP data for all of the 303(d) listed water bodies in the UNFCRS are presented in Table 6.

Idaho determines if its narrative sediment criteria are met by surveying streams to verify if viable communities of aquatic organisms are present and if evidence of beneficial uses exists in the stream. The BURP is a consistent scientific process used statewide for collecting this data. The WBAG evaluations of BURP data result in indices used to compare water quality with the standards to determine beneficial use support status. The macrobiotic index (MBI) is the primary index used to confirm beneficial use support status. An MBI score of 2.5 or less indicates not full support of beneficial uses, a score between 2.5 and 3.5 indicates that more information is needed to make a determination, and a score of 3.5 or greater indicates that the beneficial uses are fully supported. The state's procedure also specifies when to supplement the MBI with fish data, algal data, and habitat data in making water quality impairment determinations.

WBAG Plus

As a result of internal and external review of the 1996 WBAG (DEQ 1996), guidance from DEQ since that time indicates that support status determinations should be made in light of other biological, chemical, or habitat data, as well as agency reports with solid findings or conclusions. Therefore, we reviewed a considerable amount of other data and derived results to help us draw a conclusion of whether or not a given water body is actually of sufficient quality to support its beneficial uses.

In this chapter and in Chapter 3 we present a variety of data and modeled predictions specific to the water bodies on the 303(d) list. We use all these as well as other data to help evaluate whether water quality is meeting the state standards. Finally, in Chapter 5, we summarize, discuss, and draw our conclusions, water body-by-water body, about what these data mean with respect to water quality and support of beneficial uses.

Table 6. BURP/WBAG results for the 303(d) listed water bodies in the UNFCRS.

Water Body	Macro-biotic Index (MBI)	Salmonid Age Classes[1]	Temp °C/°F (instant-aneous)	Habitat Index (HI)	BURP % Fines	BURP CE[2] Rating	WBAG+ Rating[3]
China	3.81	4+j	13/55.4	106	13	30	NFS(t)
Cold Springs	5.00	4+j	15/59.0	107	8	40	NFS(t)
Cool	4.75	4+j	12/53.6	101	17	40	NFS(t)
Cougar	4.74	2+j	16/60.8	119	9.4	40	NFS(t)
Deception	5.86	4+j[4]	13/55.4	84	29	70	NFS(t&s)
Gravey (L)	5.15	3+j	6/42.8	95	17	50	NFS(t)
Gravey (U)	4.75	3+j	9/48.2	106	18	60	NFS(t)
Grizzly	5.12	2+j	12/53.6	95	28	40	NFS(t)
Hem 1997	5.34	2+j	16/60.8	105	21	35	FS
Hem 1998	5.55	3+j	15/59.0	111	21	20	FS
Laundry	4.83	3+j	8/46.4	121	8	25	NFS(t)
Marten	4.95	2+j	8/46.4	111	12	65	NFS(t)
Middle	4.96	3+j	11/51.8	105	24	25	NFS(t)
Orogrande (L)	5.08	3+j	18/64.4	114	9	20	NFS(t)
Orogrande (U)	3.26	1	12.5/54.5	110	16	20	NFS(t)
Osier (L)	4.59	3+j	14/57.2	102	29	55	NFS(t)
Osier (U)	4.59	3+j	11/51.8	104	15	40	NFS(t)
Sugar	4.04	2+j	7/44.6	107	23	35	NFS(t)
Swamp	4.48	3+j	12/53.6	107	19	40	NFS(t)
Sylvan 1997	4.34	5+j	12.5/54.5	106	21	50	NFS(t)
Sylvan 1998	5.68	5+j	10/50.0	99	25	20	NFS(t)
Tamarack	5.07	2+j	13/55.4	103	33	50	NFS(t)
Tumble	5.09	2+j	11/51.8	119	27	25	FS
Sneak	4.36	3+j	14/57.2	105	29	50	NFS(t)

[1] includes fish collection data from BURP and CNF bio-physical studies; +j = including young-of-the-year
[2] CE = cobble embeddedness, taken at the BURP reach
[3] NFS = Not fully supporting, FS = fully supporting, (t) = temperature is cause of not full support, (t&s) = both temperature and sediment are causes for not full support
[4] New data added for this revision

CNF Stream Bio-Physical Studies

Over approximately the last 10 years, the CNF has contracted bio-physical studies of all of 303(d) listed streams in the UNFCRS, except for Deception Gulch. (Note: Since this TMDL was originally written in February 2001, a bio-physical study has been completed of Deception Gulch as well.) 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 (1994) channel types and major hydrologic features. They are far more extensive and exhaustive than the BURP data, except that they do not collect and analyze macrobiota other than fish. The "Reach Overview Form" completed by the field crews when conducting these surveys provides valuable insight to the current condition of the streams on a reach-by-reach basis. Physical data from these studies used in this report are presented in Table 7. Table 6 above incorporates the biological results from these studies with respect to the fish present in the streams.

We used the data and conclusions in these reports to help make determinations about water quality status. First, the fish data collected in these surveys have been used to help make the WBAG-based beneficial use support determinations on the 303(d) listed streams. This meets the WBAG plus requirements of using electrofishing data collected either in the process of conducting BURP activities or collected by others in a reliable manner.

Second, we use the bank stability index and the actual measures of the percentage of raw banks in the given stream as measures of channel stability. These are the direct measures we use to assess the listing of Sneak Creek as water quality impaired due to channel instability. In addition we use the bank stability index in our consideration of in-stream erosion as producing sediment that impairs beneficial uses and water quality.

Finally, we considered cobble embeddedness as an indicator of stream sediment accumulation. Cobble embeddedness refers to the percentage of a larger streambed particle's long axis surrounded by particles less than 6.4 millimeters (mm) in size. Some of the bio-physical surveys identify high levels of cobble embeddedness as a factor limiting fish habitat potential on some streams in the subbasin.

Fish Data

Table 6 summarizes the salmonid fish data for the 303(d) listed streams. These data were derived from BURP electrofishing and data collected by the CNF at the fish stations established during the bio-physical surveys. Table 6 notes when young-of-the-year were observed, which is an indicator that successful spawning and rearing occur in the stream. These data and other data not presented here demonstrate that the subbasin water quality provides for protection, maintenance, and propagation of a salmonid fish population.

Table 7. Stream data from CNF-contracted studies of the 303(d) listed water bodies.

	Study Area Length (m)	Average Stream Gradient (%)	Average Cobble Embed.[1] (%)	Bank Stability Index	Raw Banks (m/km)[2]	Percent Pools	Percent Riffles
China	6,660	3.1	48.3	4.8	64	43.1	32.6
Cold Springs	7,095	11.0	20.8	4.6	88	13.2	67.6
Cool	4,790	14.0	27.2	4.8	48	15.6	67.9
Cougar	4,180	14.0	41.2	5.0	12	23.4	57.6
Deception[3]	7,410[3]	4.7[3]	48.6[3]	4.8[3]	41.9[3]	28.5[3]	49.0[3]
Gravey	15,120	2.6	22.1	4.0	135	32.0	68.0
Grizzly	5,100	15.0	34.6	5.0	10	21.7	54.3
Hem	7,230	5.0	29.2	4.9	21	19.1	67.6
Laundry	6,420	5.5	53.2	4.9	37	30.8	67.5
Marten	7,020	4.2	30.6	4.0	113	46.0	54.0
Middle	25,590	3.8	19.1	4.0	124	42.14	57.9
Orogrande	23,255	1.7	24.5	4.7	73	8.9	55.2
Osier	11,550	3.5	56.0	4.4	62	nd	nd
Sugar	6,205	3.8	64.3	5.0	nd	20.6	33.1
Swamp	11,870	3.9	43.8	4.9	nd	10.5	37.6
Sylvan	7,095	4.9	23.4	5.0	6	19.8	64.3
Tamarack	6,090	7.9	39.6	5.0	6	23.9	61.0
Tumble	7,485	6.2	56.2	5.0	1	46.1	22.6
Sneak	3,695	15.0	33.6	5.0	0	25.3	53.5

[1] Embed. = Embeddedness
[2] m/km = meters per kilometer
[3] New data added for this revision

2.4 Data Gaps

Overall, there are numerous data about water quality in the UNFCRS. However, an abundance of data does not always lead directly to answers. It often leads to more questions. This is the case with the temperature and aquatic life data in the UNFCRS.

Statewide temperature criteria have been established to define when the thermal load results in an environment unsuitable to successful spawning and propagation of various aquatic life species. The assumption has been that when these temperature criteria are exceeded, the water has been polluted and made unsuitable for its designated beneficial uses. In the UNFCRS, we have many in-stream temperature measurements that exceed those criteria, and

yet we also have abundant documentation of coincident successful spawning and propagation of the desired cold water aquatic life species. We do not have a data set that helps us identify what is going on in these situations.

The case for sediment in relation to water quality is even murkier. We are fairly certain that turbidity is not exceeding the state standards, although we don't have data on the specific 303(d) streams we think are questionable. The BURP and other snapshot-in time-fish data show that by and large salmonid spawning is being supported as determined by the WBAG process. However, there are water bodies that have received and continue to receive heavy sediment loads. We need a data set that would help determine whether these heavy sediment loads threaten the long-term viability of the salmonid populations. We need to know how much sediment loads can be above background for a given landscape setting that will still allow beneficial uses to be supported over time.

3. Subbasin Assessment – Pollutant Source Inventory

3.1 Sources of Pollutants of Concern

This section lists potential sources of surface water pollutants in the subbasin. The pollutants cited as causing exceedances of water quality standards in the 303(d) listing of subbasin streams are discussed in detail. Pollutant sources may occur as point sources, those for which effluent limitations may be required under sections 301(b)(1)(A) and 301(b)(1)(B) of the CWA, or as non-point sources of pollutants that are not subject to effluent limitations.

Point Sources

There are no known point sources of pollutants within the UNFCRS.

Sediment Non-Point Sources

The data sets discussed in this section are primarily pollutant source data sets, but since they were developed in response to water quality issues and we use them to help us draw conclusions about the water quality status, we present them below. Summaries of the data for the watershed by watershed analyses are presented in Tables 6 through 9. Non-point sources of sediment above natural background in the UNFCRS include forest management activities, fires, roads and trails, recreational activities, mining, landslides, in-stream erosion, other land administrative activities, and airfall. The precise amounts of pollutant contributions from each of these non-point sources to the subbasin are unknown.

The CNF, IDL, and private timber companies conduct forest management activities including road construction, reconstruction, and maintenance; timber thinning, fertilization, and harvesting; and fire suppression that may result in increased erosion and sedimentation. The state and private timberlands are primarily in the upper Orogrande Creek watershed. The remainder of the timber-producing land is managed by the CNF.

Road Data

The UNFCRS has 1,951 miles of roads, virtually all of which are unpaved, and most of which are native surfaced. Figure 10 shows the distribution of these roads in the subbasin. Note the correlation of highly roaded areas with 303(d) listed watersheds. Approximately 622 miles of the roads have some kind of travel restriction, designed at least in part to reduce erosion. Still, even under the best of circumstances, road erosion is known to be the major contributor of sediment to streams in roaded forest systems. Within timber management areas, roads are recognized as the primary source of sediment being delivered to waterways. Roads directly affect natural sediment and hydrologic regimes by altering stream flow, sediment loading, sediment transport and deposition, channel morphology, channel stability, substrate composition, stream temperatures, and riparian conditions in the watershed (USFS 1997). Road-related surface erosion and mass failures can continue for decades after the roads are constructed. 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 (Furniss 1991).

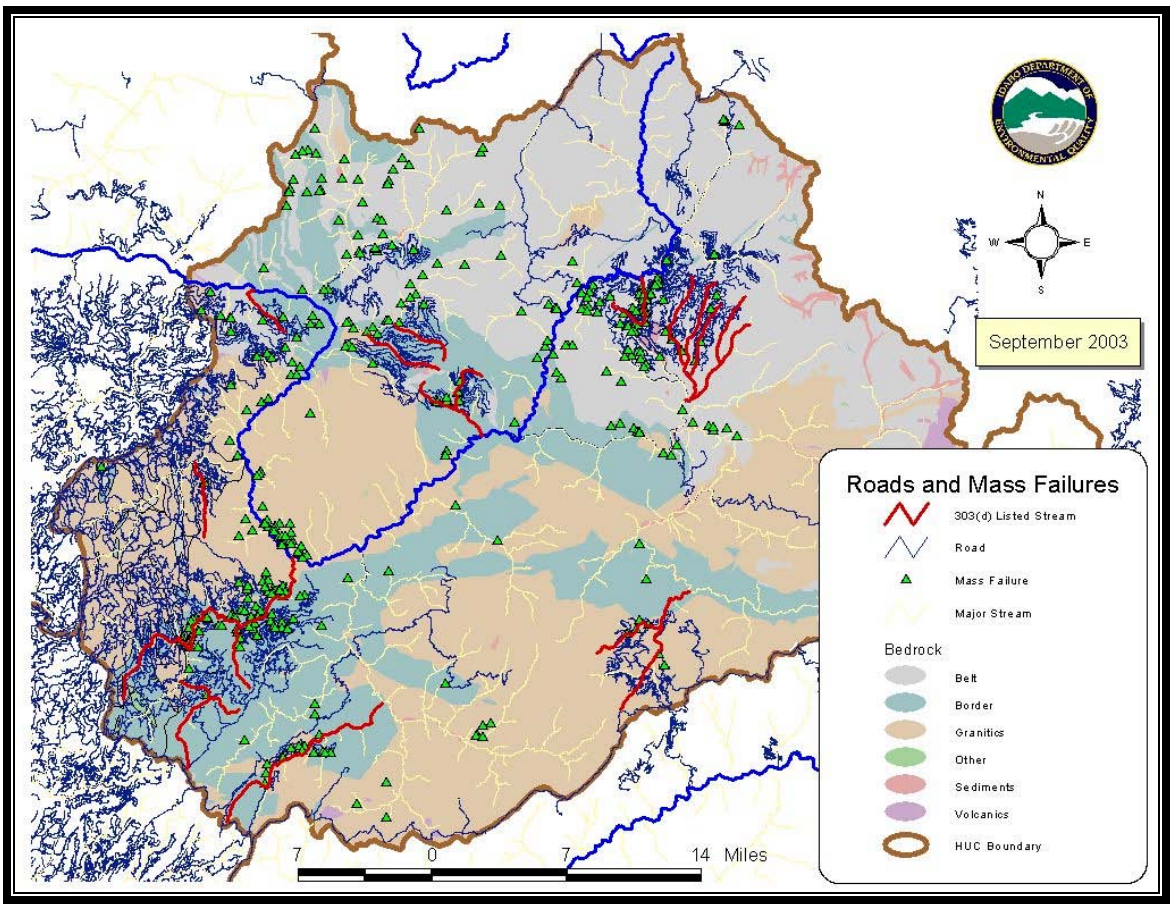


Figure 10. Roads and Mass Failures Related to 303(d) Streams in the UNFCRS

Table 8 shows a tabulation of various statistics related to roads and mass failures. Within the UNFCRS, 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 cut 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 streams on the 303(d) list, the China, Cool, Deception, Grizzly, Cougar, Laundry, Orogrande, Osier, Sylvan, Sneak, and Tumble Creek 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 landtypes identified as having a high risk for mass failures. Approximately 25 percent of the roads in the UNFCRS are on mass failure sensitive landtypes. Still another indicator is the percentage of roads within 100 feet of a stream. Approximately 18 percent of the roads in the UNFCRS are close to streams. We examined these indicators for each of the 303(d) listed streams.

Table 8. Road and mass failure data for the 303(d) listed water bodies in the UNFCRS.

Water Body[1]	Area	Area	Roads	Road Density[2]	Roads in SPZ[3]	Roads in High Risk Land-types	Number of Mass Failures	Mass Failure Density
	(acres)	(mi^2)	(miles)	(mi/ mi^2)	(%)	(%)		($\#/mi^2$)
China	2,606	4.1	25	6.1	10	5	1	0.2
Cold Springs	4,041	6.3	23	3.6	13	16	3	0.5
Cool	2,828	4.4	23	5.2	9	28	8	1.8
Cougar	3,232	5.1	24	4.8	6	79	0	0.0
Deception	2,973	4.7	42	9.0	13	50	24	4.9
Gravey	16,254	25.4	75	3.0	12	5	2	0.1
Grizzly	2,771	4.3	25	5.8	5	81	0	0.0
Hem	4,768	7.5	12	2.8	2	38	0	0.0
Laundry	1,845	2.9	22	7.6	11	8	3	1.0
Marten	3,936	6.2	16	2.6	27	2	4	0.7
Middle	17,643	27.6	43	1.6	7	22	14	0.5
Orogrande (L)	11,170	17.5	106	6.1	36	28	51	2.9
Orogrande (U)	19,929	31.1	250[4]	8.1[4]	13[4]	nd[5]	9	0.3
Osier	5,006	7.8	52	6.7	13	13	5	0.6
Sugar	2,411	3.8	9	2.4	7	0	0	0.0
Swamp	7,956	12.4	1	0.1	0	0	0	0.0
Sylvan	3,464	5.4	36	6.7	3	24	1	0.2
Tamarack	3,562	5.6	15	2.7	1	43	5	0.9
Tumble	2,069	3.2	20	6.2	25	0	1	0.3
Sneak	2,488	3.9	19	4.9	15	58	1	0.3

[1] (L) = lower; (U) = upper
[2]Shading identifies data on the high end of the range
[3]Stream Protection Zone
[4]Road data for upper Orogrande are more detailed than for other watersheds.
[5] nd = data not available.

Mass Failure Data

The CNF, IDL, and Potlatch Corporation collaborated in collecting an extensive data set on the mass failures that occurred in the 1995-96 rain-on-snow event. The results of this data collection effort are presented in McClelland et al. (1997). In addition, the locations of the

mass failures, and some of the related data, have been entered in a GIS database (Figure 9). We have used that database to stratify and analyze the mass failures on a watershed by watershed basis. These data are presented in Table 8.

Mass failures are an important sediment source in the subbasin. The combination of highly weathered and altered bedrock, steep slopes, substantial road building, fire- and logging-reduced vegetative cover, and rain-on-snow events has resulted in significant landslides. Including and since the 1995-96 rain-on-snow event, 370 landslides have been documented in the UNFCRS (Figure 9). Of these, 130, or about 35 percent, occurred in 303(d) listed watersheds; however, 303(d) listed watersheds comprise only about 13 percent of the acreage in the subbasin.

The USFS has determined that about two-thirds of the mass failures are related to management activities and about one-third are natural (58% are road-related, 12% are associated with timber harvest, and 29% are natural) (McClelland et al. 1997). These findings are similar to those for the major landslide event in 1974, which was also triggered by rain-on-snow, but the more recent event is estimated to have produced twice the sediment volume. Total sediment volume, rather than number of slides, may be more relevant to water quality. The best available estimate is that sediment volume delivered to streams is apportioned as follows: 25 percent from roads, 4 percent from timber harvest areas, and 71 percent from natural landslides. For example, two of the 907 landslides resulting from the 1995-96 rain-on-snow events on the CNF together produced 38 percent of the sediment volume delivered to streams (McClelland et al. 1997). These two slides were concluded to have been natural. One of these, the Quartz Creek slide, occurred in the UNFCRS, albeit on a water body that is not 303(d) listed.

Mining and Other Sediment Sources

Limited placer mining for precious metals and gemstones is conducted at several locations. Small-scale, recreational dredge mining in the Moose Creek and Orogrande Mining Districts may be contributing some sediment. However, most of the sediment being produced in these areas is cobble-sized material as stream channels reestablish their normal meander patterns in the placer-mining debris produced in the last half of the 19th century.

In addition to the known in-stream erosion of placer mining debris in the mining districts, other streams in the subbasin may be producing some sediment through bank erosion and downcutting. Geologic and geomorphic evidence indicates that streams in the UNFCRS are actively downcutting geologically, and as such, should be expected to exhibit a certain amount of in-stream erosion. On the other hand, logging activities, especially road construction and canopy removal, alter the hydrologic balance and may lead to channel instability and erosion. Without getting into a discussion of what might be geologically natural, and what might be management induced, it is noted that CNF data indicate that Cool Creek, Hem Creek, Osier Creek, and Sylvan Creek have some in-stream erosion occurring.

A native-surfaced airplane runway is situated on the divide between Osier Creek and Independence Creek, near Deception Saddle. The airport is on a mining claim patented as

private property. While evidence of erosion on the runway is clear, we were not able to track any significant sediment to an active stream channel. It is almost certain that some clay and silt sized material are being transported to active stream channels during spring snowmelt and other periods of high runoff. However, it is doubtful that this runway contributes significant sediment loads to Osier or Independence Creeks.

Recreational activities in the subbasin may contribute to erosion and sedimentation. These activities include picnicking, hiking, camping, hunting, horseback riding, bicycling, using off-road vehicles, fishing, kayaking, canoeing, rafting, swimming, cross country skiing, snowmobiling, and scenery and wildlife viewing. However, field observations indicate that none of these activities are producing any significant sediment in the UNFCRS.

In thinking about non-point source pollutants, one must suppose that some sediment comes from airfall, the effects of fires, and administrative activities in the subbasin (maintaining the USFS Kelly Forks Work Station and fire lookouts, for example). Some of these contributors may be significant on a larger scale, at least at times. However, for the water bodies being assessed in this document, it is concluded that these types of sediment sources are insignificant.

Stone, sand, and gravel are mined for local road construction and surfacing at several sites within the subbasin. While most of these are away from riparian areas and streams and are well designed to reduce sediment moving off the sites, at least one site on Osier Creek was observed that needed improvement.

Grazing activities that may contribute to riparian area denudation and the sediment load within the subbasin are relatively few. They include short-term, site-specific grazing of pack and saddle stock and minor domestic livestock grazing that occurs mostly on private lands in the lower part of the subbasin. Potlatch Corporation and IDL have grazing leases in the upper Orogrande drainage.

In conclusion, only the effects of sediment from roads, mass failures, and in-stream channel erosion are considered significant for this assessment. The effects of sediment from grazing, mining, recreation, administrative activities, and the airport in Osier Creek are observable but much less significant.

Idaho's Cumulative Watershed Effects Process

Cumulative Watershed Effects assessments have been completed for virtually all of the upper Orogrande Creek and French Creek watersheds (the French Creek watershed includes the Hem and Sylvan Creeks watersheds). The CWE process collects and organizes data on mass failure and surface erosion hazards, stream temperature, watershed canopy condition, hydrologic risk, sediment production and delivery to a waterway, stream channel stability, and water nutrient condition. The process relies on the WBAG beneficial use support determination as the measure of whether or not a stream is water quality impaired. The CWE methodology analyzes these data and determines whether forest practices are creating "adverse conditions" due to sediment, temperature, nutrients, and/or hydrologic impacts (IDL 2000).

While CWE adverse conditions are not defined using the state's water quality standards, the intent of the process is to respond to the CWA and devise surrogate measures for when forest practices are significantly impacting water quality. Since CWE is conducted on the ground, in the watershed, the results are a systematic and up-to-date assessment of how forest practices are impacting a watershed and its water quality. If CWE identifies adverse conditions for any of the four pollutants it screens for, then the water body assessors need to look at the situation carefully. Conversely, if CWE concludes that forest practices are not contributing substantially to any of the pollutants under consideration for a watershed, the data are considered reliable indicators of the situation on the ground.

In particular, in this assessment, because most of the streams are 303(d) listed for sediment, we use CWE road sediment delivery scores and the CWE mass failure data where available. Estimated CWE road sediment delivery ratings are presented in Table 9. In watersheds that are temperature limited, we use the CWE stream temperature assessment model where percent shade and elevation predict stream temperature as the indicator of where temperature loading is occurring. By this, we are setting the stage to use this relationship in the TMDL as our measure of whether stream temperature is being reduced in temperature limited streams.

WATBAL Predictions

The CNF uses the WATBAL model to help it allocate resources and make management decisions. In its forest plan, the CNF states its management goal for water quality 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). Since, as with CWE, the ultimate goal is to achieve water quality, we use the CNF data in this assessment to help us evaluate whether a given water body is water quality limited.

The WATBAL model was developed to predict the amount of sediment being produced naturally from a given landtype based on a fairly extensive data collection effort on the CNF. Then, as roading, logging, and other management activities take place in a watershed, WATBAL predicts the additional amount of sediment being produced by these activities. These predictions were calibrated against data collected in the late 1970s and 1980s. We use the CNF's WATBAL predictions of percent sediment over background to help identify watersheds that need closer evaluation of their sediment condition. The results are shown in Table 9.

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

Water Body[1]	Cobble Embeddedness Threshold	Current Sediment (% over background)	CWE Road Sediment Delivery Rating[2]
China	25-30	8	Medium
Cold Springs	25-30	17	nd
Cool	25-30	13	nd
Cougar	30-35	15	nd
Deception	40-45	28	Medium
Gravey (L)	30-35	11	nd
Gravey (U)	30-35	nd	nd
Grizzly	30-35	28	nd
Hem	30-35	5	Low
Laundry	25-30	12	Medium
Marten	30-35	20	nd
Middle	35-40	17	nd
Orogrande (L)	40-45	nd	High
Orogrande (U)	40-45	nd	Low
Osier	25-40	5	Medium
Sugar	30-35	15	Low
Swamp	30-35	0	Low
Sylvan	30-35	14	Low
Tamarack	30-35	40	nd
Tumble	35-40	39	nd
Sneak	25-30	90	Low

[1] (L) = lower; (U) = upper
[2] nd = no data

Heat Non-Point Sources

Osier Creek is the only water body in the UNFCRS that is 303(d) listed for temperature. This means that heat is the pollutant. In our conclusions in this subbasin assessment, we identify several other water bodies where water quality is limited by heat loading. We suspect this is true of many other water bodies in the subbasin, as well. Those other water bodies not included on the current 303(d) list will be evaluated during the development of Idaho's upcoming 303(d) listing cycle and during an assessment of the adequacy of the state's current temperature standard criteria. All the current 303(d) listed water bodies, regardless of the suspected pollutant, are evaluated herein for temperature exceedances.

Additional heat being absorbed by a water body beyond background in forested environments is usually a function of shade reduction. Certainly in the case of Osier Creek, which was heavily logged in the 1960s and 1970s, it is reasonable to think that an additional heat load and, therefore, increased stream temperature, have resulted from decreased stream shading.

One aspect of heat loading is a change in channel morphology such that a channel becomes wider and shallower (higher width to depth ratio), with a resultant increase in surface exposure to solar and long-wave radiation. In most cases within the UNFCRS subbasin, 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 or mining alteration of the channel. Less obviously, the change can be the result of removal of streamside vegetation that kept the channel narrow and sinuous.

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. In the case of lower volume flows, one might expect a greater temperature increase for a given amount of heat loading. The CNF notes that its data for the UNFCRS on increasing or decreasing stream flow due to canopy changes is inconclusive.

We do not address this situation herein because flow modification is not a pollutant under the CWA. The loading of heat as a pollutant in both scenarios is roughly equivalent, given similar channel and habitat conditions. Higher early season flows could possibly result in channel widening (and subsequent increased heat loading), but we do not see evidence for this in the channel stability data in this subbasin. We point out the possible flow modification situations for the benefit of land managers who will be developing management strategies to reduce stream temperatures as a result of the TMDLs included in this document: increasing late season flows for a given heat load might be a good strategy for reducing stream temperatures.

An outstanding question at this point is whether additional heat loading as a result of logging and road building is causing water quality numeric criteria exceedances in other water bodies of the UNFCRS. Also outstanding is the question of which streams do or would exceed the Idaho and federal water quality numeric criteria in the absence of logging related shade reduction.

3.2 Data Gaps

This section discusses where additional data could help clarify questions about water pollution and how to maintain water in the subbasin so it meets state water quality standards. While considerable data are available such that water quality can be assessed with a reasonable degree of certainty, better and more specific data would certainly be helpful.

One of the biggest questions regarding water quality in the UNFCRS has to do with heat as a pollutant and to what degree 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 UNFCRS exceed the state water quality standards for salmonid spawning. A question beyond the scope of the UNFCRS problem assessment is whether the state temperature standards (including the methods for measuring stream temperature) are correct for the designated beneficial uses. What we do know is that we have stream temperature data collected using the standard methodology that indicate water pollution according to the state water quality standards, yet we also have what appear to be healthy, reproducing populations of sensitive salmonids such as westslope cutthroat trout. We need some other data that will help rectify the discrepancy between these two data sets.

The extent to which riparian timber harvest has altered streamside shading and channel morphology is not known. We do not have historic records that show how much shading existed before logging began, nor what the channels looked like. Therefore, we don't have a very accurate picture of what really is human-caused heat loading and what is natural. The same can be said for the effects of mining on shading. We also do not have much of an idea of what long-term effects the large fires during the first half of the twentieth century had on shading.

We do not have good data about the exact sources and amount of sediment from roads and its percent delivery. Since mass failures are episodic, our relatively limited data do not provide enough information for a good understanding of how mass failures are distributed through time.

We have very little data about sediment from modern or historic mining. The majority of mining alteration of the landscape occurred before passage of the CWA, so likely is outside the scope of this legislation. Modern day mining operations are regulated and appear to be having a minimal impact, but no data are available.

We have very little data on the sediment condition of streams before the early 20th century fires or the large 1975-76 rain-on-snow event. We have WATBAL predictions, but we really

don't know what the baseline condition is for sediment in different streams on different landtypes. The data for WATBAL validation were collected after these events.

We lack reliable data on the extent and cause of bull trout declines in this subbasin. We do not have information to help us sort out what part of the decline is due to habitat factors or food chain factors and what part might be the result of heat or sediment pollution.

Modeling efforts would be greatly improved if we had accurate and consistent GIS layers. We do not have accurate topographic layers to be able to identify all potential waterways. We do not have good layers for riparian and streamside zones, other than some coarse buffers. Even though we know that much sediment is being delivered from roads directly to waterways, the GIS layers do not accurately depict the situation on the ground for lack of good road and stream channel layers. Data on road type, size, condition, maintenance, culverts, and drainage location in a GIS format would be invaluable.

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. Its scope is limited to those efforts that could control sediment and temperature, the parameters of concern identified in the 1998 303(d) list.

4.1 Past Water Pollution Control Efforts

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 best management practices (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 forestry practice compliance with the FPA were conducted in 1978, 1984, 1988, 1992, 1996, and 2000. Because of these audits, BMPs have been revised to promote better water quality protection.

4.2 Present Water Pollution Control Efforts

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, suppression, and 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.

From a state policy and legislatively mandated point-of-view, perhaps the most important pollution control activities on forested land in the state of Idaho, including the UNFCRS, are those derived from the FPA. The FPA established a Forest Practices Advisory Committee composed of various interest groups. The committee has 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 UNFCRS to improve water quality are the direct result of improved practices and BMPs put in place by the FPA. Given the results of current research and knowledge development, the Forest Practices Advisory Committee is currently working on improving BMPs for the sediment and temperature issues addressed in this subbasin assessment and TMDLs.

Under the FPA, the forest industry and the state of Idaho have developed and are implementing a CWE process for forestlands in the state. The goal of this methodology is to systematically examine forested watersheds and identify on-the-ground cases where

forestland 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. The CWE assessments have been completed on virtually all of the state and private managed land in the UNFCRS. Corrective management prescriptions, where indicated, are currently being developed and implemented. A large GIS database has been developed that helps the Forest Practices Advisory Committee develop and improve BMPs to systematically address identified problems.

A 1997 study of the 1995-96 landslide event made recommendations to reduce slides associated with forest management (McClelland et al. 1997). One management action resulting from this study is the effort to identify and either abandon or obliterate roads with high risk for mass failure or sediment delivery. The CNF established a goal to obliterate 100 miles of road per year in the CNF (USFS 1999c), with the long-term goal of reducing the number of miles of road on the forest by about one third. In 1999, 83 miles of road in the forest were actually obliterated. The CNF has a program to monitor the results of road obliteration, in terms of sediment produced by the process and long-term sedimentation reduction. While there usually is a short-term spike in sediment as a result of road obliteration, long-term sediment production should be reduced to near background for areas with obliterated roads.

Very little road construction is occurring in the subbasin (Jones and Murphy 2000). In February 1999, an 18-month moratorium on road construction in unroaded areas on federal lands went into effect. In October 1999, President Clinton directed the USFS to develop a proposal to protect all roadless areas larger than 5,000 acres. Existing roads and trails are maintained on a somewhat irregular basis and the CNF has requested more funds for this important activity. Potlatch Corporation and IDL have rules, funding mechanisms, and schedules in place for road maintenance.

Timber harvest is no longer occurring in riparian areas on CNF-managed lands (Jones 1999). An interagency agreement has created minimum stream protection zones (SPZ) for protecting anadromous and inland fish species. These measures are more restrictive than those in the FPA and are being used by the CNF throughout the subbasin. Even under the FPA, while limited timber removal is allowed in the SPZ, no logging equipment is allowed in the SPZ in an effort to minimize site disturbance.

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). These and other stream temperature data from around the state, when coupled with salmonid spawning information, have convinced DEQ and the USEPA to reconsider water temperature criteria with the goal of establishing more data-based locally applicable temperature standards for desired beneficial uses.

In addition, the CNF has an active intensive stream inventory program. These inventories result in identification of areas in need of habitat improvement. In 1999, 238 acres of anadromous and inland streams were improved throughout the forest.

Off-road vehicle (ORV) use of the forest is being monitored. At the moment, ORV damage to water resources has not been documented and is considered minimal. However, ORV use is growing dramatically.

The CNF has 92 mining operations: 75 are non-bonded, non-energy operations; 17 are bonded, non-energy operations. All 17 bonded, non-energy operations are administered to standards. Since the listing of bull trout as a threatened species, the approval of 19 additional mining permits has been postponed until completion of consultation with the USFWS.

The CNF audits the FPA on its lands. In 1999, over 99 percent of BMPs were implemented. State, federal, and private timber management agencies are moving forward with efforts to determining the actual effectiveness of BMPs in maintaining water quality. The quadriennial interagency audit of forest practice BMPs was conducted during the summer of 2000 with specific goals of examining the effectiveness of BMPs relating to SPZs, water quality, and beneficial uses. As the results of these studies are analyzed, it can be assumed that the BMPs will be modified as required.

5. Water Body Summaries and Water Quality Conclusions

This section summarizes the characteristics of each subbasin stream included on the 1996 303(d) list, the results of the state's investigation of the stream's water quality, and the assessment conclusions. DEQ is addressing the stream segments identified on the 1996 303(d) list created by the USEPA to comply with a federal court order. The 1998 list created by DEQ and submitted to USEPA includes all these segments because no additional evaluation of data had been completed at that time (DEQ 1999). Due to time constraints, we are not evaluating any water bodies not included on the 1998 303(d) list even though we suspect a large number of them in the UNFCRS do not meet the water temperature standards. We recommend that these water bodies be evaluated for the next round of TMDL development. The formal 303(d) listing process will allow opportunity for input from the various interested parties

There is general pattern to the water quality condition of the 303(d) listed water bodies in this subbasin. Most of the streams are listed for sediment as the pollutant. We find, however, that most of the streams do not meet the numeric temperature criteria, either for bull trout or other salmonids, and we conclude that temperature TMDLs need to be developed. On the other hand, based on our assessment of existing data, we conclude that most of the streams are not excessively impaired by sediment and should be delisted for sediment.

In the case of our conclusions about the need for temperature TMDLs, exact spawning periods for cutthroat and rainbow trout are unknown so we assumed the default time periods from earlier versions of Idaho's water quality standards. These presumed spawning periods are no longer part of Idaho code because it is known that spawning periods vary from location to location. If additional information proves these assumptions wrong for the UNFCRS, then a modification of the TMDLs will be needed.

Below is a discussion of each of the 303(d) listed water bodies, arranged alphabetically. Table 10 summarizes the conclusions.

Table 10. Summary of conclusions and recommended actions.

Stream Name	Boundaries[1]	Stream Miles	Listed Pollutant[2]	Conclusions
China Creek	HW to Osier creek	4.9	Sediment	Delist for Sediment Temperature TMDL
Cold Springs Creek	HW to NF Clearwater River	4.8	Sediment	Delist for Sediment Temperature TMDL
Cool Creek	HW to Cold Springs Creek	3.3	Sediment	Delist for Sediment Temperature TMDL
Cougar Creek	HW to Quartz Creek	3.7	Sediment	Delist for Sediment Temperature TMDL
Deception Gulch	HW to NF Clearwater River	4.7	Sediment	Sediment TMDL Temperature TMDL

Stream Name	Boundaries[1]	Stream Miles	Listed Pollutant[2]	Conclusions
Gravey Creek	HW to Cayuse Creek	9.0	Sediment	Delist for Sediment Temperature TMDL
Grizzly Creek	HW to Quartz Creek	4.5	Sediment	Delist for Sediment Temperature TMDL
Hem Creek	HW to Sylvan Creek	5.0	Sediment	Delist for Sediment
Laundry Creek	HW to Osier Creek	4.4	Sediment	Delist for Sediment Temperature TMDL
Marten Creek	HW to Gravey Creek	4.5	Sediment	Delist for Sediment Temperature TMDL
Middle Creek	HW to Weitas Creek	13.3	Sediment	Delist for Sediment Temperature TMDL
Upper Orogrande Creek	HW to French Creek	19.5[2]	Sediment	Delist for Sediment Temperature TMDL
Lower Orogrande Creek	French Creek to NF Clearwater River	19.5[2]	Sediment	Delist for Sediment Temperature TMDL
Osier Creek	HW to Moose Creek	8.1	Sediment Temperature	Delist for Sediment Temperature TMDL
Sneak Creek	HW to NF Clearwater River	3.5	Channel Stability	Delist for Channel Stability Temperature TMDL
Sugar Creek	HW to Swamp Creek	4.0	Sediment	Delist for Sediment Temperature TMDL
Swamp Creek	HW to Osier Creek	5.4	Sediment	Delist for Sediment Temperature TMDL
Sylvan Creek	HW to French Creek	4.3	Sediment	Delist for Sediment Temperature TMDL
Tamarack Creek	HW to Orogrande Creek	3.9	Sediment	Delist for Sediment Temperature TMDL
Tumble Creek	HW to Washington Creek	4.6	Sediment	Delist for Sediment

[1] HW = Headwaters, NF = North Fork
[2] Stream miles for the Upper Orogrande and Lower Orogrande combined, as listed on the 1998 303(d) list

5.1 China Creek

China Creek is 303(d) listed for sediment. China Creek is a third-order tributary of Osier Creek, which then empties into Moose Creek, and then into Kelly Creek, and the into the North Fork Clearwater River. China Creek originates on Osier Ridge and flows in a southerly direction to its confluence with Osier Creek. Elevations range from 3,600 feet at the confluence to over 6,000 feet on Osier Ridge. The predominant landtypes are Moderate Relief Uplands, Mountain Slopelands, and Rounded Mountain Slopelands derived from metasedimentary quartzites and undifferentiated rocks. The predominant mapped bedrock

type is the Lower Wallace Formation interbedded with gneissic quartzite, limestone, dolomite, and siltstone.

The BURP evaluation reach and the CNF temperature-recording site are near the mouth of China Creek at 3,600 feet elevation. The 3.5 percent reach slope is typical of a Rosgen type B channel. The measured discharge on July 27, 1997, was 6.1 cubic feet per second; it was 4.8 cubic feet per second on July 17, 1994, and 2.9 cubic feet per second on August 15, 1994. BURP identified forestry, mining, and recreation as human activities affecting the reach. China Creek has an MBI score of 3.8, a habitat index (HI) score of 106 (generally, an HI score of >73 indicates good condition), and is supporting salmonid spawning as evidenced by the presence of four age classes of westslope cutthroat trout, including juveniles.

China Creek is not listed by either the federal regulations or the state's bull trout problem assessment as a stream to be protected for bull trout. Therefore, stream temperature was assessed using the cutthroat temperature standards shown in Table 5, where the mean daily temperature shall be less than or equal to 9 ^{o}C (48.2 ^{o}F) from April through July. As shown by the temperature data for China Creek in Appendix 3, mean daily temperatures begin to exceed 9 ^{o}C (48.2 ^{o}F) near the end of June or early July and continue to throughout the month of July. Therefore, China Creek's water temperature exceeds the state's numeric standard and a temperature TMDL is required.

Since China Creek is 303(d) listed for sediment and not temperature, we continued following the WBAG plus process to determine whether or not water quality is in fact impaired by sediment.

China Creek has been subjected to extensive road building and timber harvesting activities. Timber harvest has removed 20-30 percent of the canopy in this watershed. The watershed has approximately 25 miles of roads resulting in a density of about 6.1 road miles per square mile of watershed. About 10 percent of the roads are within 100 feet of a perennial stream, and about five percent of the roads are on hazardous landtypes. The CNF is implementing activities to reduce the density and use of roads in this watershed. The CNF limits access to many of the roads and has plans to obliterate some roads within this watershed. China Creek was one of the watersheds most heavily impacted by the 1975-76 rain-on-snow landslide event. One large landslide with high delivery occurred during the 1995-96 event.

The CNF bio-physical survey identified limiting factors for salmonid production as "very high levels of streambed sedimentation and shallow pool depths." "Streambed particles in non-riffle habitats … are dominated by fine sediment which would be easily mobilized by high spring flows." On the other hand, "westslope cutthroat were widespread and were seen at all 10 of the fish stations…" Rainbow-steelhead were observed in two of the lower stations in China Creek (Clearwater Biostudies, Inc. 1995a).

The average stream gradient is 3.1 percent, which limits the system's ability to move sediment. Current cobble embeddedness is about 48 percent, which is a little high for this system (compared to 44% for Swamp Creek which is unroaded with similar geology and

landtypes). WATBAL predicts current sediment production is eight percent above background, well under the CNF's conservative goal of 55 percent.

It is concluded that China Creek is supporting salmonid spawning and should be removed from the 303(d) list for sediment. Road erosion and mass failures associated with roads are contributing some sediment to the system, but the evidence indicates that China Creek's water quality meets the state's standards and is not seriously threatened by the degree of erosion currently taking place in the watershed. The water quality condition probably is continuing to improve from the 1975-76 rain-on-snow event. The majority of sediment being delivered from roads is the result of inadequate and/or inappropriate culvert locations and drainage. Water quality would greatly improve if the CNF were to address this problem.

5.2 Cold Springs Creek

Cold Springs Creek is 303(d) listed for sediment. Cold Springs Creek is a third-order tributary of the North Fork Clearwater River in north-central Idaho. Cold Springs Creek heads on Pot Mountain Ridge and flows in a southeasterly direction to its confluence with the North Fork Clearwater River. Elevations range from 2,800 feet at the confluence to around 6,200 feet on Pot Mountain Ridge. The higher elevations of this watershed exhibit glacially-derived landforms. The predominant landtypes are Mountain Slopelands, Rounded Mountain Slopelands, Steep Broadly Rounded Mountain Slopelands, and Dissected Stream Breaklands of mixed and undifferentiated lithologies ranging from granite to schist to quartzite common to the border zone. The predominant mapped bedrock types are Wallace Formation interbedded calc-silicate, schist, and quartzite; Prichard Formation schist and quartzite; some granites; and other intruded rocks.

The BURP evaluation reach is at 2,920 feet elevation, upstream from the gauging station where the CNF recorded stream temperatures. The 12.5 percent reach slope is typical of a Rosgen type A channel. The measured discharge on August 8, 1997, was 15.1 cubic feet per second. BURP identified forestry and roading (USFS Road 711 parallels the creek) as human activities affecting the reach. Cold Springs Creek is supporting its beneficial uses as substantiated by an MBI score of 5.0, an HI score of 107, and four age classes of westslope cutthroat trout, including juveniles.

Cold Springs Creek is identified in the federal regulations as protected for bull trout and it is listed as a priority bull trout watershed in the state's bull trout problem assessment. Because of the federal listing, the water temperature of Cold Springs Creek was evaluated using the 10 ^{o}C (50 ^{o}F) MWMT for June through September temperature standard. The two years of stream temperature data presented in Appendix 3 show that stream temperatures exceed the standard for most of July and August. Therefore, Cold Springs Creek water temperatures exceed the federal numeric standard and a temperature TMDL is required.

Since Cold Springs Creek is 303(d) listed for sediment and not temperature, we continued following the WBAG plus process to determine whether or not water quality is in fact impaired by sediment.

Road building and timber harvesting have been the major economic activities in the Cold Springs watershed. Timber harvest has removed 20-30 percent of the canopy in this watershed. The watershed has approximately 23 miles of roads resulting in a density of about 3.6 road miles per square mile of watershed. Thirteen percent of the roads are within 100 feet of a perennial stream and 16 percent of them are on hazardous landtypes. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. Within the whole Cold Springs/Cool Creek watershed, the CNF has plans to obliterate 22 miles of road and place long-term closures on 20 miles of road in the 2001-2010 time frame. Three mass failures were recorded for the 1995-96 rain-on-snow event, with considerable delivery to the stream. In summer 1996, the Clearwater Biostudies stream survey crew noted definite effects of mass failure-derived sediment in the stream channel.

No particular factors are identified for Cold Springs Creek that might raise concerns about sediment in relation to the state water quality standards. Current cobble embeddedness is about 21 percent. The WATBAL model predicts that current sediment production is 17 percent above background in the lower section and near background in the upper section, both well under the CNF's current conservative goal of 55 percent.

The CNF bio-physical survey identified the following limiting factors for salmonid production: recent mass failures and debris torrents (the survey was completed in summer 1996, immediately after the 1995-96 event) coupled with sedimentation in depositional areas, migration barriers, and limited spawning and overwintering habitat in several reaches. On the other hand, abundant westslope cutthroat were found at all the lower stations (below fish barriers?), and rainbow-steelhead were found at the lowest stations (Clearwater Biostudies, Inc. 1997).

It is concluded that Cold Springs Creek is supporting salmonid spawning and should be removed from the 303(d) list for sediment. It is recognized that road erosion and mass failures associated with roads are contributing some sediment to the system, but cobble embeddedness ratings indicate that the high-energy system is able to quickly move the sediment out of the system, thus minimizing its effect. It is noted that (1) the majority of sediment being delivered from roads is the result of inadequate and/or inappropriate culvert locations and drainage and (2) all the mass failures in the Cold Springs watershed occurred in landtype 61, Dissected Breaklands. Water quality would be greatly improved if the CNF were to address the culvert problems.

5.3 Cool Creek

Cool Creek is 303(d) listed for sediment. Cool Creek is a third-order tributary of Cold Springs Creek and thence of the North Fork Clearwater River in north-central Idaho. Cool Creek heads on Pot Mountain Ridge and flows in a south-southwesterly direction to its confluence with Cold Springs Creek. Elevations range from 3,400 feet at the confluence to nearly 6,700 feet on Cold Springs Peak. The higher elevations of this watershed exhibit glacier-derived landforms. The predominant landtypes are Rounded Mountain Slopelands, Broadly Rounded Mountain Slopelands, Steep Broadly Rounded Mountain Slopelands, and Dissected Stream Breaklands of mixed and undifferentiated lithologies ranging from schist to

quartzite common to the border zone. Over one percent of the landscape is identified as mass wasted. The predominant mapped bedrock types are Wallace interbedded calc-silicate and Prichard schist, with much smaller areas of other bedrocks.

The BURP evaluation reach is at 3,520 feet elevation and the CNF temperature-recording site is in the same general location. The 13 percent reach slope is typical of a Rosgen type A channel. The measured discharge on August 8, 1997, was 7.2 cubic feet per second. BURP identified forestry and roading as human activities affecting the reach. Cool Creek's MBI score is 4.75, its HI score is 101, and it is supporting salmonid spawning as evidenced by four age classes of westslope cutthroat trout, including juveniles.

Cool Creek is identified in the federal regulations as protected for bull trout, but it is not listed as a priority bull trout watershed in the state's bull trout problem assessment. However, given the location of Cool Creek, the state's bull trout problem assessment may have assumed that it is part of Cold Springs Creek, which is listed. Because of the federal listing, the water temperature of Cool Creek was evaluated using the 10 ^{o}C (50 ^{o}F) MWMT for June through September temperature standard. The three years of stream temperature data for Cool Creek presented in Appendix 3 show that stream temperatures exceed the standard for most of July and August. Therefore, the Cool Creek water temperature exceeds the federal numeric standard and a temperature TMDL is required.

Since Cool Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG plus process to determine if water quality is in fact impaired by sediment.

Road building and timber harvesting have been the major economic activities in the Cool Creek watershed. Timber harvest has removed approximately 30 percent of the original canopy in this watershed. The watershed has approximately 23 miles of roads resulting in a density of about 5.2 road miles per square mile of watershed. Only nine percent of the roads are within 100 feet of a perennial stream, but 28 percent are on hazardous landtypes. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. Within the whole Cold Springs/Cool Creek watershed, the CNF has plans to obliterate 22 miles of road and place long-term closures on 20 miles of road in the 2001-2010 time frame. Eight mass failures, resulting in a relatively high density of 1.8 failures per square mile, were recorded for the 1995-96 rain-on-snow event, with considerable delivery to the stream. In summer 1996, the Clearwater Biostudies stream survey crew noted the effects of mass failure sediment in the stream channel.

The CNF bio-physical survey identified the following limiting factors for salmonid production: recent mass failures and debris torrents (the survey was completed in summer 1996, immediately after the 1995-96 event), coupled with sedimentation in depositional areas; migration barriers; and limited spawning and overwintering habitat in several reaches. On the other hand, abundant westslope cutthroat were found at all the lower stations (below fish barriers?) and rainbow-steelhead were found at the lowest stations (Clearwater Biostudies, Inc., 1997).

The average stream gradient is 14 percent, indicating that sediment should be moving through the system fairly quickly. Current cobble embeddedness is about 27 percent, indicating that sediment is being added to the system. The WATBAL model predicts current sediment production is 13 percent above background, well under the CNF's conservative goal of 55 percent.

It is concluded that Cool Creek is supporting salmonid spawning and should be removed from the 303(d) list for sediment. Road erosion and mass failures associated with roads are contributing some sediment to the system, but the state's narrative sediment standard is met and is not seriously threatened by the degree of erosion taking place in the watershed. It is noted, however, that (1) the majority of sediment being delivered from roads is the result of inadequate and/or inappropriate culvert locations and drainage, and (2) all the mass failures in the Cool Creek watershed occurred in landtype 61, Dissected Breaklands. Water quality would be greatly improved if the CNF were to address the culvert problems.

5.4 Cougar Creek

Cougar Creek is 303(d) listed for sediment. Cougar Creek is a third-order tributary of Quartz Creek and thence of the North Fork Clearwater River in north-central Idaho. Cougar Creek heads on Pot Mountain Ridge and flows in a westerly direction to its confluence with Quartz Creek. Elevations range from 2,350 feet at the confluence to near 6,700 feet on Cold Springs Peak. The higher elevations of this watershed exhibit glacier-derived landforms. The predominant landtypes are Moderate Relief Rolling Uplands, Mountain Slopelands, Rounded Mountain Slopelands, and Dissected Stream Breaklands of mixed and undifferentiated lithologies primarily of schist common to the border zone. Approximately eight percent of the landscape is identified as mass wasted. The predominant mapped bedrock type is Prichard schist with much smaller areas of quartzite.

The BURP evaluation reach is at 2,640 feet elevation, just above where the main road to Quartz Creek crosses Cougar Creek – well down in the lower end of the creek. The CNF temperature recording site is near the mouth of the creek. The 18 percent reach slope of the BURP reach is a steep Rosgen type A channel. The measured discharge on August 7, 1997, was 5.9 cubic feet per second. BURP identified forestry and roading as human activities affecting the reach. Cougar Creek's MBI score is 4.74, its HI score is 119, and it is supporting salmonid spawning as evidenced by two age classes of rainbow trout, including juveniles.

Cougar Creek is identified in the federal regulations as protected for bull trout and it is also listed as a priority bull trout watershed in the state's bull trout problem assessment. Because of the federal listing, the water temperature of Cougar Creek was evaluated using the 10 ^{o}C (50 ^{o}F) MWMT for June through September temperature standard. As can be seen from the three years of stream temperature data for Cougar Creek presented in Appendix 3, stream temperatures exceed the standard for most of July and August. Therefore, Cougar Creek water temperatures exceed the federal numeric standard and a temperature TMDL is required.

Since Cougar Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG plus process to determine if water quality is in fact impaired by sediment.

Road building and timber harvesting have been the major economic activities in the Cougar Creek watershed. Timber harvest has removed approximately 30-40 percent of the canopy in this watershed. The watershed has approximately 24 miles of roads resulting in a density of about 4.8 road miles per square mile of watershed. Notably, about 80 percent of the roads are on high-risk landtypes, but only about six percent of them are within 100 feet of a perennial stream. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. No mass failures were recorded for the 1995-96 rain-on-snow event, although the mass failure hazard rating for the landtypes in this watershed is high. Two relatively new mass failures were observed at the time of field work in summer 2000.

The CNF bio-physical survey identified the following limiting factors for salmonid production: low nutrient levels, migration barriers from very steep stream gradients and large amounts of logging debris, and limited spawning and overwintering habitat in several reaches. Rainbow-steelhead were found only at the lowest fish sampling stations (Clearwater Biostudies, Inc. 1999). The BURP crew also noted steep gradients and migration barriers above its site.

The average stream gradient is 14 percent, indicating that sediment should be moving through the system fairly quickly. Current cobble embeddedness is about 41 percent, indicating that sediment is building up in the system, either through input or the stream's inability to move sediment through the system very well. The WATBAL model predicts current sediment production is 15 percent above background, well under the CNF's conservative goal of 55 percent. Logging debris is probably limiting the ability of the system to transport the sediment.

It is concluded that Cougar Creek is supporting salmonid spawning and should be removed from the 303(d) list for sediment. While it has been noted that salmonids do not occur in the upper reaches, this is most likely the result of natural barriers. Since the water quality in the lower reaches supports its beneficial uses, it must be assumed that the water flowing from above is of equal or better quality.

5.5 Deception Gulch

Deception Gulch is 303(d) listed for sediment. Deception Gulch is a third-order tributary of the North Fork Clearwater River in north-central Idaho. Deception Gulch heads on the Moose Mountains and flows in a large "U" – first flowing to the southeast then turning and flowing north – to its confluence with the North Fork. Elevations range from 3,480 feet at the confluence to nearly 5,700 feet on the Moose Mountains. The predominant landtypes are Moderate Relief Rolling Uplands, Mountain Slopelands, Rounded Mountain Slopelands, and Dissected Stream Breaklands of mixed and undifferentiated lithologies primarily of schist and quartzite common to the border zone. Approximately three percent of the landscape is identified as mass wasted.

The predominant mapped bedrock types are the lower members of the Wallace Formation, which include limestones, dolomites, gneisses, and quartzites, and the Revett Formation quartzite. All of the rocks in this area are highly weathered, decomposed, and unstable. Deception Gulch borders on a major deposit of Tertiary sediments to the south; therefore, it is likely that these rocks have been exposed to weathering for a very long period of time. Revett quartzite weathers to a fine sand that has low bearing strength and erodes easily.

The BURP evaluation reach and the CNF temperature recording site are both located at 3,500 feet elevation, near the mouth of the stream. The 2.5 percent reach slope is typical of a Rosgen type B channel. The measured discharge on August 7, 1997, was 5.1 cubic feet per second. BURP identified forestry and roading as human activities affecting the reach. Deception Gulch's MBI score is 5.86, its HI score is 84, and it is supporting salmonid spawning as evidenced by four age classes of rainbow trout, including juveniles. With a score of only 84, the HI is the lowest of any in the UNFCRS. It is conceivable that the high MBI score is a function of the calcareous bedrock substrate supplying nutrients to maintain an insect population above what otherwise might be expected.

Deception Gulch is not included on the federal list as protected for bull trout, nor is it included on the state's list as a priority bull trout watershed. Therefore, the temperature data for the stream are evaluated using the state's standard for salmonid spawning. Based on the documented presence of westslope cutthroat trout, rainbow trout, and kokanee salmon, and the spawning periods presented in Table 5, the stream is evaluated against the 9 ^{o}C (48.2 ^{o}F) mean daily temperature standard. Temperature data are available only for 2000 and are presented in Appendix 3. The data show that the water temperature begins to exceed the standard by mid-June and continues to until late August. Therefore, a temperature TMDL must be developed for this water body.

Since Deception Gulch is 303(d) listed for sediment and not temperature, we continue following the WBAG plus process to determine if water quality is in fact impaired by sediment.

Road building, mining, and timber harvesting have been the major economic activities in the Deception Gulch watershed. Timber harvest has removed approximately 30 percent of the canopy in this watershed. The watershed has approximately 42 miles of roads resulting in a density of about 9 road miles per square mile of watershed, the highest of any watershed we studied in the UNFCRS. About 50 percent of the roads are on high-risk landtypes. Many of the roads are currently closed or impassable, thus limiting their sediment contribution from surface erosion. However, many of them still represent a high mass failure potential. Twenty-two mass failures were recorded for the 1995-96 rain-on-snow event and two have been recorded since then. This is the second highest number and the highest density of mass failures for any watershed in the UNFCRS. In addition, many of the mass failures had high delivery rates.

The WATBAL model predicts the current sediment production is 28 percent above background, which is still under the CNF's conservative goal of 55 percent. A preliminary CWE assessment of this watershed clearly results in a high sediment delivery rating. The

roads in the watershed receive a delivery score of 46, a high-moderate score, which when coupled with a high mass failure score, results in an overall high sediment delivery rating for the watershed and an identified adverse condition. With these data, the CNF supervisor has recommended to DEQ that Deception Creek be kept on the 303(d) list (Caswell 1997).

It is concluded that Deception Gulch is not fully supporting its beneficial uses and should have a TMDL developed to address the sediment problem. Even though salmonids, including young of the year, have been recorded in the water body, other evidence suggests that sediment is significantly threatening water quality in this watershed. The BURP HI is low for this subbasin. Massive amounts of sediment have been delivered to the stream channel in the last few years, and it is not steep enough to flush the material. Field examinations indicate that the potential is high for additional mass failures. The CNF has examined its own data and recommended that the stream should be retained on the water quality limited list. Idaho's CWE process clearly indicates that the watershed has an adverse condition for sediment. One strong piece of evidence for full support status is the MBI, and it may be skewed by the unique nutrient status of the bedrock in the upper part of the watershed.

5.6 Gravey Creek

Gravey Creek is 303(d) listed for sediment. Gravey Creek is a fourth-order tributary of Cayuse Creek, which then empties into Kelly Creek, which empties into the North Fork Clearwater River. Gravey Creek heads on Indian Grave Peak and flows in a northeasterly direction to its confluence with Cayuse Creek. Elevations range from 3,900 feet at the confluence with Cayuse Creek to 6,980 feet on Horseshoe Lake Lookout. The predominant landtypes are Moderate Relief Uplands; Rounded, Broadly Rounded, and Steep Broadly Rounded Mountain Slopelands; Undissected and Dissected Breaklands; and various alpine glacial landtypes, all derived from undifferentiated rocks, granitics, and grussic granitics. The predominant mapped bedrock types are batholithic granitics with small areas of Wallace Formation quartzite.

A BURP crew collected data at two sites on Gravey Creek – an upper and a lower – with very similar results. The upper site is at 4,800 feet elevation, just below USFS Road 587, while the lower site is at the end of USFS Road 107 at 4,220 feet elevation. The upper site has a four percent reach slope which is a Rosgen type B channel and the lower site has a three percent slope (also Rosgen type B). Most of Gravey Creek is a Rosgen type B channel, with average gradient of 2.6 percent. The measured discharge on July 24, 1997, at the upper site was 5.3 cubic feet per second while the measured discharge on July 25, 1997, at the lower site was 65.7 cubic feet per second. Human activities affecting the reaches include forestry and roads. The Gravey Creek MBI scores are 4.75 at the upper site and 5.15 at the lower site, the HI scores are 106 at the upper site and 95 at the lower site, and salmonid spawning is occurring, as evidenced by three age classes of westslope cutthroat trout, including juveniles.

Gravey Creek is identified in the federal regulations as protected for bull trout and it is listed as a priority bull trout watershed in the state's bull trout problem assessment. Because of the

federal listing, the water temperature of Gravey Creek was evaluated using the 10 ^{o}C (50 ^{o}F) MWMT for June through September temperature standard. As can be seen from the two years of stream temperature data for Gravey Creek presented in Appendix 3, stream temperatures exceed the standard for most of July and August. Therefore, Gravey Creek water temperatures exceed the federal numeric standard and a temperature TMDL is required. However, instantaneous stream temperature readings taken at the BURP sites on July 24, 1997, were well within the standard.

Since Gravey Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG plus process to determine whether or not water quality is in fact impaired by sediment.

Road building and timber harvesting have been the major economic activities in Gravey Creek. Timber harvest has removed approximately 25 percent of the canopy in this watershed. The watershed has approximately 75 miles of roads resulting in a density of about 3 road miles per square mile of watershed. About 12 percent of the roads are with 100 feet of a stream, and five percent are on high-risk landtypes. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. Two landslides were recorded for the 1995-96 event, which results in a very low mass failure density, given the large size of this watershed.

The CNF bio-physical survey identified lack of cover and large woody debris, with a resultant lack of quality pools, as limiting factors for salmonid production. Westslope cutthroat were widespread and were seen at 11 of the 12 fish stations (Isabella Wildlife Works 1998a).

Isabella Wildlife Works listed an average stream gradient of 2.6 percent. Current cobble embeddedness is about 22 percent, which is low for the environment of this stream (i.e., low gradient and granitic parent material). The bank stability index of 4.0, with 135 meters per kilometer of raw banks indicates in-stream erosion producing sediment, which is fairly consistent for streams in granitic landscapes. The WATBAL model predicts current sediment production is 11 percent above background, which is well under the CNF's conservative goal of 55 percent.

It is concluded, therefore, that Gravey Creek is supporting salmonid spawning and should be removed from the 303(d) list for sediment. The evidence indicates that Gravey Creek's water quality fully meets the state's sediment standards and is not being seriously impacted by erosion in the watershed.

5.7 Grizzly Creek

Grizzly Creek is 303(d) listed for sediment. Grizzly Creek is a second-order tributary of Quartz Creek and thence of the North Fork Clearwater River in north-central Idaho. Grizzly Creek heads on Pot Mountain Ridge and flows in a west-northwesterly direction to its confluence with Quartz Creek. Elevations range from 2,200 feet at the confluence to near 6,300 feet on Pot Mountain Ridge. The higher elevations of this watershed exhibit glacier-

derived landforms. The predominant landtypes are Mountain Slopelands, Rounded Mountain Slopelands, Glaciated Cirque Headwalls, and Stream Breaklands of mixed and undifferentiated lithologies primarily of schist common to the border zone. Approximately 19 percent of the landscape is identified as mass wasted. The predominant mapped bedrock type is Prichard schist and quartzite with much smaller areas of glacial debris, granitic migmatites, and Wallace schist/gneiss/amphibolite.

The BURP evaluation reach is at 3,240 feet elevation. The CNF temperature recording site is near the mouth of the stream. The 21 percent reach slope of the BURP site is steep even for a Rosgen type A channel. The measured discharge on August 9, 1997, was 4.8 cubic feet per second. BURP identified forestry and roading as human activities affecting the reach. Grizzly Creek's MBI score is 5.12, its HI score is 95, and it is supporting salmonid spawning as evidenced by two age classes of rainbow trout, including juveniles.

Grizzly Creek is identified in the federal regulations as protected for bull trout and it is also listed as a priority bull trout watershed in the state's bull trout problem assessment. Because of the federal listing, the water temperature of Grizzly Creek was evaluated using the 10 ^{o}C (50 ^{o}F) MWMT for June through September temperature standard. As can be seen from the four years of stream temperature data for Grizzly Creek presented in Appendix 3, stream temperatures exceed the standard for most of July and August. Therefore, Grizzly Creek water temperatures exceed the federal numeric standard and a temperature TMDL is required.

Since Grizzly Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG plus process to determine whether or not water quality is in fact impaired by sediment.

Road building and timber harvesting have been the major economic activities in the Grizzly Creek watershed. Timber harvest has removed approximately 40-50 percent of the canopy in this watershed. The watershed has approximately 25 miles of roads resulting in a density of about 5.8 road miles per square mile of watershed. About 80 percent of these roads occur in high-risk landtypes, while only about five percent are within 100 feet of a perennial stream. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. No mass failures were recorded for the 1995-96 rain-on-snow event, although the mass failure hazard rating for the landtypes in this watershed is high and 19 percent of this watershed is mass wasted. One relatively new mass failure was observed at the time of field work in summer 2000.

The CNF bio-physical survey identified the following limiting factors for salmonid production: low nutrient levels, migration barriers from both very steep stream gradients and large amounts of logging debris, and limited spawning and overwintering habitat in several reaches. Rainbow-steelhead were found only at the lowest fish sampling stations (Clearwater Biostudies, Inc., 1999). The BURP crew also noted steep gradients and migration barriers at its site. The Clearwater Biostudies crew also noted a stream blowout causing the stream to go subsurface and logging activity down to the streamside – a violation of the FPA rules.

The average stream gradient is 15 percent, indicating that sediment should be moving through the system fairly quickly. Current cobble embeddedness is about 35 percent, indicating that sediment may be building up in the system, either through input or the stream's inability to move sediment through the system very well. The WATBAL model predicts current sediment production is 28 percent above background, well under the CNF's conservative goal of 55 percent. Logging debris probably is limiting the ability of the system to transport the sediment.

It is concluded that Grizzly Creek is supporting salmonid spawning and should be removed from the 303(d) list for sediment. While it has been noted that salmonids do not occur in the upper reaches, this is most likely the result of very steep stream gradients and natural barriers. Since the water quality in the lower reaches supports its beneficial uses, it must be assumed that the water flowing from above is of equal or better quality.

5.8 Hem Creek

Hem Creek is 303(d) listed for sediment. Hem Creek is a third-order tributary of Sylvan Creek, which then empties into French Creek, and thence into Orogrande Creek, and finally into the North Fork Clearwater River. Hem Creek heads on Hemlock Butte and flows in a northeasterly direction to its confluence with Sylvan Creek. Elevations range from 4,000 feet at the confluence to 6,000 feet on Hemlock Butte. The predominant landtypes are Moderate Relief Uplands, Mountain Slopelands, and Rounded Mountain Slopelands, all derived from granitics, metasedimentary schists, and undifferentiated rocks. The predominant mapped bedrock types are Wallace Formation schist, gneiss, and amphibolite. In addition, there is a small area of St. Regis Formation schist.

BURP crews evaluated sites at the lower end of Hem twice – once in 1997 and again in 1998 – with very similar results. The 1997 reach is at 4,040 feet elevation, about 60 feet above the confluence of Joy Creek with Hem Creek, while the 1998 site is about 0.25 mile upstream from the confluence with Sylvan Creek at 5,020 feet. The 1997 site has a four percent slope which is on the low end of a Rosgen type A channel, and the 1998 site has an eight percent slope (Rosgen type A). Most of Hem Creek is a Rosgen type B channel, with an average slope of five percent. The measured discharge on August 7, 1997, was 10 cubic feet per second, while the measured discharge on August 5, 1998, was 6.7 cubic feet per second. Human activities affecting the reach include forestry and roads. DEQ 1996 WBAG results indicate that Hem Creek is fully supporting its beneficial uses because its 1997 MBI score is 5.34 (1998 MBI score is 5.55), its 1997 HI score is 105 (1998 HI score is 111), and it is supporting salmonid spawning as evidenced by three age classes of westslope cutthroat trout, including juveniles.

Hem Creek is not listed by either federal regulations or the state's bull trout problem assessment as a stream to be protected for bull trout. Therefore, the stream temperature was assessed using the cutthroat temperature standards shown in Table 5, where mean daily temperatures shall be less than or equal to 9 ^{o}C (48.2 ^{o}F) from April through July. As shown by the temperature data for Hem Creek in Appendix 3, mean daily temperatures at the mouth of Hem Creek begin to exceed 9 ^{o}C (48.2 ^{o}F) by early to mid-July and continue throughout

the month. Therefore, Hem Creek water temperatures exceed the state's numeric standard. However, there is a large degree of variability from year to year.

Some particular conditions apply to Hem Creek. First, the time period and degree of temperature exceedance for Hem Creek is the least of any streams evaluated in the UNFCRS. Second, the Hem Creek watershed has only had a small amount of logging, and no trees were removed from the streamside zone (i.e., no shade has been removed from the SPZ), and it is in a nearly natural condition. The CWE model being used in this subbasin to determine the adequacy of stream shading to protect stream temperatures shows that Hem Creek has adequate canopy closure and shading (See Loading Allocation Map for Orogrande Creek, Appendix 4). Therefore, we conclude that the temperature exceedance in Hem Creek is a natural condition and no TMDL is necessary.

Since Hem Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG process to determine whether or not water quality is in fact impaired by sediment.

Hem Creek is in a largely unroaded watershed with only a few logging roads in the lower end and a road along the ridge. Timber harvest has removed less than 10 percent of the canopy in this watershed. The watershed has approximately 17 miles of roads resulting in a density of about 2.8 road miles per square mile of watershed. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. No landslides were recorded for the 1995-96 rain-on-snow event and none were identified during a CWE assessment in 1999.

The CNF bio-physical survey did not identify any limiting factors for salmonid production except a possible natural migration barrier in the upper reach. Westslope cutthroat were widespread and were seen at four of the five fish stations on Hem Creek (Clearwater Biostudies, Inc. 1998a).

Clearwater Biostudies listed an average stream gradient of five percent. Current cobble embeddedness is about 29 percent, which is low for the environment of this stream. The WATBAL model predicts current sediment production is five percent above background, well under the CNF's conservative goal of 55 percent. Given the largely unroaded nature of the drainage, these figures seem realistic.

The IDL conducted a CWE assessment for the entire French Creek watershed in 1999, which includes Hem Creek. When the data for Hem Creek were sorted from the rest of the watershed data, no adverse conditions were identified using the CWE protocols.

It is concluded, therefore, that Hem Creek is fully supporting its beneficial uses and should be removed from the 303(d) list for sediment. The evidence indicates that Hem Creek's water quality fully meets the state's water quality standards. No particular threats to water quality were identified in this watershed.

5.9 Laundry Creek

Laundry Creek is 303(d) listed for sediment. Laundry Creek is a third-order tributary of Osier Creek, which then empties into Moose Creek, and then into Kelly Creek, and into the North Fork Clearwater River. Laundry Creek heads on Osier Ridge and flows in a south-southwesterly direction to its confluence with Osier Creek. Elevations range from 3,480 feet at the confluence to 5,400 feet on Osier Ridge. The predominant landtypes are Moderate Relief Uplands, Mountain Slopelands, Rounded Mountain Slopelands, and Dissected Stream Breaklands, all derived from metasedimentary quartzites and undifferentiated rocks. The predominant bedrock types are Lower Wallace Formation interbedded gneissic quartzite, limestone, dolomite, and siltstone.

The BURP-evaluated reach is at 3,840 feet elevation. The CNF temperature site is nearer the mouth at approximately 3,500 feet elevation. The nine percent slope of the BURP-evaluated reach is typical of a Rosgen type A channel; however, most of Laundry Creek is a Rosgen type B channel, with an average slope of 5.5 percent. The measured discharge on July 28, 1997, was 3.3 cubic feet per second. Human activities affecting the reach include forestry and roads. The Laundry Creek MBI score is 4.83, its HI score is 121, and it is supporting salmonid spawning as evidenced by three age classes of westslope cutthroat trout, including juveniles.

Laundry Creek is identified in the federal regulations as protected for bull trout; however, it is not listed as a priority bull trout watershed in the state's bull trout problem assessment. Because of the federal listing, the water temperature of Laundry Creek was evaluated using the 10 ^{o}C (50 ^{o}F) MWMT for June through September temperature standard. As can be seen from the stream temperature data for Laundry Creek presented in Appendix 3, stream temperatures exceed the standard for most of July and August. Therefore, Laundry Creek water temperatures exceed the federal numeric standard and a temperature TMDL is required.

Since Laundry Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG plus process to determine whether or not water quality is in fact impaired by sediment.

Laundry Creek has been subjected to extensive road building and timber harvesting activities. Timber harvest has removed approximately 50 percent of the canopy in this watershed. The watershed has approximately 22 miles of roads resulting in a density of about 7.6 road miles per square mile of watershed. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. Laundry Creek was one of the watersheds most heavily impacted by the 1975-76 rain-on-snow landslide event. Three landslides with considerable delivery were recorded for the 1995-96 event.

The CNF bio-physical survey identified limiting factors for salmonid production as "very high levels of streambed sedimentation and shallow pool depths." They also noted low stream flows of 1.8 cubic feet per second when they completed their survey in July 1994. "Streambed particles in non-riffle habitats … are dominated by fine sediment which would

be easily mobilized by high spring flows." On the other hand, "westslope cutthroat were widespread and were seen at all 10 of the fish stations…." Rainbow-steelhead were observed at two of the lower stations in Laundry Creek (Clearwater Biostudies, Inc. 1995a).

The average stream gradient is 5.5 percent, which, with a small stream flow, limits the system's ability to move sediment. Current cobble embeddedness is about 53 percent, which is high for this system. It can be compared to 43 percent for Swamp Creek, which is unroaded with similar geology and landtypes. The WATBAL model predicts current sediment production is 12 percent above background, well under the CNF's conservative goal of 55 percent.

It is concluded that Laundry Creek is fully supporting its beneficial uses in terms of salmonid spawning and should be removed from the 303(d) list for sediment. It is noted that road erosion and mass failures associated with roads are contributing some sediment to the system, but the evidence indicates that Laundry Creek's water quality meets the state's sediment standards and is not seriously threatened by the degree of erosion currently taking place in the watershed. The water quality condition probably is continuing to improve from the 1975-76 event. It is noted, however, that (1) the majority of sediment being delivered from roads is the result of inadequate and/or inappropriate culvert locations and drainage, and (2) this watershed does have one of the highest road densities of any in the UNFCRS. The water quality would be greatly improved if the CNF were to address these problems.

5.10 Marten Creek

Marten Creek is 303(d) listed for sediment. Marten Creek is a third-order tributary of Gravey Creek, which flows into Cayuse Creek, then into Kelly Creek, and finally into the North Fork Clearwater River. Marten Creek heads near Marten Hill and flows in a northeasterly direction to its confluence with Gravey Creek. Elevations range from 4,200 feet at the confluence with Gravey Creek to near 6,000 feet on the ridge surrounding the watershed. The watershed is located in a fairly featureless mountain upland. The predominant landtypes are Rounded, Broadly Rounded, and Steep Broadly Rounded Mountain Slopelands, with lesser amounts of Undissected and Dissected Breaklands, all derived from undifferentiated granitics and grussic granitics. The predominant mapped bedrock types are batholithic granitics with small areas of Wallace Formation quartzite.

The BURP data collection site is at 4,560 feet elevation near the confluence with False Creek. The site has a 2.5 percent gradient, which is a Rosgen type B channel. The measured discharge on July 24, 1997, was 14.6 cubic feet per second. Human activities affecting the reaches include forestry, recreation, and roads. Marten Creek's MBI score is 4.95, its HI score is 111, and it supports salmonid spawning as evidenced by two age classes of westslope cutthroat trout, including juveniles.

Marten Creek is identified in the federal regulations as protected for bull trout. It is not listed as a priority bull trout watershed in the state's bull trout problem assessment, although it can reasonably be considered a part of Gravey Creek, which is. Because of the federal listing, the water temperature of Marten Creek should be evaluated using the 10 ^{o}C (50 ^{o}F) MWMT

for June through September temperature standard. However, the only temperature datum available is one instantaneous reading taken by the BURP crew and this is inadequate to make a definitive determination of a temperature exceedance.

However, since we are evaluating Marten Creek in the context of the UNFCRS subbasin, we think there are good reasons to develop a temperature TMDL for Marten Creek at this time. Marten Creek is an integral part of the Gravey Creek watershed, for which a temperature TMDL is being developed. Within Idaho's administrative rules, Marten Creek is considered the same water body as Gravey Creek (IDAPA 58.01.02.109.09: C-22). Also, given the fact that no other water body in the subbasin meets the federally promulgated temperature standard for bull trout, there is no reason to assume that Marten Creek does. Finally, as we allocate shading for Gravey Creek to meet its bull trout temperature requirements, Marten Creek will receive a shading reduction allocation due to locational proximity and integrity of the watershed.

The most consistent resolution to the question of Marten Creek would be to integrate it into Gravey Creek on the 303(d) list. In light of the remote likelihood of that happening in the near future, we shall proceed with the development of a temperature TMDL for Marten Creek.

Since Marten Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG plus process to determine if quality is in fact impaired by sediment.

Road building and timber harvesting have been the major economic activities in Marten Creek. Timber harvest has removed approximately 20 percent of the canopy in this watershed. The watershed has approximately 16 miles of roads resulting in a density of about 2.6 road miles per square mile of watershed. Approximately 25 percent of the roads are with 100 feet of a stream, which is a high percentage. Only two percent of the roads are on high-risk landtypes. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. Four landslides were recorded for the 1995-96 rain-on-snow event, resulting in a moderate landslide density.

The CNF bio-physical survey identified relatively high cobble embeddedness and a lack of spawning gravels as limiting factors for salmonid production. In addition, a migration barrier exists in the upper reach. Westslope cutthroat were widespread and were seen at all six fish stations on Marten Creek (Isabella Wildlife Works 1998a).

Isabella Wildlife Works listed an average stream gradient of 4.2 percent. Current cobble embeddedness is about 31 percent, which is moderate for the environment of this stream (i.e., low gradient and granitic parent material). The bank stability index of 4.0 with 113 meters per kilometer of raw banks indicates in-stream erosion producing sediment, which is fairly consistent for streams in granitic landscapes. The WATBAL model predicts the current sediment production is 20 percent above background, well under the CNF's conservative goal of 55 percent.

It is concluded, therefore, that Marten Creek is supporting salmonid spawning and should be removed from the 303(d) list for sediment. The evidence indicates that Marten Creek's water quality meets the state's sediment standards and is not being seriously impacted by erosion in the watershed.

5.11 Middle Creek

Middle Creek is 303(d) listed for sediment. Middle Creek is a fourth-order tributary of Weitas Creek, which then empties into the North Fork Clearwater River. Middle Creek heads on Snowy Summit and flows in a north-northeasterly direction to its confluence with Weitas Creek. Elevations range from 2,880 feet at the confluence to 6,000 feet on Snowy Summit. The predominant landtypes are Low and Moderate Relief Uplands, Mountain Slopelands, Rounded Mountain Slopelands, and Dissected Stream Breaklands, mostly derived from granitics and undifferentiated rocks. Some of the higher elevation landforms reflect glaciation. The predominant mapped bedrock types are Wallace Formation impure quartzite and calc silicates and Cretaceous granitics.

The BURP-evaluated reach is at 3,880 feet elevation, near the bridge of USFS Road 103. The CNF temperature recording site is near the mouth of the creek. The four percent slope of the BURP site is typical of a Rosgen type B channel. Most of Middle Creek is a Rosgen type B channel, with an average slope of 3.8 percent. The measured discharge on August 10, 1997, was 16.5 cubic feet per second. Human activities affecting the reach include logging and roads. Middle Creek's MBI score is 4.96, its HI score is 105, and it is supporting salmonid spawning as evidenced by three age classes of westslope cutthroat trout, including juveniles.

Middle Creek is identified in the federal regulations as protected for bull trout; it is also listed as a priority bull trout watershed in the state's bull trout problem assessment. Because of the federal listing, the water temperature of Middle Creek was evaluated using the 10 ^{o}C (50 ^{o}F) MWMT for June through September temperature standard. As can be seen from the stream temperature data for Middle Creek presented in Appendix 3, stream temperatures exceed the standard for most of July and August. Therefore, Middle Creek water temperatures exceed the federal numeric standard and a temperature TMDL is required.

Since Middle Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG plus process to determine whether or not water quality is in fact impaired by sediment.

Middle Creek has been subjected to some road building and timber harvesting activities. Timber harvest has removed less than 10 percent of the canopy in this watershed. The watershed has approximately 43 miles of roads resulting in a density of about 1.6 road miles per square mile of watershed. Approximately 22 percent of the roads are on high hazard landtypes, and seven percent of them are within 100 feet of a perennial stream. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. Fourteen landslides with moderate delivery were recorded for the 1995-96 rain-on-snow event. While

the number of mass failures is high, this is a large watershed, such that the mass failure density is only 0.5 per square mile.

The CNF bio-physical survey did not identify any particular limiting factors for salmonid production. The channel stability rating of four, with 124 meters per kilometer of raw banks (high for this subbasin), is a result of the fact that the stream alternates between Rosgen A and B type channels. The type B channels exhibit some bank instability, which, Isabella Wildlife Works comments, "contributes to fish habitat." Rainbow-steelhead are abundant at the lower sampling stations in Middle Creek and cutthroat trout are abundant in all of the upper reaches (Isabella Wildlife Works 1998b).

The average stream gradient is 3.8 percent, which, when coupled with the large stream flow, contributes to the system's ability to move sediment. Current cobble embeddedness is about 19 percent, which is low for a granitic watershed. The Isabella Wildlife Works crew commented often about the low cobble embeddedness of this stream. The WATBAL model predicts current sediment production is 17 percent above background, well under the CNF's conservative goal of 55 percent. A preliminary CWE road score of 28 coupled with the low mass failure density helps substantiate the conclusion that sediment delivery to this system is low.

We have concluded that Middle Creek is supporting salmonid spawning and should be removed from the 303(d) list for sediment. Road erosion and mass failures associated with roads are contributing some sediment to the system, but the evidence indicates that Middle Creek's water quality meets the state's water quality standards for sediment and is not seriously threatened by the degree of erosion currently taking place in the watershed. It is further noted that (1) the majority of sediment being delivered from roads is the result of inadequate and/or inappropriate culvert locations and drainage, and (2) most of the mass failures in the watershed are associated with roads. The case for water quality would be greatly improved if the CNF were to address these problems.

5.12 Upper Orogrande Creek

Orogrande Creek as a whole is 303(d) listed for sediment. For the purposes of this assessment, we divided Orogrande Creek into two segments, an upper and a lower segment, divided at the confluence of Orogrande Creek and French Creek. (French Creek and its tributaries form another water body unit within which occur Hem and Sylvan Creeks, which are assessed in sections 5.8 and 5.17, respectively, of this report.) This division is consistent with the water body units described in IDAPA 58.01.02.120.09. The preponderance of the upper Orogrande Creek watershed is managed by Potlatch Corporation and IDL, while the lower Orogrande Creek watershed is managed by the CNF.

Upper Orogrande Creek is a fifth-order tributary of lower Orogrande Creek (below where it meets French Creek), which then empties into the North Fork Clearwater River. Upper Orogrande Creek heads on the French Mountain ridge and flows in a generally easterly direction to its confluence with French Creek. The watershed as delineated for this

assessment includes Orogrande Creek to its headwaters, plus the South Fork, Breakfast, Crystal, Silver, and Elk Creek watersheds.

Elevations range from 3,200 feet at the confluence to over 5,000 feet on the French to Elk Mountain ridge. Predominant landtypes are Low and Moderate Relief Uplands, mostly derived from grussic granitics (highly weathered granitics) and undifferentiated rocks. These are significantly different landtypes and bedrock from the rest of this subbasin. The watershed is unique in the UNFCRS in that it is a moderately rolling granitic plateau with a very fine dendritic drainage pattern. Steep canyon lands typical of the UNFCRS only occur where Orogrande Creek cuts down to meet French Creek, comprising no more than 5-10 percent of the watershed. The predominant mapped bedrock type is Cretaceous granite, grading into border zone Wallace Formation gneiss on the eastern border.

Upper Orogrande Creek has been subjected to intensive road building and timber harvesting activities and some placer mining activity. This watershed, being relatively gentle and productive terrain in proximity to Pierce and Headquarters, is some of the best timber producing land in north Idaho. Whereas the primary data source for the other creeks and watersheds in this assessment has been the CNF, the primary data source for this watershed is the state of Idaho's CWE assessment conducted in 1999, although some CNF data are available too.

Over the last 50-75 years, timber harvest has removed at least 80-90 percent of the original canopy in this watershed. Much of the canopy has recovered such that the CWE assessment of this watershed calculated a 40-50 percent canopy removal index, meaning that 40-50 percent of the watershed has a canopy condition of less than full hydrologic interception. While this figure is high, it is not out of the range of some other watersheds in this subbasin. In addition, the CWE ranks the canopy removal index against the stability of the streams in a watershed to determine whether canopy removal may be impacting water quality through stream channel destabilization. The canopy removal plotted against the channel stability ratings (which are moderate) for upper Orogrande results in a moderate hydrologic risk rating. This rating indicates that forestry as currently being practiced has potential to be impacting water quality, but it is not considered to be an "adverse condition," as defined by the CWE methodology.

The BURP-evaluated reach is at 3,360 feet elevation, just below the confluence of Elk Creek with Orogrande Creek. The CNF temperature recording station is just above the confluence with Elk Creek. The three percent reach slope is typical of a Rosgen type B channel; most of upper Orogrande Creek is a Rosgen type B channel. The measured discharge on August 8, 1997, was 39.3 cubic feet per second. Human activities affecting the reach include forestry, mining, recreation, and roads. The DEQ 1996 WBAG results indicate that upper Orogrande Creek exceeds the water quality temperature standard and is not fully supporting its beneficial uses because its MBI score is 3.26 and only one age class of adult westslope cutthroat and rainbow trout were collected at the site. The HI score of 110 is high. In addition, there is anecdotal evidence of fishable populations of salmonids higher in the watershed.

Orogrande Creek is not listed by either the federal regulations or the state's bull trout problem assessment as a stream to be protected for bull trout. Therefore, the stream temperature was assessed using the cutthroat temperature standards shown in Table 5, where mean daily temperature shall be less than or equal to 9 ^{o}C (48.2 ^{o}F) from April through July. As shown by the temperature data for upper Orogrande Creek in Appendix 3, mean daily temperatures at the mouth of Elk Creek begin to exceed 9 ^{o}C (48.2 ^{o}F) by mid-June and continue throughout the month of July. Therefore, upper Orogrande Creek water temperatures exceed the state's numeric standard and a temperature TMDL is required.

Since upper Orogrande Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG process to determine whether or not water quality is in fact impaired by sediment.

The watershed has approximately 250 miles of roads resulting in a density of 8.1 road miles per square mile of watershed, the second highest in the subbasin after Deception Gulch. About 13 percent of the roads are within 100 feet of a stream. Unlike many roads on CNF land that have been more-or-less permanently closed or abandoned, roads in this watershed are generally open and maintained for continuous forestry practices. Some roads are temporarily gated and grassed to minimize erosion, but the road system is maintained for the purposes of harvesting timber.

Nine mass failures were recorded in this watershed from the 1995-96 event, but with the size of the watershed, the density of mass failures is only about one for every three square miles (0.3 per square mile, which is low). The bank stability index from both CWE and the CNF bio-physical survey is moderate, indicating some contribution of sediment from instream erosion.

The CNF bio-physical survey covered the portion of Orogrande Creek below the confluence with Elk Creek, approximately the lower mile of the stream. The average stream gradient in this lower reach is two percent (Rosgen type B channel). Channel stability ranged from fair to good and cobble embeddedness is about 22 percent. The survey did not identify any salmonids in this reach (Clearwater Biostudies, Inc. 1998a). The general comments from Clearwater Biostudies, Inc. were, "Characteristic stream features were a wide channel with low to moderate gradients, a high width/depth ratio, and poor bank cover; low pool frequency; frequent influence by USFS Road 250; and signs of recent substantial bedload movement…the presence of moderate to large quantities of materials deposited by recent landslides or debris torrents…." Clearwater Biostudies, Inc. also identified the following limiting factors, "3) Limited availability of good spawning habitat for resident trout…6) Suspected high summer water temperatures in mainstem Orogrande Creek…."

Two CWE reports cover the rest of the watershed: one for Elk Creek and the other for upper Orogrande Creek above Elk Creek. Of the 250 miles of road in this watershed, CWE crews evaluated almost half of them, primarily those close to streams that had potential for sediment delivery. The CWE road sediment delivery score for both the Orogrande and Elk Creek watersheds is 23, which is low. The CWE did not evaluate the road from Elk Creek down to the confluence with French Creek. However, a preliminary evaluation of this road,

which closely follows the creek, indicates that it has a high sediment delivery rating of 51. Weighing in this score would still result in a low road sediment delivery rating for this watershed.

The CWE identified three mass failures in this watershed, resulting in a low mass failure sediment delivery score. The CNF 1995-96 landslide inventory identified an additional six mass failures along the road from Elk Creek to French Creek, all of which probably had moderate to high delivery. Adding these into the CWE score for the total watershed would at most result in a moderate mass failure sediment delivery score. Therefore, even after adding in the effects of the road from Elk Creek to French Creek, the total CWE sediment delivery rating for upper Orogrande Creek is low.

In spite of the fact that 1996 WBAG process results in a conclusion that upper Orogrande Creek is not fully supporting its beneficial uses, it is not at all clear that sediment is the problem pollutant. There is no significant source of sediment, and a cobble embeddedness of 22 percent does not indicate a buildup of sediment in the stream. We conclude, therefore, that a TMDL for sediment is not warranted, that the problem-causing pollutant was misidentified on the 303(d) list, and that the listing should be changed to show temperature as the pollutant.

It is concluded, therefore, that upper Orogrande Creek is not fully supporting its beneficial uses; however, the major cause of the problem is temperature exceedance rather than sediment. A temperature TMDL needs to be developed.

Road erosion, in-stream erosion, and mass failures associated with roads are contributing some sediment to the system, but the low cobble embeddedness score indicates that upper Orogrande Creek is flushing the sediment on through and water quality is not seriously threatened by the degree of erosion currently taking place in the watershed. It is further noted that (1) the majority of sediment being delivered from roads is the result of inadequate and/or inappropriate culvert locations and drainage, and (2) most of the mass failures in the watershed are associated with roads. The water quality would be greatly improved if IDL, Potlatch Corporation, and the CNF were to address these problems.

5.13 Lower Orogrande Creek

Orogrande Creek as a whole is 303(d) listed for sediment. For the purposes of this assessment, we divided Orogrande Creek into two segments, an upper and a lower segment, divided at the confluence of Orogrande Creek and French Creek. (French Creek and its tributaries then become another water body unit within which occur Hem and Sylvan Creeks which are assessed in sections 5.8 and 5.17, respectively, of this report.) This division is consistent with the water body units described in IDAPA 58.01.02.120.09. The preponderance of the upper Orogrande Creek watershed is managed by Potlatch Corporation and IDL, while the lower Orogrande Creek watershed is managed by the CNF.

Lower Orogrande Creek is a sixth-order tributary of the North Fork Clearwater River. Lower Orogrande Creek has feeder tributaries that head on French Mountain, Elk Mountain, Clark

Mountain, and Hemlock Ridge. Lower Orogrande Creek flows in a northeasterly direction to its confluence with the North Fork Clearwater River. The watershed as delineated for this assessment includes the lower Orogrande Creek mainstem, plus the Elbow, Cache, Shake, Grand, Cottonwood, Hook, Knute, Jazz, Tama, Fir, Fuzzy, and Mill Creeks' side tributary watersheds. The major side tributaries of Pine and Tamarack Creeks, while technically part of the DEQ lower Orogrande water body unit, are treated separately. The assessment of Tamarack Creek is included herein as Section 5.18 because it is 303(d) listed separately.

Elevations of the lower Orogrande Creek being considered here range from 2,200 feet at the confluence with the North Fork Clearwater River, to 5,800 feet on Elk Mountain, to over 5,000 feet on most of the watershed divides on both sides. The predominant landtypes are Moderate Relief Uplands, Mountain Slopelands, and Stream Breaklands, derived from a wide range of granitic, metamorphic, and undifferentiated rocks. Nearly three percent of the watershed is identified as mass failures. The predominant mapped bedrock type is Cretaceous granite, intermixed with border zone Wallace Formation gneiss, schist, quartzite, and calc-silicates.

The BURP evaluated reach is at 2,880 feet elevation, just below the confluence of Tamarack Creek with Orogrande Creek. The 2.5 percent reach slope is typical of a Rosgen type B channel; most of lower Orogrande Creek is a Rosgen type B channel. The measured discharge on August 8, 1997, was 76.5 cubic feet per second. Human activities affecting the reach include forestry, roads, and recreation. The DEQ 1996 WBAG results indicate that lower Orogrande Creek is not fully supporting its beneficial uses because of a major temperature exceedance. However, the MBI score is 5.00 and three age classes of salmonids, including juveniles, have been identified in the stream. In addition, the HI score of 114 is high.

Similar to the upper Orogrande Creek segment, temperature data (see Appendix 3) clearly show that stream temperatures exceed the state's water quality standards for most of June and July, based on the spawning needs of cutthroat and rainbow trout. The CNF temperature recording station is near the mouth. Virtually none of the lower Orogrande Creek mainstem from the French Creek confluence to the North Fork Clearwater River has adequate shading to protect stream temperatures, based on FPA standards. Therefore, we conclude that a TMDL for temperature should be developed for lower Orogrande Creek.

Also similar to upper Orogrande Creek, the question then becomes whether sediment is also a pollutant of this stream in a magnitude that warrants development of a TMDL for sediment. The average cobble embeddedness for lower Orogrande Creek is 25 percent, which is low. Tamarack Creek, a major tributary of lower Orogrande Creek, is discussed in section 5.18, where it is concluded that it is not sediment impaired. Similarly, Hem and Sylvan Creeks, tributaries to French Creek, are evaluated in this assessment and concluded not to be sediment impaired either. CWE assessments were conducted on French Creek, Elk Creek, and upper Orogrande Creek. These are the major tributaries of lower Orogrande Creek and all were identified as having low total sediment delivery scores.

Lower Orogrande Creek has been subjected to extensive road building and timber harvesting and some mining activities. Timber harvest has removed about 50-60 percent of the canopy in this watershed. Based on the CNF GIS roads layer, the watershed has approximately 106 miles of roads resulting in a density of about 6.1 road miles per square mile of watershed. About 36 percent of the roads are within 100 feet of a perennial stream, the highest percentage for any watershed studied in this subbasin. Twenty-six percent of the roads are on high-risk landtypes. However, since 1995, the CNF has obliterated 51 miles of roads in the watershed, and it is not known how much of this activity has been transferred to GIS. The GIS-developed data for road density, roads on hazardous landtypes, and roads close to streams may be incorrect. Many roads are currently closed or impassable, thus limiting their sediment contribution, and there are plans to close and/or obliterate others.

Lower Orogrande Creek was one of the areas most heavily impacted by the 1995-96 rain-on-snow landslide event. Approximately 50 landslides with moderate to heavy delivery were identified from the event. These result in a density of 2.9 per square mile, the second highest density in this subbasin.

The major sediment sources that appear to have contributed significant amounts of sediment are the mass failures in winter 1995-96 along the lower mainstem, Pine Creek, Hook Creek and Jazz Creek. Still, the 25 percent cobble embeddedness score measured in summer 1997 immediately after the event indicates that the large flow of lower Orogrande Creek is moving the sediment through the system. Good MBI and HI scores, and the presence of three age classes of rainbow trout, indicate that the system is in relatively good shape in spite of the temperature exceedances.

Therefore, we conclude that a sediment TMDL is not necessary. Lower Orogrande Creek should be 303(d) listed for temperature only, and a temperature TMDL should be developed for this stream. Road erosion, in-stream erosion, and especially mass failures associated with roads are contributing sediment to the system, but low cobble embeddedness indicates that lower Orogrande Creek is flushing the sediment on through and water quality is not seriously threatened by the degree of erosion currently taking place in the watershed. It is further noted that (1) the majority of sediment being delivered from roads is the result of inadequate and/or inappropriate culvert locations and road drainage, and (2) most of the mass failures in the watershed are associated with roads. Water quality would be greatly improved if the CNF were to address these problems.

5.14 Osier Creek

Osier Creek is 303(d) listed for sediment, temperature, flow, and habitat alteration. This assessment does not address flow and habitat alteration issues because Section 303(d) of the CWA does not required that these parameters be addressed. We evaluate herein the need for TMDLs for sediment and temperature.

Osier Creek is a fifth-order tributary of Moose Creek, which flows into Kelly Creek. Osier Creek heads on Osier Ridge and flows in a southerly direction to its confluence with Moose Creek. Elevations range from 3,320 feet at the confluence to over 5,600 feet on Spring Hill.

The predominant landtypes are Moderate Relief Uplands, Mountain Slopelands, Rounded Mountain Slopelands, and Dissected Stream Breaklands derived from metasedimentary quartzites, Revett quartzite, and other undifferentiated rocks. The predominant mapped bedrock type is Lower Wallace Formation interbedded gneissic quartzite, limestone, dolomite, and siltstone, with much smaller areas of Revett Formation quartzite and Tertiary sediments. The presence of Tertiary sediment in this relatively gentle terrain indicates that the Osier Creek watershed is part of a landscape that has been exposed to weathering for a long period of time. Therefore, much of the bedrock is highly weathered, decomposed, and incompetent.

Two BURP evaluation reaches were completed for Osier Creek –an upper and a lower. The lower site at 3,320 feet elevation has a three percent reach slope typical of a Rosgen type B channel. This is also the general location of the CNF temperature records presented in Appendix 3. The measured discharge on July 29, 1997, was 52 cubic feet per second (this site is below and includes all the inflow from China, Laundry, Sugar, Pollack, and Swamp Creeks). The BURP crews identified forestry, mining, and recreation as human activities affecting the reach. The lower Osier Creek site has an MBI score of 4.59, an HI score of 102, and salmonid spawning as evidenced by three age classes of westslope cutthroat trout, including juveniles.

The upper Osier Creek BURP site at 3,960 feet elevation has a six percent slope and is classified as a Rosgen type A channel. The measured discharge on July 26, 1997, at this upper site was 6.9 cubic feet per second (this site is above the confluence with China Creek, but below the confluence of Osier and West Osier). The BURP crews identified forestry, mining, roads, and recreation as human activities affecting the reach. Upper Osier Creek is supporting salmonid spawning as evidenced by the presence of three age classes of salmonids, including juveniles. The HI score is 104, but the MBI score for the reach is only 3.31.

Osier Creek is identified in the federal regulations as protected for bull trout; however, it is not listed as a priority bull trout watershed in the state's bull trout problem assessment. Because of the federal listing, the water temperature of Osier Creek was evaluated using the 10 ^{o}C (50 ^{o}F) MWMT for June through September temperature standard. As can be seen from the stream temperature data for Osier Creek presented in Appendix 3, stream temperatures exceed the standard for most of July, all of August, and into September. Therefore, Osier Creek water temperatures exceed the federal numeric standard and a temperature TMDL is required.

Since Osier Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG plus process to determine whether or not water quality is in fact impaired by sediment.

Osier Creek has been subjected to extensive road building, timber harvesting, and mining. Timber harvest has removed about 40-50 percent of the canopy in this watershed. The watershed has approximately 52 miles of roads resulting in a density of about 6.7 road miles per square mile of watershed. About 13 percent of the roads are within 100 feet of a stream,

and approximately the same percentage of roads are on hazardous landtypes. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. Osier Creek was one of the watersheds most heavily impacted by the 1975-76 rain-on-snow landslide event. In addition, five landslides with moderate delivery were identified for the 1995-96 event. Placer mining in the late 1800s and early 1900s severely impacted Pioneer Gulch and channelized parts of Osier Creek below the confluence with Pioneer Gulch.

The CNF bio-physical survey identified limiting factors for salmonid production as "…high sediment loads present in reaches 10 through 13 of Osier Creek (upper Osier), and both reaches of the West Fork of Osier Creek. Past timber harvest activities have definitely had an adverse impact on the quality of fish habitat present in the upper reaches of this drainage. The upper portion of this drainage has an extensive and highly erosive road system which will continue to be a major source of sediment into the future." Still, the survey found that "[m]oderate densities of juvenile and adult cutthroat trout were noted in the lower two fish sampling stations," and, "[m]oderate to low densities of cutthroat trout were present in the upper reaches of Osier Creek, and in the West Fork of Osier Creek." Kokanee were present in all the lower reaches (Isabella Wildlife Works 1996).

The average stream gradient is 3.5 percent, which limits upper Osier Creek's ability to move sediment out of the upper portions where stream flow is relatively low. Current cobble embeddedness is about 56 percent on average, with some reaches in upper Osier having 80 percent cobble embeddedness, which is high for this system. The system can be compared to Swamp Creek, which is unroaded and is located in similar landtypes, but has a cobble embeddedness score of 44 percent. A channel stability rating of 4.4 indicates some channel instability and in-stream erosion, much of which may be the result of past mining practices. The WATBAL model predicts current sediment production is five percent above background, well under the CNF's conservative goal of 55 percent.

We have concluded that Osier Creek is fully supporting its beneficial uses in terms of salmonid spawning and should be removed from the 303(d) list for sediment. We have also noted that road erosion and mass failures associated with roads are contributing some sediment to the system, but the evidence indicates that Osier Creek's water quality meets the state's standards for sediment and is not seriously threatened by the degree of erosion currently taking place in the watershed. The water quality condition probably is continuing to improve from the 1975-76 rain-on-snow event. It is noted, however, that the majority of sediment being delivered from roads is the result of inadequate and/or inappropriate culvert locations and drainage. The water quality would be greatly improved if the CNF were to address this problem.

5.15 Sugar Creek

Sugar Creek is 303(d) listed for sediment. Sugar Creek is a second-order tributary of Swamp Creek, which flows into Osier Creek, which then empties into Moose Creek, and thence into Kelly Creek. Sugar Creek heads on Osier Ridge and flows in a south-southwesterly direction to its confluence with Swamp Creek. Elevations range from 3,700 feet at the confluence to 6,100 feet on Osier Ridge. The predominant landtypes are Moderate Relief Uplands,

Mountain Slopelands, Rounded Mountain Slopelands, and Stream Breaklands, all derived from metasedimentary quartzites and undifferentiated rocks. The predominant mapped bedrock type is Lower Wallace interbedded gneissic quartzite, limestone, dolomite, and siltstone.

The BURP-evaluated reach is at 4,800 feet elevation. The nine percent reach slope is typical of a Rosgen type A channel. However, most of Sugar Creek is a Rosgen type B channel, with an average slope of 3.8 percent. The measured discharge on July 27, 1997, was 2.8 cubic feet per second. Human activities affecting the reach include forestry and roads. Sugar Creek's MBI score is 4.04, its HI score is 107, and it is supporting salmonid spawning as evidenced by two age classes of westslope cutthroat trout, including juveniles.

Sugar Creek is identified in the federal regulations as protected for bull trout. It is not listed as a priority bull trout watershed in the state's bull trout problem assessment. Because of the federal listing, the water temperature of Sugar Creek should be evaluated using the 10 ^{o}C (50 ^{o}F) MWMT for June through September temperature standard. However, the only temperature datum available is one instantaneous reading taken by the BURP crew. This is inadequate data to make a definitive determination of a temperature exceedance.

Since we are evaluating Sugar Creek in the context of the UNFCRS subbasin, we think there are good reasons to develop a temperature TMDL for Sugar Creek at this time. Sugar Creek is an integral part of the Swamp and Osier Creeks watersheds, for which temperature TMDLs are being developed. Within Idaho's administrative rules, Sugar Creek is considered the same water body as Swamp and Osier Creeks (IDAPA 58.01.02.109.09: C-31). Also, given the fact that no other water body in the subbasin meets the federally-promulgated temperature standard for bull trout, there is no reason to assume that Sugar Creek does. Finally, as we allocate shading for Osier and Swamp Creeks to meet their bull trout temperature requirements, Sugar Creek will, out of locational proximity and integrity of the watershed, receive a shading reduction allocation.

The most consistent resolution to the question of Sugar Creek would be to integrate it into Swamp Creek on the 303(d) list. We will proceed with temperature TMDLs for Sugar and Swamp Creeks; however, with a strong notation that the lack of shading in the critical parts of these watersheds has little to do with human activity and much to do with fires in the early part of the 20th century. These are watersheds protected by federal regulation for bull trout (Swamp Creek has a documented bull trout presence) and recovery plans are required. The temperature data presented for Swamp Creek in Appendix 3, which are ascribed to Sugar Creek for lack of any data specific to Sugar Creek, reflect canopy conditions that have resulted from fires almost a century ago. Only a small portion of the upper end of the Sugar Creek watershed has been logged. The rest of the two watersheds are unroaded and unentered.

Since Sugar Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG plus process to determine whether or not water quality is in fact impaired by sediment.

Sugar Creek has been subjected to some road building and timber harvesting activities in the upper end, primarily on land previously owned by private timber companies. Timber harvest has removed less than 10 percent of the canopy in this watershed. The watershed has approximately nine miles of roads resulting in a density of about 2.4 road miles per square mile of watershed. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. Sugar Creek was one of the watersheds impacted by the 1975-76 rain-on-snow landslide event; however, no landslides were recorded for the 1995-96 event.

The CNF bio-physical survey identified limiting factors for salmonid production as: "First, the low levels of active debris in many stream reaches do not provide significant structural diversity to existing habitat and form very few pools." (Author's note: this is likely the result of fires in the early 20th century removing much of the overstory.) "Second, moderate to high levels of cobble embeddedness may limit overall stream productivity in several upper stream reaches…." On the other hand, "[a]ll five fish stations sampled … contained moderate densities of westslope cutthroat trout….two of the fish counted at the Sugar Creek station were spawning." (Clearwater Biostudies, Inc. 1989).

The average stream gradient is 3.8 percent, which with a small stream flow, limits the system's ability to move sediment. Current cobble embeddedness is about 64 percent, which is high for this system. This system can be compared to Swamp Creek, which is unroaded with similar geology and landtypes. Swamp Creek has a cobble embeddedness score of 43 percent. The WATBAL model predicts current sediment production is only 15 percent above background, well under the CNF's conservative goal of 55 percent. A preliminary CWE road score of 36 indicates some sediment production and delivery from road surfaces, cut slopes, and drainage ditches.

We have concluded that Sugar Creek is supporting salmonid spawning and should be removed from the 303(d) list for sediment. While we have noted that road erosion is contributing some sediment to the system, the evidence indicates that Sugar Creek's water quality meets the state's water quality standards for sediment and is not seriously threatened by the degree of erosion currently taking place in the watershed. The water quality condition probably is continuing to improve from the 1975-76 rain-on-snow event. It is noted, however, that the majority of sediment being delivered from roads is the result of inadequate and/or inappropriate culvert locations and drainage. The water quality would be greatly improved if the CNF were to address this problem.

5.16 Swamp Creek

Swamp Creek is 303(d) listed for sediment. Swamp Creek is a fourth-order tributary of Osier Creek, which then empties into Moose Creek, and thence into Kelly Creek. Swamp Creek heads on Osier Ridge and flows in a west-southwesterly direction to its confluence with Osier Creek. Elevations range from 3,350 feet at the confluence to 6,000 feet on Swamp Ridge. The predominant landtypes are Moderate Relief Uplands, Mountain Slopelands, Rounded Mountain Slopelands, Broadly Rounded Mountain Slopelands, and Stream Breaklands, all derived from metasedimentary quartzites and undifferentiated rocks. The

predominant mapped bedrock type is Lower Wallace interbedded gneissic quartzite, limestone, dolomite, and siltstone.

Swamp Creek is an unlogged and unroaded watershed. Swamp Creek was one of the watersheds impacted by the 1975-76 rain-on-snow landslide event, although the extent of the impact is unknown. No landslides were recorded for the 1995-96 event.

The BURP-evaluated reach is at 3,440 feet elevation. The CNF temperature recording site is near the mouth of the creek where it empties into Osier Creek. The 4.5 percent slope of the BURP site is a Rosgen type A channel; however, most of Swamp Creek is a Rosgen type B channel, with average slope of 3.9 percent. The measured discharge on July 29, 1997, was 33 cubic feet per second. Swamp Creek's MBI is score 4.48, its HI score is 107, and it is supporting salmonid spawning as evidenced by three age classes of westslope cutthroat trout, including juveniles.

Swamp Creek is identified in the federal regulations as protected for bull trout; however, it is not listed as a priority bull trout watershed in the state's bull trout problem assessment. Because of the federal listing, the water temperature of Swamp Creek should be evaluated using the 10 ^{o}C (50 ^{o}F) MWMT for June through September temperature standard. Swamp Creek is the one 303(d) listed water body with a documented presence of bull trout (Murphy et al. 2000). As can be seen in the year 2000 temperature data for Swamp Creek presented in Appendix 3, temperatures began exceeding the standard in mid-June and continued into September.

We conclude that a temperature TMDL for Swamp (and Sugar) Creeks is justified; however, we want to emphasize that the lack of shading in the critical parts of these watersheds has little to do with human activity, but instead was caused by fires in the early part of the 20th century. These are watersheds protected by federal regulation for bull trout and recovery plans are required. The stream shading data presented for Swamp Creek in Appendix 5 reflect canopy conditions that have resulted from fires almost a century ago. Only a small portion of the upper end of the Sugar Creek watershed has been logged. The rest of the two watersheds is unroaded and unentered. The shading allocation that will result from the TMDL is a *pro forma* exercise to show the magnitude of this natural problem and how that problem affects the TMDLs for Osier, Laundry, and China Creeks.

Since Swamp Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG plus process to determine whether or not water quality is in fact impaired by sediment.

The CNF bio-physical survey identified limiting factors for salmonid production as, "First, the low levels of active debris in many stream reaches do not provide significant structural diversity to existing habitat and form very few pools." (Author's note: this is likely the result of fires in the first half of the 20th century removing much of the overstory.) "Second, moderate to high levels of cobble embeddedness may limit overall stream productivity in several upper stream reaches…." On the other hand, "[a]ll five fish stations sampled …

contained moderate densities of westslope cutthroat trout….Two of the fish counted at the Sugar Creek station were spawning," (Clearwater Biostudies, Inc. 1989).

The average stream gradient is 3.9 percent. Current cobble embeddedness is about 44 percent, which seems high for an unroaded system. This may be function of the highly weathered and erosive bedrock. The WATBAL model predicts current sediment production is equal to background.

It is concluded that Swamp Creek is supporting salmonid spawning and should be removed from the 303(d) list for sediment.

5.17 Sylvan Creek

Sylvan Creek is 303(d) listed for sediment. Sylvan Creek is a fourth-order tributary of French Creek, which flows into Orogrande Creek, and thence into the North Fork Clearwater River in north-central Idaho. Sylvan Creek heads on Hemlock Ridge and flows in a west-northwesterly direction to its confluence with French Creek. Elevations range from 3,560 feet at the confluence to near 5,500 feet on Hemlock Ridge. The predominant landtypes are Low and Moderate Relief Rolling Hills, Mountain Slopelands, and Rounded Mountain Slopelands of granitics, schists, and undifferentiated lithologies. The predominant mapped bedrock types are Wallace Formation schist and gneiss, with smaller areas of calc-silicates and granitics.

The BURP crew evaluated sites at the lower end of Sylvan Creek twice – once in 1997 and again in 1998 – with very similar results. The reach evaluated in 1997 is at 3,960 feet elevation, immediately downstream from the confluence with Hem Creek, while the 1998 site is just upstream from the confluence with Hem Creek at 4,000 feet elevation. The 1997 site has a 3.5 percent slope typical of a Rosgen type B channel and the 1998 site has a six percent slope (Rosgen type A channel); most of Sylvan Creek is a Rosgen type B channel, with an average slope of 4.9 percent. The measured discharge on August 7, 1997, was 13.8 cubic feet per second (this site includes flow from both Sylvan and Hem Creeks), while the measured discharge on August 6, 1998, was 2.1 cubic feet per second (this site includes flow from Sylvan Creek only). Human activities affecting the reach include forestry and roads. Sylvan Creek is supporting salmonid spawning as evidenced by five age classes of westslope cutthroat trout, including juveniles. It has MBI scores of 4.34 and 5.68 and HI scores of 106 and 99.

Sylvan Creek is not listed by either the federal regulations or the state's bull trout problem assessment as a stream to be protected for bull trout. Therefore, the stream temperature was assessed using the cutthroat temperature standards shown in Table 5, where the mean daily temperature shall be less than or equal to 9 ^{o}C (48.2 ^{o}F) from April through July. As shown by the temperature data for Sylvan Creek in Appendix 3, mean daily temperatures at the mouth of Sylvan Creek begin to exceed 9 ^{o}C (48.2 ^{o}F) by late June and continue throughout the month of July. Therefore, Sylvan Creek water temperatures exceed the state's numeric standard and a temperature TMDL is required.

Since Sylvan Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG process to determine whether or not water quality is in fact impaired by sediment.

Road building and timber harvesting have been the major economic activities in the Sylvan Creek watershed. Timber harvest has removed 40-50 percent of the canopy in this watershed. The watershed has approximately 36 miles of roads resulting in a density of about 6.7 road miles per square mile of watershed. Only three percent of the roads are within 100 feet of a stream, whereas 24 percent of them are on high-risk landtypes. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. Only one mass failure was recorded for the 1995-96 rain-on-snow event.

The average stream gradient is 4.9 percent, although this varies immensely from reach to reach. Current cobble embeddedness averages 23 percent. The CNF bio-physical survey identified only one limiting factor for salmonid production in Sylvan Creek: "Low abundance of good overwintering habitat in the upper Sylvan drainage…" (Clearwater Biostudies, Inc. 1998a). The Clearwater Biostudies, Inc. crew observed westslope cutthroat trout throughout the drainage.

In 1999, IDL conducted a CWE assessment of the entire French Creek watershed, including Sylvan Creek. Data selected for Sylvan Creek indicate that very few roads are delivering sediment to the creek and that only one mass failure in the watershed continues to be a problem. The overall CWE sediment delivery rating is low.

It is concluded that Sylvan Creek is supporting salmonid spawning and should be removed from the 303(d) list for sediment. The data suggest that water quality is meeting the state's water quality standards for sediment in spite of some erosion from roads. In the interest of water quality, the CNF should address this problem.

5.18 Tamarack Creek

Tamarack Creek is 303(d) listed for sediment. Tamarack Creek is a third-order tributary of Orogrande Creek, which flows into the North Fork Clearwater River in north-central Idaho. Tamarack Creek heads on Hemlock Ridge and flows in a northerly direction to its confluence with Orogrande Creek. Elevations range from 2,880 feet at the confluence to near 5,500 feet on Hemlock Ridge. The predominant landtypes include Low and Moderate Relief Rolling Hills, Mountain Slopelands, Rounded Mountain Slopelands, and Stream Breaklands of granitics, schists, and undifferentiated lithologies. Approximately seven percent of the watershed is identified as mass wasted, and about 50 percent of the watershed is rated as having a high mass wasting potential. The predominant mapped bedrock types are Wallace Formation schist and gneiss, undifferentiated quartzites, and calc-silicates.

The BURP-evaluated reach is located at 2,960 feet elevation, about 1,200 feet upstream from Tamarack Creek's confluence with Orogrande Creek. The CNF stream temperature recording site is near the mouth of Tamarack Creek. The four percent slope of the BURP reach is somewhat low for a Rosgen type A channel – most of Tamarack Creek is a Rosgen type B channel, with average gradient of 7.9 percent. The measured discharge on August 11,

1997, was 4.3 cubic feet per second. Human activities affecting the reach include forestry and roads. Tamarack Creek has an MBI score of 5.07, an HI score of 103, and it is supporting salmonid spawning as evidenced by two age classes of westslope cutthroat trout, including juveniles.

Tamarack Creek is not listed by either the federal regulations or the state's bull trout problem assessment as a stream to be protected for bull trout. Therefore, the stream temperature was assessed using the cutthroat temperature standards shown in Table 5 where mean daily temperature shall be less than or equal to 9 ^{o}C (48.2 ^{o}F) from April through July. As shown by the temperature data for Tamarack Creek in Appendix 3, mean daily temperatures at the mouth of Tamarack Creek begin to exceed 9 ^{o}C (48.2 ^{o}F) by mid-June and continue throughout the month of July. Therefore, Tamarack Creek's water temperatures exceed the state's numeric standard and a temperature TMDL is required.

Since Tamarack Creek is 303(d) listed for sediment and not temperature, we continue following the WBAG process to determine whether or not water quality is in fact impaired by sediment.

Road building and timber harvesting have been the major economic activities in the Tamarack Creek watershed. Timber harvest has removed 20-30 percent of the canopy in this watershed. The watershed has approximately 15 miles of roads resulting in a density of about 2.7 road miles per square mile of watershed. Virtually none of the roads are within 100 feet of perennial streams, but 43 percent of them are on unstable landtypes. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. Five mass failures with relatively high delivery were recorded for the 1995-96 rain-on-snow event.

The WATBAL model prediction of 40 percent over background of sediment delivery is a relatively high figure in comparison to other streams being evaluated in the UNFCRS. Current cobble embeddedness averages 40 percent, which is also an indicator of sediment loading to the system.

The CNF bio-physical survey identified the following limiting factors for salmonid production in Tamarack Creek: "1) High levels of fine streambed sediment in many reaches, and particularly in the Tamarack … Creek drainage(s). 2) Channel instability caused by landslides or movement of instream woody debris during recent flooding along multiple reaches of …Tamarack…Creek. … 5) Low abundance of good overwintering habitat …" (Clearwater Biostudies, Inc. 1998a). The Clearwater Biostudies crew observed westslope cutthroat trout at one of the three fish sites.

It is concluded that Tamarack Creek is supporting salmonid spawning and should be removed from the 303(d) list for sediment. The data suggest that water quality is meeting the state's standards for sediment in spite of some sediment loading from roads. In the interest of water quality, the CNF should address the problems of sediment from mass failures and roads in this watershed.

5.19 Tumble Creek

Tumble Creek is 303(d) listed for sediment. Tumble Creek is a third-order tributary of Washington Creek, which flows into the North Fork Clearwater River in north-central Idaho. Tumble Creek heads on Elk Mountain and flows in a northerly direction to its confluence with Washington Creek. Elevations range from 3,440 feet at the confluence to near 5,800 feet on Elk Mountain. The predominant landtypes include Low and Moderate Relief Rolling Hills, Mountain Slopelands, and Rounded Mountain Slopelands of granitics, grus (highly weathered granitics), and undifferentiated lithologies. The predominant mapped bedrock types are Tertiary granitics.

The BURP evaluation reach is at 3,520 feet elevation, near the mouth of the stream. The two percent reach slope is typical of a Rosgen type C channel, although the majority of the stream is a type B channel. The measured discharge on August 12, 1997, was 2.4 cubic feet per second. DEQ identified logging and roading as human activities affecting the reach. The DEQ 1996 WBAG results indicate that Tumble Creek is fully supporting its beneficial uses because its MBI score is 5.09, its HI score is 119, and it is supporting salmonid spawning as evidenced by two age classes of brook trout, including juveniles. The only temperature datum available is the instantaneous BURP reading of 11 ^{o}C (51.8 ^{o}F) on August 12, 1997. The only salmonid of record in Tumble Creek is brook trout, and spawning for this species begins in the fall after temperatures have cooled. It is assumed, therefore, that a temperature exceedance does not exist for this water body and a temperature TMDL is not needed.

Road building and timber harvesting have been the major economic activities in the Tumble Creek watershed. Timber harvest has removed 40-50 percent of the canopy in this watershed. The watershed has approximately 20 miles of roads resulting in a density of about 6.2 road miles per square mile of watershed. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. Only one mass failure with considerable delivery was recorded for the 1995-96 rain-on-snow event.

The CNF bio-physical survey identified the following limiting factors for salmonid production: “1) Moderately high to very high levels of substrate embeddedness…2) A lack of deep pools….6) Migration barriers (steep cascades and falls) in TUM-6 that prevent fish from utilizing habitat in most of Tumble Creek.” (Clearwater Biostudies, Inc. 1998b). They noted significant erosion of granitic sand from logged areas and an accumulation in the upper reaches. They observed only brook trout in the lower reaches of Tumble Creek and no fish above the cascades.

The average stream gradient is 6.2 percent, although this varies immensely from reach to reach. The current cobble embeddedness averages 56 percent, but some reaches are 70 percent embedded. High cobble embeddedness is expected in grussic landscapes. The WATBAL model predicts 39 percent sediment delivery above background, but given the grussic nature of this watershed, and observations by field crews, it is likely that WATBAL is underpredicting sediment delivery to this stream.

We have concluded that Tumble Creek is fully supporting its beneficial uses and should be removed from the 303(d) list for sediment. The BURP results indicated that this stream is fully supporting its beneficial uses with a good MBI and HI scores and two age classes of brook trout, including juveniles. The data suggest that water quality is meeting the state's standards in spite of considerable sediment loading. The lack of fish in the upper reaches is likely the result of natural migration barriers. Still, it is noted that considerable sediment is being delivered to the stream from logging roads. In the interest of water quality, the CNF should address this problem.

5.20 Sneak Creek

Sneak Creek is 303(d) listed for channel stability – one of only two water bodies in the state listed for this impairment. We evaluate Sneak Creek both for channel stability and sediment, which would be the pollutant if Sneak Creek does in fact have unstable banks.

Sneak Creek is a third-order tributary of the North Fork Clearwater River in north-central Idaho. Sneak Creek heads on Eagle Point and flows in a northwesterly direction to its confluence with the North Fork Clearwater River. Elevations range from 1,720 feet at the confluence to near 5,700 feet on Eagle Point. The predominant landtypes are Mountain Slopelands, Rounded Mountain Slopelands, and Dissected Stream Breaklands of undifferentiated lithologies primarily of mixed schist and granitics common to the border zone. Approximately three percent of the landscape is identified as mass wasted and 66 percent of the watershed is classed as having a high mass wasting potential. The predominant mapped bedrock types are Prichard schist and quartzite and Wallace schist and quartzite.

The BURP evaluation reach is near the mouth at 1,800 feet elevation, at approximately the same location as the CNF stream temperature recording site. The 8.2 percent reach slope is typical of a Rosgen type A channel (Rosgen 1994). The measured discharge on August 20, 1997, was 3.8 cubic feet per second. The BURP crews identified forestry and roading as human activities affecting the reach. Sneak Creek's MBI score is 4.36, its HI score is 105, and it is supporting salmonid spawning as evidenced by three age classes of rainbow trout, including juveniles. Cutthroat trout were also recorded as present in the stream.

Sneak Creek is not listed by either the federal regulations or the state's bull trout problem assessment as a stream to be protected for bull trout. Therefore, the stream temperature was assessed using the cutthroat temperature standards shown in Table 5, where mean daily temperature shall be less than or equal to 9 ^{o}C (48.2 ^{o}F) from April through July. As shown by the temperature data for Sneak Creek in Appendix 3, mean daily temperatures at the mouth of Sneak Creek exceed 9 ^{o}C (48.2 ^{o}F) for most of June and July. Therefore, Sneak Creek's water temperatures exceed the state's numeric standard and a temperature TMDL is required.

Since Sneak Creek is 303(d) listed for channel stability and not temperature, and we assume that channel stability implies sediment as the pollutant, we continue following the WBAG process to determine whether or not water quality is in fact impaired by sediment.

Road building and timber harvesting have been the major economic activities in the Sneak Creek watershed. Timber harvest has removed approximately 50 percent of the canopy in this watershed. The watershed has approximately 19 miles of roads resulting in a density of about 4.9 road miles per square mile of watershed. The WATBAL model predicts a 90 percent over background sediment delivery from roads in this watershed. However, a preliminary CWE assessment of the roads in this watershed results in a low score of 14. We conclude that for some reason WATBAL is overpredicting sediment production in this watershed. Many of the roads are currently closed or impassable, thus limiting their sediment contribution. Only one mass failure was recorded for the 1995-96 rain-on-snow event, although the mass failure hazard rating for the landtypes in this watershed is high. Three percent of this watershed is mass wasted.

With respect to channel stability as a threat to Sneak Creek's water quality, the CNF contracted a bio-physical study of the stream in 1994. The report from that study (Clearwater BioStudies, Inc. 1995b) has data for a bank stability index (with ratings form 1 [poor] to 5 [excellent]) and the amount of raw banks (meters per kilometer). For both metrics, Sneak Creek was rated perfect, with a bank stability index score of 5 and a raw banks measure of 0 meters per kilometer. Therefore, we conclude that channel stability is not a problem with Sneak Creek.

The CNF bio-physical survey identified the following three limiting factors for salmonid production: "High levels of cobble embeddedness…Few pools of high quality…Steep channel gradients." (Clearwater Biostudies, Inc. 1995b). Still, the survey crew observed moderate densities of cutthroat and rainbow-steelhead at the fish stations snorkeled.

The average stream gradient is 15 percent, indicating that sediment should be moving through the system fairly quickly. Current cobble embeddedness is about 34 percent, which is somewhat high. Field crews identified a number of logjams in the system, limiting movement of sediment through the system. The logjams are identified as natural, as opposed to logging debris. The field crews also identified a number of falls acting as natural migration barriers.

We conclude that Sneak Creek is fully supporting salmonid spawning and should be removed from the 303(d) list for channel stability. It is clearly not limited by channel instability, and the data suggest that water quality is meeting the state's standards for sediment in spite of some sediment loading.

6. 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 among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation; and nonpoint sources, which receive a load allocation. Natural background, 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 (Water Quality Planning and Management, 40 CFR 130) require a margin of safety be a part of the TMDL.

Practically, the margin of safety is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to humanmade pollutant sources. This can be summarized symbolically as the equation: Load Capacity = (Margin of Safety) + (Natural Background) + (Load Allocations) + (Wasteload Allocations) = TMDL. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First the load capacity is determined. Then the load capacity is broken down into its components: the necessary margin of safety is determined and subtracted; then natural background, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation is completed we have a TMDL, which must equal the load capacity.

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

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

Chapter 5 identifies 18 water bodies in the UNFRCS that are water quality limited. Of the 303(d) listed water bodies, only Hem and Tumble Creeks are identified as fully supporting their beneficial uses. Each of the other 18 water bodies must have a TMDL developed for its particular pollutant. All of the 18 water bodies require a TMDL for temperature, and Deception Gulch also requires a TMDL for sediment. A TMDL includes targets for the pollutant being reduced, a loading analyses for each pollutant in each water body, and a load allocation.

6.1 Temperature TMDLs

Eighteen water bodies were identified in Chapter 5 (Table 10) as water quality limited due to temperature.

Heat Loading

Generally, we conclude that increased temperature in the UNFCRS is primarily the result of increased heat loading from solar radiation to the water body as a result of removal of riparian shading. Logging and road building are the two primary anthropogenic causes of shade reduction over the last half century. Mining in the late 19th and early 20th centuries undoubtedly had some effects. In some cases, lack of shade beyond that which will maintain stream temperatures within the applicable standard is natural, and/or may be the result of forest fires. In addition, solar radiation and resultant heat loading may have been increased by widening of the stream channel (an increase in the width-to-depth ratio). In most cases, this would have been the result of deterioration and/or removal of the streamside vegetation and its ability to hold the stream in a more confined and sinuous channel. In a few cases, stream widening could have resulted from sediment accumulation and stream aggradation.

For the sake of the discussions to follow, we assume that heat loading is directly related to stream temperature. We discuss stream temperature in degrees centigrade and heat loading in watts per square meter. Increasing net heat loading to the surface of a stream segment increases the stream temperature. Heat loading to a stream surface, however, has both temporal and spatial variability within the 18 water bodies for which TMDLs are being developed. Predicting stream temperature at any location and time in a water body requires an understanding of how heat loading is distributed through space and time. In fact, for the purposes of a TMDL, we are less interested in knowing the stream temperature at any given location and time, and more interested in knowing that heat loading is such that stream temperatures throughout a water body are not exceeding water quality standards at any time.

In terms of timing, heat loading in the UNFCRS is at its greatest during late July and early August and is reflected in the higher stream temperatures at this time (see temperature plots in Appendix 3, which also show the temperature standards). July and August are the critical months for temperature exceedances. Water temperatures begin to increase through May and June, but are consistently at their peaks during late July and early August. Water temperatures decrease rapidly after the first wet cold fronts of late August or early September. We analyze heat loading and stream temperature for the critical period of late July through early August, and assume that if stream temperatures are in compliance with the

water quality standards during this period, they will be in compliance throughout the rest of the year.

The stream temperature data in Appendix 3 show the stream temperatures for one location in a water body. These data are usually collected near the mouth where temperatures are likely to be the highest. However, since water quality standards apply throughout a water body, it is necessary to understand heat loading distribution throughout a water body. Solar insolation at some reference elevation over the whole of a water body can be assumed to be constant at any given moment; that is, there is no spatial variation to solar insolation at the scale of a water body. Spatial variation of heat loading is largely a function of how solar insolation interacts with a stream and its immediate surroundings.

The six modes of heat transfer important in stream temperature analyses are (Adams and Sullivan 1990):

Solar radiation (short wave)
Radiation between the stream and the adjacent vegetation and sky (long wave)
Evaporation from the stream
Convection between the stream and the air
Conduction between the stream and the streambed
Ground water and tributary inflow to the stream

There are process-based stream temperature models such as *Heat Source* (Boyd 1996) or SSTEMP (Theurer et al. 1984; Bartholow 1997) for analyzing stream temperatures by quantifying the heat transfer processes. However, these models tend to require extensive inputs, many of which are not easily available or reliable for remote, mountain streams (See Appendix 13 for lists of variables required by SSTEMP and *Heat Source*). The relative importance of each mode of heat transfer varies according to the specific environmental conditions present from reach to reach.

Analyses have established that the primary environmental factors affecting stream temperature are local air temperature, stream depth, ground water inflow, and the extent to which riparian canopy and topography shade the stream (Sullivan and Adams 1990; Theurer et al. 1984; Beschta and Weatherred 1984). In forested environments, stream shading and local air temperature are widely recognized as the major environmental determinants of stream temperature, accounting for up to 90 percent of stream temperature variability (Brown 1971; IDL 2000). Of these two primary factors, canopy cover or shade is the one most modified by human use. Ideally, one would like a stream temperature prediction model based on easily measurable and understandable parameters, but one that could also be translated to describe the physics of the heat loading process.

The Idaho Forest Practices Act Coordinating Committee has developed an empirical model (the CWE model) of stream temperature based on continuous water temperature measurements, elevation, and percent canopy cover data collected throughout north Idaho:

$$MWMT = 29.1 - 0.00262\ E - 0.0849\ C$$

where MWMT = maximum weekly maximum temperature (^{o}C)
E = stream reach elevation (feet)
C = riparian canopy cover (%)

This model utilizes percent stream canopy shading and elevation to predict the maximum weekly mean maximum stream temperature (the MWMT of the hottest week of the year) for forestlands. Elevation and percent shading are easy to acquire: elevation from topographic maps or digital elevation models and percent shading from aerial photography correlated to canopy cover collected using a densiometer. In mountainous terrain such as the UNFCRS, increases in elevation result in reductions in ambient air temperature, thus reducing heat loading in a predictable manner. In addition, increases in shading decrease heat loading by reducing solar insolation impinging on the water surface and by lowering the local air temperature under the canopy. The utility of the CWE model is that it can be solved for percent canopy cover, the one major environmental factor that can be managed to affect stream temperature. It satisfies the need for ease of use and for being reasonable and understandable.

However, since the CWE model is not process based, it does not result in the type of numbers that USEPA prefers for TMDL loading analyses. Further, USEPA has expressed concern as to the accuracy of the CWE temperature predictions. To answer the latter point, DEQ contracted with Western Watershed Analysts of Lewiston, Idaho, to determine the accuracy by comparing the CWE model with other stream temperature models. The report of their short study, *Comparison Between Stream Temperature Prediction Models: SSTEMP, Heat Source, and Idaho Cumulative Watershed Effects,* appears as Appendix 13. Their results, however limited, show that CWE is a better predictor of stream temperature than either SSTEMP or *Heat Source* – the root mean square (RMS) error of the CWE prediction is about 1 degree centigrade, while the RMS errors for SSTEMP and *Heat Source* are between 1 and 2 degrees centigrade. Further analyses would be needed to bring these results up to statistical significance.

To address the concern regarding conversion of CWE results to heat loading per unit time, we take an approach of separating the effects of insolation from the other heat flux processes. The two primary environmental variables that determine stream temperature are air temperature and stream shading. Air temperature enters into the heat transfer relationships for many of the heat transfer processes associated with streams (e.g., convection, evaporation, long wave radiation), and is the primary driver of average water temperature. The CWE model accounts for the variation in air temperature in the elevation variable. Stream shading affects the amount of solar radiation impinging on the water surface and is the primary driver of the diurnal fluctuations in water temperature. The CWE results are, in effect, the change in heat loading associated with changes in stream shading.

In order to quantify heat loading to a stream surface due to insolation, we used SSTEMP-(Bartholow 1997) derived data for August 1 (median hottest day) for insolation rates and calculated the heat loading for different levels of percent shade. The amounts of solar

radiation incident on the stream and its immediate surroundings at different shadings for two stream orientations are presented in Table 11. Fixed conditions used in SSTEMP to develop the solar radiation numbers are 47 degrees latitude, 5,000 feet elevation, a stream width of 10 feet, a buffer height of 60 feet, a buffer width of 30 feet, and topographic shade of 30 degrees. These are generalized standard conditions for streams of the UNFCRS. Under these conditions, incident solar radiation decreases regularly by 21 watts per square meter for every 10 percent increase in canopy density for north-south oriented streams and 26 watts per square meter for east-west oriented streams.

Table 11. Average daily solar radiation incident on a stream related to canopy closure.

	Stream Orientation	
Canopy Density (percent)	North-South (watts per square meter)	East-West (watts per square meter)
0	226	274
10	205	248
20	185	223
30	164	197
40	143	172
50	122	146
60	101	120
70	80	95
80	59	69
90	38	43
100	17	18

These heat flux amounts do not represent the total heat flux, but just the heat flux directly from the sun (insolation). This is the portion of heat flux this TMDL addresses because it is readily increased by human activity in reducing stream shading and can be managed to decrease stream temperatures. Insolation flux rates decrease linearly with increases in shading (Table 11). Considering the CWE model above, the decrease in stream temperature due to increased percent canopy closure at a given elevation is also linear. Assuming the CWE model is correct, as verified by the study cited above comparing the three models, the linear decrease in temperature implies that the change in heat flux is constant and directly related to shading. These results indicate that the total heat flux is linearly related to the insolation rates, such that the percentage heat reduction required by the TMDL will be the same whether its calculated from total heat flux, or simply that associated with insolation rates. In this TMDL, we use the CWE model with percent canopy closure as the dependent variable directly related to insolation rates.

In summary, we approach heat loading and stream temperature by addressing the primary environmental factors of concern. We address the temporal and spatial variability of heat

loading. Within that framework, we address percent canopy closure as it varies in time and space as the major environmental variable affecting heat loading of any given stream reach. And, we quantify the changes in heat loading as they occur throughout the water bodies as the result of changes in stream shading.

Heat Loading Capacity

All 18 of the water bodies have designated beneficial uses of cold water aquatic life and salmonid spawning. In addition, the USEPA has designated 11 of the water bodies as protected for bull trout, and these must meet the federally promulgated bull trout temperature standard of 10 ^{o}C (50 ^{o}F) MWMT. The remaining creeks, upper Orogrande, lower Orogrande, Sylvan, Tamarack, Sneak, Deception, and China, must meet the applicable standards presented in Table 5 (i.e., a daily average water temperature no greater than 9 ^{o}C [48.2 ^{o}F] and a daily maximum water temperature no greater than 13 ^{o}C [55.4^{o}F] for the time periods when salmonids are spawning). Using a conversion factor developed by Sugden et al. (1998) for northern Idaho and western Montana, a 9 ^{o}C (48.2 ^{o}F) daily average temperature is equivalent to a 9.7 ^{o}C (49.5 ^{o}F) MWMT, such that the federal bull trout temperature standard and Idaho's salmonid standard are roughly equivalent in terms of mean weekly maximum temperatures. We assume they are equivalent and use 10 ^{o}C (50 ^{o}F) MWMT for both standards in our calculations below.

The time periods for which the standards apply are dependent on the salmonid species present in the particular water body. The numeric standards from the Idaho administrative rules (IDAPA 58.01.02.250.02.e.ii) for the applicable time periods are the loading capacities for the upper Orogrande, lower Orogrande, Sylvan, Tamarack, Sneak, Deception, and China water bodies. The remaining 11 water bodies (Cold Springs, Cool, Cougar, Grizzly, Middle, Gravey, Marten, Osier, Laundry, Sugar, and Swamp Creeks) must meet the USEPA promulgated 10 ^{o}C (50 ^{o}F) MWMT for the months of June through September for bull trout. The 10 ^{o}C (50 ^{o}F) MWMT numeric standard from 40 CFR Part 131.33(a) is the loading capacity for the water bodies protected for bull trout.

The heat loading capacity applicable to the UNFCRS in relation to state and federal temperature standards is primarily a consideration during the months of July and August when heat loading is the greatest. Because of the regular seasonal progression in stream temperature, if we target a stream's annual peak in temperature, and bring the temperature down to within criteria limits, then we can safely assume criteria will also be met at cooler times of the year. This is the basis of using metrics like MWMT for criteria and makes CWE particularly relevant to the problem at hand.

The specifics for each 303(d) listed water body are discussed in their respective parts of Chapter 5 and shown graphically on charts in Appendix 3. The charts in Appendix 3 clearly show the time periods when, and degrees to which, the stream temperatures exceed the state and federal water quality standards. The heat loading capacity is exceeded when stream temperatures exceed the temperature standards, but we do not define this capacity in terms of watts per meter squared. The data shown are for one point in the water body; that point where the temperature data are collected. We think it is more appropriate to understand how

the heat loading is distributed throughout the water body and use percent shading as a surrogate measure to develop this understanding.

Heat Loading Capacity Surrogate Measure

In order to understand how heat loading capacity is distributed throughout a water body, we use the CWE temperature model developed for north Idaho under the auspices of the Idaho FPA (IDL 2000). The modeled relationship was developed from data collected in north Idaho whereby the maximum weekly mean maximum stream temperature (the maximum MWMT of the year) is predicted by elevation and percent shading. The CWE model is an empirical, reach-based model that predicts the amount of stream canopy shading required in a given 200-foot elevational range to be able to maintain a given mean weekly maximum stream temperature (usually a given temperature standard such as 10 ^{o}C [50 ^{o}F] MWMT). Each elevational reach has a predicted shading requirement, and shade requirements increase with decreasing elevation as would be expected to account for increasing air temperatures. The model assumes that water temperature has been protected upstream. It accounts for the two primary environmental factors affecting stream temperature – local air temperature as it varies by elevation and microclimatic modification by the canopy and shade of the stream surface by the riparian canopy.

Using the CWE model, we convert the heat loading capacity in terms of stream temperature to a surrogate measure of percent canopy closure. Table 12 shows the percent canopy closure required to maintain a heat loading capacity to attain the temperature standard of 10 ^{o}C MWMT by 200-foot elevation reaches. This is the shading required to maintain stream temperatures during the period of the year with highest ambient air temperatures (late July and early August). Thus, the CWE model predicts the percent canopy closure required at a given elevation to maintain stream temperatures within the water quality standards. The heat loading capacity in terms of the surrogate measure of required percent canopy closure to maintain stream temperatures is distributed throughout the water body, depending on the elevation of the reach.

Using the CWE process, we analyzed the current shade condition of 860 stream reaches in the 18 watersheds for which TMDLs are being developed and compared the results to the surrogate loading capacities (percent stream canopy closure) in Table 12. A stream reach break was defined by a maximum of 200 feet elevation difference from bottom to top (based on the elevation zones in Table 12), an intersection of two perennial streams, or a major change in canopy closure. All of the perennial tributaries were analyzed as contributing to the heat loading process. While we are aware of research by Zwieniecki and Newton (1999) and others indicating that downstream temperature is essentially independent of upstream conditions as long as the stream has sufficient time to equilibrate, we do not proceed with this level of analysis, but rely exclusively on the CWE predictions and their consequent processes under Idaho's FPA.

Table 12. The heat loading capacities for the UNFCRS in terms of CWE-derived percent stream canopy closure by elevation and associated insolation rates for the 10 ^{o}C MWMT code and regulation defined heat loading capacity.

Elevation Zones	Percent Stream Canopy Closure	Insolation Rate North-South Oriented Stream	Insolation Rate East-West Oriented Stream
(feet)	(%)	(watts/m^2)	(watts/m^2)
5,400-5,599	58	105	125
5,200-5,399	64	93	110
5,000-5,199	71	78	92
4,800-4,999	77	65	77
4,600-4,799	83	53	61
4,400-4,599	89	40	46
4,200-4,399	95	28	31
4,000-4,199	100	17	18
3,800-3,999	100 *	**	**
3,600-3,799	100 *	**	**
3,400-3,599	100 *	**	**
3,200-3,399	100 *	**	**
3,000-3,199	100 *	**	**
2,800-2,999	100 *	**	**
2,600-2,799	100 *	**	**
2,400-2,599	100 *	**	**
2,200-2,399	100 *	**	**
2,000-2,199	100 *	**	**
1,800-1,999	100 *	**	**
1,600-1,799	100 *	**	**
1,400-1,599	100 *	**	**
1,200-1,399	100 *	**	**
1,000-1,199	100 *	**	**
800-999	100 *	**	**

* Below about 4,000 feet elevation, the CWE model predicts a need for greater than 100% canopy closure to protect a maximum stream temperature of 10 ^{o}C MWMT. Since this is not possible, 100% canopy closure is set as the surrogate heat loading capacity. In some cases, 100% canopy closure may not be achievable because of the canopy type, in which case it should be noted in the implementation plan.

** SSTEMP predicts insolation rates of 17 or 18 watts per square meter, depending on aspect, for 100% canopy closure

In summary, the heat loading capacity is defined here for the critical time of the year and for various reaches throughout the water body. The heat loading capacity is 10 ^{o}C MWMT as defined by the water quality standards, but is measured by a surrogate environmental variable, percent canopy closure X elevation. Using SSTEMP, we identify the heat loading associated with solar insolation as that portion of heat loading affected by stream shading, the environmental variable that can be managed for heat flux control. We show that the heat loading due to solar insolation is distributed over the water body in a predictable manner and that, further, heat loading capacities for different stream reaches can be translated to surrogate percent canopy cover targets.

Excess Heat Load

Excess heat loading is the heat increase in net heat flux that causes temperatures at any given time and location to exceed the applicable water quality standards (loading capacity). While the excess heat loading is variable over time as a function of weather and spawning periods for the species in question, the data presented here are considered representative of the general pattern over time in the UNFCRS. As shown in Appendix 3 and discussed water body by water body in Chapter 5, 18 water bodies in the UNFCRS regularly exceed the applicable water quality temperature standards during July and August of every year. This exceedance extends into June and September for some water bodies and some years. Based on the data presented in this report, there is no particular reason to think that the years when data were collected are anomalous in relation to the long-term climate of the subbasin.

The spatial distribution of excess heat loading over a water body is more complicated, but largely predictable using the CWE model. The temperature data presented in Appendix 3 are collected near the mouths of the water bodies. They give some idea of the overall magnitude of excess heat loading to a water body, but provide little information about where in the water body heat is gained such that temperatures exceed the water quality standards.

Based on our analysis of water bodies in the UNFCRS, we conclude that the manageable part of any excess heat loading is the result of reduction of canopy shading over a water body. We use the CWE relationship to show the distribution of locations throughout the water body where excess heat is being gained. In addition, the CWE relationship shows the degree to which excess heat is gained based on the percent canopy closure lacking for each particular reach in relation to the percent canopy closure of the heat loading capacity.

Whereas in the Heat Loading section above we do not quantify the total heat loading distributed across the landscape as it results in ambient stream temperatures, we do quantify in general terms the portion of heat loading coming from solar insolation. We establish a framework for calculating the heat loading capacity for a given stream reach based on knowledge of the elevation, orientation, and existing percent canopy shading. From Table 12, one can identify the percent shading at a given elevation needed to protect the stream temperature. Within this framework, excess heat loading occurs during the critical time periods wherever existing percent canopy closure over a stream is less than that identified as needed to protect stream temperatures within the state's standards.

Excess Heat Load Allocation

The only known source of human-caused heat to increase the heat load to excess is increased insolation largely as a result of reduced shading over streams. Therefore, the excess heat load is grossly allocated to nonpoint sources. One hundred percent of the excess heat load is allocated to activities and processes that have reduced percent canopy closure over the streams. Primary among these activities and processes are roading, timber harvesting, mining, natural fires, and storm events. At many locations on the landscape these activities and processes have been intermixed. Because virtually all of the land is managed by the CNF, and they are implementing the federal Inland Native Fish Strategy (INFISH) (USFS 1995) to address excess heat loading regardless of original cause, we do not make any effort to allocate excess heat load to the various causes. In the case of upper Orogrande Creek, it is assumed that Potlatch Corporation and IDL will implement FPA standards and some site-specific BMPs to address excess heat load, also regardless of original cause.

The heat load reduction allocations presented are specific to the 303(d) listed water quality limited streams and are defined in terms of the temperature exceedances and heat capacity temperatures for each water body (Appendix 3). In those situations where the effects of heat loading from non-303(d) listed streams are contributing to water standard exceedances in a 303(d) listed water body, the load reduction allocation is assigned to the 303(d) listed water body, even though corrective action may be recommended further upstream. The assigned load reduction allocation has been distributed appropriately throughout the watersheds wherever stream shading is inadequate according to the CWE model.

Heat Load Reduction Targets

The heat load reduction targets are the state's water quality temperature standards for salmonid spawning for the most limiting salmonid species or the federally promulgated temperature standards for bull trout. The critical time period has been determined to be the months of July and August; therefore, the targets are set for those months. If the targets are attained during July and August, when water flows are low and air temperatures are high, it is assured the water quality temperature standards will be met throughout the rest of the year. For federally protected bull trout watersheds, the target shall be 10 ^{o}C (50 ^{o}F) MWMT during the months of July and August. For other streams that support cutthroat trout, the target shall be 9 ^{o}C (48.2 ^{o}F) mean daily temperature for the month of July. For water bodies that support only rainbow trout, the target shall be 9 ^{o}C (48.2 ^{o}F) mean daily temperature from July 1 through July 15.

Surrogate Water Temperature Targets

Stream temperature, per se, is of limited use in guiding activities that will reduce nonpoint source heat loading to a water body. Instead, for the UNFCRS temperature TMDLs, we have chosen to use a surrogate target as provided under USEPA regulations [40 CFR §130.2(I)]. The surrogate target we use is percent canopy closure by stream reach elevation. Stream shading is the most important controlling factor of heat loading in forested environments.

Stream reaches can be located on the ground and their canopy cover producing shade can be managed.

The surrogate loading capacities are the surrogate targets set for the temperature TMDLs. To develop the surrogate targets for the 18 temperature impaired streams, we converted the 10 ^{o}C MWMT loading capacity water quality standard to the percent canopy closure X elevation required to attain that target using the CWE relationship. The surrogate percent canopy closure targets are calculated for individual segments based on 200-foot elevational ranges. The insolation heat load targets are calculated for each elevational range and four classes of stream orientation – east/west, north/south, northeast/southwest, and northwest/southeast.

Based on the conclusions by Zwieniecki and Newton (1999) that downstream temperature is essentially independent of upstream conditions as long as the stream has sufficient time to equilibrate, we believe that a reach by reach allocation is appropriate. Stream temperatures continuously tend towards equilibration with their environment such that any extra cooling upstream from a given reach is unlikely to have much effect further down a stream network if temperature protection is not maintained. The conditions controlling stream temperatures are relatively local and should be controlled at a localized scale.

However, EPA has expressed concerns that the CWE model "is not a precise or accurate tool for predicting stream temperature response" and its use in setting shade targets "could result in on the ground reductions in shade below levels that are currently present, particularly at higher elevations in the watershed" (Psyk 2001). We have adopted EPA recommendations for setting percent canopy closure targets as follows:

- If existing percent canopy closure is less than what CWE predicts is necessary to achieve the state's water quality standards, then the CWE temperature model estimate of necessary percent canopy closure is set as the target.
- If the existing percent canopy closure is greater than what the CWE temperature model predicts is necessary to achieve the state's water quality standards, the target percent canopy closure is set at current percent canopy closure. This ensures that CWE derived estimations will not result in a reduction of shade below current levels in impaired water bodies.

Percent canopy closure surrogate targets are set for 303(d) listed water bodies on a watershed-wide basis. The water bodies for which targets are set are:

- Orogrande Creek watershed (Appendix 4)
  Includes upper Orogrande, lower Orogrande, Tamarack, and Sylvan Creeks

- Osier Creek watershed (Appendix 5)
  Includes Osier, China, Laundry, Swamp, and Sugar Creeks

- Cold Springs and Cool Creeks (Appendix 6)

- Cougar and Grizzly Creeks (Appendix 7)

- Gravey and Marten Creeks (Appendix 8)
- Middle Creek (Appendix 9)
- Sneak Creek (Appendix 10)
- Deception Gulch (Appendix 11)

For each stream segment in a watershed, existing percent canopy closure determined by aerial photo interpretation is subtracted from the CWE model prediction of necessary percent canopy closure to protect stream temperatures. As noted above, if the existing percent canopy closure is less that what the CWE temperature model predicts as necessary, the CWE model prediction is set as the target. If the existing percent canopy closure is equal to or greater than what the CWE model predicts is necessary, then the existing percent canopy closure is set as the target. The targets by stream segment are presented in graphic form on a map and in a table in an appendix for each water body. An ArcView shapefile containing the graphics and target allocation data are on the diskette included with this document. It will be necessary to use the ArcView shapefile to identify the target for a specific stream reach.

The upper Orogrande, lower Orogrande, and French Creek watersheds were analyzed as a whole (the Orogrande Creek watershed). The upper Orogrande watershed is made up of Orogrande Creek above the confluence with French Creek, including all of Elk Creek, Silver Creek, Crystal Creek, Breakfast Creek, South Fork Creek, and numerous smaller perennial streams. Lower Orogrande Creek is fed not only by all of the upper Orogrande Creek, but also by French Creek and its major tributaries of Sylvan, Hem, and Joy Creeks. Lower Orogrande Creek also has tributaries of Pine Creek, Tamarack Creek, Cache Creek, Grand Creek, Shake Creek, and numerous smaller perennial streams.

The watershed map in Appendix 4 shows the perennial streams and water bodies that were analyzed in the Orogrande Creek watershed. In all, 130 miles of stream, divided into 330 segments, were analyzed. The results are shown in Table 13, in Appendix 4, and on the included diskette.

These results and those in Appendix 4 and in the ArcView shapefile are the temperature TMDLs for the 303(d) listed water bodies upper Orogrande Creek, lower Orogrande Creek, Sylvan Creek, and Tamarack Creek. For the upper Orogrande Creek watershed, the majority of stream segments require in the range of a 26-50 percent increase in percent canopy closure to meet the targets. For the lower Orogrande Creek watershed, the majority of the stream segments require greater than a 50 percent increase in percent canopy closure. For Tamarack Creek too, as a subwatershed within the lower Orogrande Creek watershed, the majority of the stream segments require greater than a 50 percent increase in percent canopy closure. For Sylvan Creek, the majority of the stream segments require in the range of a 26-50 percent increase in percent canopy closure.

Table 13. Stream segments and shading status for the Orogrande Creek watershed.

Stream Name	Total Number of Stream Segments	Total Miles of Stream	Number of Segments Requiring a Given Range of Percent Canopy Closure Increase to Meet the Temperature TMDL Targets				
			0%	1-10%	11-25%	26-50%	>50%
Upper Orogrande	45	28.4	0	0	10	26	12
Elk	12	9.2	0	0	0	2	11
Total U. Orogrande	57	37.6	0	0	10	28	23
French	48	18.4	0	1	13	22	12
Hem/Joy	15	7.0	0	6	3	6	0
Sylvan	23	8.5	0	0	10	16	6
Total French	86	33.9	0	7	26	44	18
Lower Orogrande	108	34.1	0	2	8	42	56
Pine/Fir	21	6.3	0	0	3	2	16
Tamarack	24	6.9	0	0	3	0	21
Cache	12	4.0	2	2	2	0	6
Shake	8	3.1	0	0	0	0	8
Grand	10	3.3	0	1	2	0	7
Total L. Orogrande	183	57.7	2	5	18	44	114
Total Watershed	326	129.2	2	12	54	116	155

For the Osier Creek watershed temperature loading analysis, analyses were also conducted on Swamp Creek, Pollack Creek, Sugar Creek, Laundry Creek, China Creek, West Fork Osier Creek, and Pioneer Gulch. Osier, Swamp, Sugar, and Laundry Creeks are listed by the USEPA as protected for bull trout, so shading targets for bull trout temperatures were applied to these streams. The watershed map in Appendix 5 shows the perennial streams that were analyzed. Surrogate targets were developed for the 67 stream segments that were analyzed (Table 14) (see Appendix 5 and included diskette). These results, therefore, are the temperature TMDLs for the 303(d) listed water bodies Osier Creek, China Creek, Laundry Creek, Sugar Creek, and Swamp Creek.

Over 50 percent of the stream segments in the Osier Creek watershed require greater than a 50 percent canopy closure increase to meet the temperature TMDL targets.

Similar to the Orogrande and Osier watersheds, we have grouped the temperature TMDLs for the other 303(d) listed streams by watershed. Cold Springs Creek and Cool Creek are calculated together. Gravey and Marten Creeks are calculated together. Cougar and Grizzly Creeks are calculated together because they are adjacent with nearly identical landforms and

land uses, even though they don't actually come together to form one watershed. For Middle Creek, we include analyses of numerous important tributaries. Calculations for the Sneak Creek and Deception Gulch watersheds also include all the perennial tributaries. Results of each of the TMDL calculations are presented in their respective appendices, and the ArcView shapefile data are on the included diskette. Table 15 presents summary results by watershed. All streams were analyzed using the 10 ^{o}C MWMT temperature standard.

Table 14. Stream segments and shading status for the Osier Creek watershed.

Stream Name	Total Number of Stream Segments	Total Miles of Stream	Number of Segments Requiring a Given Range of Percent Canopy Closure Increase to Meet the Temperature TMDL Targets				
			0%	1-10%	11-25%	26-50%	>50%
Osier/WF Osier	16	10.6	0	0	1	4	11
China	11	6.2	0	0	1	1	9
Laundry	9	4.6	0	0	2	6	1
Sugar	9	3.9	0	1	5	1	2
Swamp/Pollack	22	10.2	0	2	4	7	9
Total Watershed	67	35.5	0	3	13	19	32

The maps and tables in Appendices 6 through 11 are the TMDLs for the water bodies listed in Table 15. The data for all the temperature TMDLs are available in ArcView format to those reviewing this document or implementing this TMDL. The ArcView shapefiles are on the included diskette. The surrogate water temperature targets are the segment by segment percent stream shading targets determined from the CWE analysis.

For Cold Springs Creek, Cougar Creek, Grizzly Creek, Gravey Creek, Middle Creek, Sneak Creek, and Deception Gulch, the majority of the stream segments require in the range of a 11-50% canopy closure increase to meet the temperature targets. For Cool Creek and Marten Creek, the majority of the stream segments require in the range of a 1-25% increase in canopy closure to meet the temperature targets.

Stream Temperature Reduction Margin of Safety

The CWA requires a margin of safety to ensure that load allocations will result in water quality attainment. In the case of the load allocations for heat in the UNFCRS, there are two levels of margin of safety. As reported in Chapter 3, Temperature Issue Analysis, of Idaho's 1998 303(d) list (DEQ 1999), stream temperature criteria for Idaho do not comport well with support of beneficial uses. In all the temperature TMDLs developed herein for salmonids other than bull trout, reasonable populations already exist in these water bodies. The temperature TMDLs were developed because of numeric exceedances even though the water quality is evidently supporting salmonid spawning as its beneficial use. Further reduction of stream temperatures can only enhance existing conditions that already appear adequate according to the state's metrics. Improving already adequate conditions is the ultimate in

Table 15. Stream segments and shading status for the Cold Springs/Cool, Cougar/Grizzly, Gravey/Marten, Middle, Sneak, and Deception Gulch watersheds.

Stream Name	Total Number of Stream Segments	Total Miles of Stream	Number of Segments Requiring a Given Range of Percent Canopy Closure Increase to Meet the Temperature TMDL Targets				
			0%	1-10%	11-25%	26-50%	>50%
Cold Springs	53	9.2	6	6	19	20	2
Cool	47	7.2	15	9	16	6	1
Total Watershed	100	16.4	21	15	35	26	3
Cougar	56	7.8	4	0	21	24	7
Grizzly	35	6.2	3	1	9	14	8
Total Watershed	91	14.0	7	1	30	38	15
Gravey	80	29.1	10	13	19	31	7
Marten	24	7.8	7	6	8	3	0
Total Watershed	104	36.9	17	19	27	34	7
Middle	73	27.9	2	7	24	24	16
Sneak	76	9.3	10	13	16	23	14
Deception Gulch	18	6.7	0	7	5	4	2

margins of safety. In the case of streams protected for bull trout, the USEPA has set a conservative standard, especially when compared to the standard thought by the state of Idaho to be adequate. The final measure in any case will be the attainment of the applicable water quality temperature standards.

Seasonal Variation

Surrogate targets are set for percent canopy closure, which is largely a year-round feature in coniferous forests. The critical time of the year for stream heating is July and August when percent canopy closure would be at it greatest because the vegetation will be fully leafed out.

Reasonable Assurance

Since no point sources of temperature loading are known to exist in the UNFCRS, reasonable assurance is not a requirement for nonpoint source loadings. However, it is reasonably clear that under the CNF INFISH policy and the FPA CWE project results, there is a large degree of institutionalized commitment to meet the targets set in these temperature TMDLs.

Background

Background stream heating is recognized in these TMDLs as that part of stream heat loading that would occur under a more-or-less natural vegetative canopy. For the most part, this degree of heat loading is not quantified in these TMDLs. The effort of the TMDLs is to identify the human-caused portion of heat loading, and the TMDLs targets are set at removing all human-caused heat loading. Natural background heat loading is assumed to exist more or less independent of human intervention and, as such, is not subject to reduction through any reasonable human management activity.

6.2 Sediment TMDL

Deception Gulch is the only water body in the UNFCRS for which it was concluded that water quality is impaired by sediment such that beneficial uses are impaired. The actual degree of impairment is unknown. Impairment from sediment is primarily the result of several large mass failures that delivered massive amounts of sediment to the stream, most recently during the 1995-96 rain-on-snow event, but also during the 1975-76 rain-on-snow events, and most likely in previous events. The watershed has a history of human use since the mid- to late-1800s when it was a transportation corridor to Moose City and its associated mining district. Since 1996, the delivery of human-caused sediment has been significantly reduced, but not stopped. Potential mass failure sites have not been adequately addressed.

The analysis of sediment loading for Deception Gulch is complicated by the fact that no specific data or standards exist defining the level of sediment beyond which salmonids cannot successfully spawn in this stream. Almost certainly, given the turbidity data from other watersheds in the UNFCRS (Appendix 2, Tables 16-20), Deception Gulch does not exceed the turbidity standard except during rain-on-snow events that cause significant mass failures. These events have occurred on an average of once every 15 years over the last century.

Our decision to develop a TMDL for Deception Gulch is based on the assessment of available data, observations, and other reliable information. Table 11 present a comparison of data from several water bodies similar to Deception Gulch. Swamp, Osier, China, Sugar, and Laundry Creeks are in the same general area as Deception Gulch (Figure 9); all have the same bedrock type (Lower Wallace Formation); all are in the same general elevation range and have similar stream gradients; all exhibit the same suite of landtypes (Moderate Relief Uplands, Mountain Slopelands, Rounded Mountain Slopelands, Dissected Stream Breaklands); and all are Rosgen B type channels. They all exhibit on the order of 1-10 cubic feet per second flow in the summer months, except Swamp Creek, which has on the order of 50 cubic feet per second flow. They are all associated with the Moose Creek mining district, which is interpreted to be an old, highly weathered surface being actively downcut, resulting in a relatively highly erodible surface with an abundance of fine-textured material. Swamp Creek is totally unroaded and not impacted by human activity. Only the headwaters of Sugar Creek have been roaded. Both, however, were severely burned in the early part of the 20th century.

Table 16. Data comparing Deception Gulch to similar water bodies.

	Deception Gulch	Swamp Creek	Sugar Creek	Osier Creek	Laundry Creek	China Creek
Elevation Range (feet)	3,480-5,700	3,350-6,000	3,700-6,100	3,320-5,600	3,480-5,400	3,600-6,000
WBAG Assessment						
MBI[1] Score	5.86	4.48	4.04	4.59	4.83	3.81
HI[2] Score	84	107	107	102	121	106
Salmonids	4+juveniles	3+juveniles	2+juveniles	3+juveniles	3+juveniles	4+juveniles
CNF[3] Stream Habitat Data						
CNF CE[4] (%)	48.6	43.8	64.3	56.1	53.2	48.3
CE Threshold (%)	30-35	30-35	30-35	25-30	25-30	25-30
Gradient (%)	4.7	3.9	3.8	3.5	5.5	3.1
Bank Stability Index	4.8	4.9	5	4.4	4.9	4.8
Raw Banks (m/km)	41.9	nd	nd	62	37	64
Percent Pools	28.5	10.5	20.6	nd	30.8	43.1
Percent Riffles	49	37.6	33.1	nd	67.5	32.6
Fish Density	Mod (?)	Mod	Mod	Mod-Low	Widespread	Widespread
Sediment Source Data						
Equivalent Clearcut Acres (%)	30	0	10	45-50	50	20-30
Road Density (mi/mi^2)	9	0.1	2.4	6.7	7.6	6.1
Roads <100 ft. from Stream (%)	13	0	7	13	11	10
Roads in High Risk Landtypes (%)	50	0	0	13	8	5
Mass Failures (No.)	24	0	0	5	3	1
Mass Failure Density (MF/mi^2)	4.9	0	0	0.6	1	0.2
CWE[5] Erosion Delivery Rating	Moderate	Low	Low	Moderate	Moderate	Moderate

	Deception Gulch	Swamp Creek	Sugar Creek	Osier Creek	Laundry Creek	China Creek
CWE Mass Failure Score	180	0	0	50	30	12
% Sediment over Background	28	0	15	5	12	8
Geomorphic Threshold (%)	163	223	207	196	212	212
Water Quality Objective (%)	150	55	55	110	110	110

[1] Macroinvertebrate biotic index
[2] Habitat index
[3] Clearwater National Forest
[4] Cobble embeddedness
[5] Cumulative watershed effects

When one examines the BURP/WBAG results and the CNF stream habitat data, Deception Gulch exhibits the same relatively good qualities as all the others. The WBAG results by themselves would indicate full support of beneficial uses by Deception Gulch, with a very good MBI score and good fish class distribution. The HI score for Deception Gulch is the weakest of the scores, but still well above the threshold of 73. Similarly, for stream habitat data from the CNF intensive bio-physical studies, Deception Gulch compares favorably with the unentered Swamp Creek and all the others. Cobble embeddedness is high by most standards for good quality spawning, but this is true for all the water bodies in this area, including Swamp Creek, and appears to be a function of the fine-textured, highly weathered nature of the bedrock and the lingering effects of early 20th century fires.

The real concern for Deception Gulch comes from the sediment source data and information which indicate the sediment loading poses a real threat to water quality. Road density in Deception Gulch is about twice of what the CNF considers acceptable for water quality. Of these roads, some 50 percent are on high-risk landtypes, which is a very high percentage. The result is that Deception Gulch has a very high mass failure rate, and most of the mass failures are associated with the roads. While sediment loading from road erosion is somewhat elevated, it is still in the moderate range using the CWE index. The real threat in terms of sediment loading is sediment from the mass failures, most of which have occurred in the past during rain-on-snow events.

All of this together indicates that the sediment problems in Deception Gulch are of a nature and magnitude that reductions in event-based loading should and can be reduced. Analysis of the roads and geology of the watershed indicates that mass failures will continue to occur and degrade the stream. The road system on the west side of the drainage is built on geologic dip slopes that will continue to fail. Forest Service Road 734 shows numerous signs of fill slope slipping. Forest Service Roads 255 and 730 cross the contact between Wallace gneiss and the Revett quartzite where most of the large mass failures have occurred. It is likely that this unstable area will continue to fail. In the final analysis, unlike all the other water bodies listed for sediment in the UNFCRS, the situation here appears to be likely to continue to degrade.

We included sediment from natural background sources and recent management activities when calculating the sediment being delivered to the stream. We relied on data from the landslide inventory and a CWE type road assessment conducted in September 2000 by DEQ personnel. We then compared these data to CNF WATBAL-derived predictions for the levels of sediment over background that would adversely affect channel stability or fish populations.

Sediment Loading and Loading Capacity

There are three major sources of sediment being delivered to Deception Gulch – natural background erosion, roads, and road-related mass failures. Wilson et al. (1982) calculated a natural background sediment rate of 25 tons per square mile per year for most of the CNF. Other research we have seen leads us to think this is a conservative estimate for this particular watershed. The area of the Deception Gulch watershed is approximately 4.7

square miles, resulting in a background sediment rate of approximately 120 tons per year for the watershed.

Twenty-four mass failures have been identified in the watershed, and all of these have an estimated volume range and percent delivery to a stream. These data and the calculations are in an ArcView shapefile named "DecepMF" located on the diskette in the pouch with this document. For each volume range and percent delivery range, we used the midpoint of the range for each mass failure and calculated the total amount of sediment delivered to the stream. For all the mass failures, we calculated the volume delivered to be 3,800 cubic yards. Using a conversion of 1.6 tons per cubic yard, this converts to 6,080 tons of sediment delivered from mass failures.

This amount of material is not delivered every year. Data from McClelland et al. (1997) show that rain-on-snow mass failure events occur on average every 15 years. Converting the 6,080 tons to a yearly basis results in an estimate of approximately 400 tons per year of sediment delivered from mass failures. This is another conservative estimate in-so-far-as it's based on data for all of north-central Idaho, with such massive results unlikely to occur throughout the area. In other words, assuming significant rain-on-snow events occur every 15 years, it is unlikely that the UNFCRS will be hit as hard in every event as it did during the 1996-97 event. Further, this calculation ignores that some percentage of the mass failures would occur naturally – perhaps as much as 100 tons per year, or 25 percent, based on the 120 tons per year background rate. Thirty percent of the mass failures in the larger study area were determined to be natural (McClelland et al. 1997). However, since all the mass failures except one in Deception Gulch were road related, we did not make this adjustment.

However, thinking about these numbers should help establish a loading capacity for sediment from mass failures. If the loading capacity for mass failure produced sediment should be somewhere close to background, or about 100 tons per year, then the target load reduction for mass failure sediment in Deception Gulch should be somewhere around 75 percent. This comports well with the reference watershed data in Table 11 wherein indications are that mass failure density needs to be reduced from about five per square mile to at most one per square mile, or an 80 percent reduction.

We conducted an assessment of road erosion in the Deception Gulch watershed using the FPA CWE methodology (IDL 2000). The results of this assessment are in Appendix 12 and the ArcView shapefile included on the diskette. We then converted the CWE scores to tons per year using a conversion developed by McGreer wherein he conducted both the Washington state watershed analysis and the CWE analysis on three watersheds and correlated the results (McGreer and Schult 1998). About 1.5 miles of USFS Road 255 have significant problems, with a CWE road score of 36. Another 6 miles of roads close to streams received CWE road scores of 20-30 because of delivery potential (Figure 11). The remaining 35 miles of road were each assigned a score of 15. Using the McGreer-developed conversion rates of 20, 10, and 5 tons per mile, respectively, roads in the watershed are delivering approximately 250 tons of sediment per year.

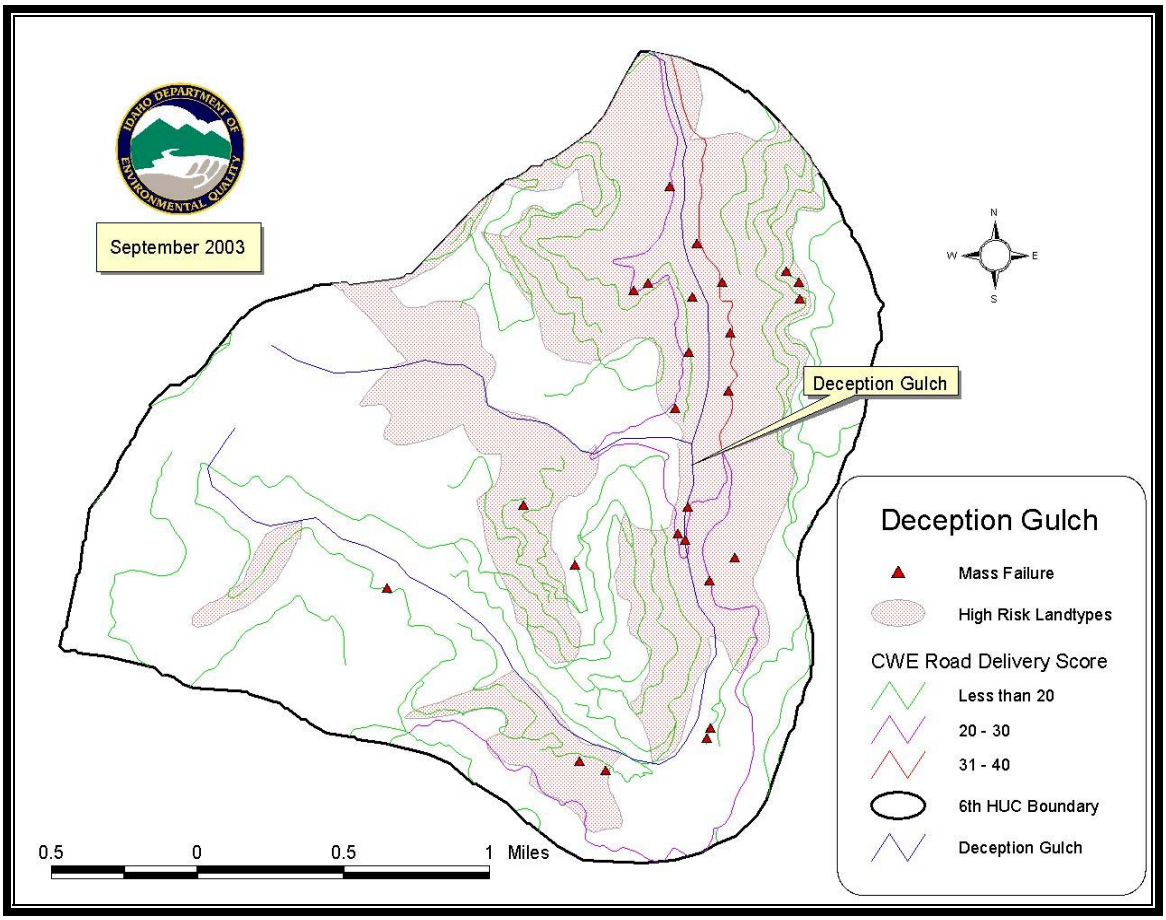


Figure 11. Mass Failures, CWE Roads, and High Risk Landtypes of Deception Gulch

The calculation for sediment from the roads is probably conservative in that other evidence indicates that the sediment from roads is less than 250 tons per year. A CNF WATBAL-generated a figure of 120 tons per year from 31 miles of the roads in this watershed (compared to 42 miles in the GIS database) indicates that McGreer-derived figure may be 50 percent too high. For the CWE assessment, we assigned a minimum CWE score of 15 to a large number of roads that probably in reality have scores no higher than 10-15, as we were unable to field verify their conditions. And, more recent work by McGreer, that is as yet unavailable for use, indicates that sediment production scores for watersheds dominated by metasedimentary rock types are less than for granitics, for which the original relation was developed.

Our conclusion, therefore, is that Deception Gulch has the following major sediment sources:

Background	120 tons/year
Mass Failures	400 tons/year
Road Erosion	250 tons/year
Total Sediment Loading	770 tons/year

We have not found any other sources of sediment of these magnitudes in Deception Gulch. Based on the reference watersheds in Table 11, and as discussed above, it appears that sediment from mass failures would need to be reduced by about 75 percent and from roads by about 50 percent to reduce the threat to water quality to tolerable levels. This would translate into a load capacity of about 340 tons per year.

Excess Sediment Load

The excess sediment load for Deception Gulch depends on a decision about what level of sediment above background is acceptable to be able to maintain beneficial uses of salmonid spawning. The CNF has derived three measures of sediment load over background for this watershed that are instructive (Jones and Murphy 1997; Jones et al. 1997). At 163 percent over background (Table 11, Geomorphic Threshold) (about 300 tons per year loading), one expects adverse conditions in the stream channel. Undoubtedly, Deception Gulch has surpassed this level.

In addition, the CNF uses a fish status classification system in its forest plan (USFS 1987) that relates channel type and threshold percent sediment over background to the viability of fish populations. The classes are as follows (assuming a B channel type for Deception Gulch and its comparable water bodies):

No Effect: No sustained, measurable adverse changes over time due to management-caused effects on turbidity, temperature, substrate composition, and chemical quality; or physical loss or degradation of existing fish habitat potential. The approximate maximum sediment loadings, expressed as increases (%) over natural sediment yields, that generally support this criteria are:

Channel type B – Threshold – 45% over natural background

High Fishable: Maximum short-term reduction of water quality that is still likely to maintain a fish habitat potential that can support an excellent fishery relative to the stream's natural potential and that will provide the capability for essentially full habitat recovery over time….

Channel type B – Threshold for cutthroat – 55% over background

Mod Fishable: Maximum short-term reduction of water quality that is still likely to maintain a fish habitat potential that can support at least a moderate harvestable surplus relative to the streams system's natural potential and that will provide the capability for significant habitat recovery over time.

Channel type B –Threshold for cutthroat – 150% over background

Low Fishable: Maximum short-term reduction of water quality that is still likely to maintain a fish habitat potential that can support at least a minimal harvestable surplus relative to the streams potential and that will provide the capability for some significant recovery over time.

Channel type B – Threshold for cutthroat – 225% over background

Min Viable: Maximum short-term reduction of water quality that is still likely to maintain a fish habitat potential that can support at least a viable fish population and that will provide the capability for some significant habitat recovery over time.

Channel type B – Threshold for cutthroat – 450% over background

We consider that for a population to be "viable," it must have enough individuals and enough interconnected, suitable habitats to have a high probability of long-term persistence. Thus, if a population is indeed "viable" as defined by the CNF, then the waters in which the population occurs would also meet the following definition of waters protected for "salmonid spawning" in Idaho's water quality standards: "waters that provide or could provide a habitat for active, self-propagating populations of salmonid fishes." Therefore, the CNF goal of "minimum viable," if met, would support salmonid spawning. The CNF goal of "low fishable," which is defined as water providing a harvestable surplus in addition to maintaining viability, would exceed the minimum standard of salmonid spawning as defined by Idaho's water quality standards, subsection 100.01(b). Idaho's water quality standards are silent on harvest goals, since Idaho considers that to be a fisheries management issue, not an issue of meeting water quality standards.

Based on our analyses of data from all the 303(d) listed streams in the UNFCRS, we recognize that these streams have a considerable capacity for sediment loading above background and still support salmonid spawning. Assuming similar sediment production and delivery in Deception Gulch compared to the other streams listed in Table 11, it would require about a 50 percent reduction (125 tons per year) in roads and an 80 percent (320 tons per year) reduction in mass failures, or about 445 tons per year total, for Deception Gulch to have similar conditions. A 445 tons per year sediment reduction would result in about 325 tons per year sediment loading, which translates to 171 percent over background. This would bring Deception Gulch well below the range of the CNF's "low fishable" sediment loading of 225 percent over background. So we think we're in the right ballpark and well within what might be called a reasonable definition of support of beneficial uses.

After considering this information, we established the conservative target of 225 percent (390 tons per year) over background sediment load as the level beyond which the sediment load would be excessive. This target is a level where our data and predictions by the CNF WATBAL procedure say that beneficial uses will be supported. Already, the BURP/WBAG assessment, the CNF stream habitat data, and the fish population indicate that current water quality of Deception Gulch is not seriously limited in relation to the state standard. A 50 percent reduction in the number of miles of roads and an 80 percent reduction in the number of mass failures for this watershed, as called for in the surrogate targets below, would bring road and mass failure densities well down into the range of other watersheds in this subbasin where we know salmonid spawning is being fully supported.

Excess Sediment Load Allocation

The only major sources of sediment that create the excess load are roads and mass failures associated with roads. Sediment resulting from road erosion is truly a nonpoint source.

Mass failures occur at particular points, but since their location cannot be predicted, they are considered nonpoint sources as well. There are no known point sources of sediment in the watershed. Therefore, 100 percent of the load is allocated to nonpoint sources affecting the water quality limited stream. One hundred percent of the excess load is allocated to road construction and road maintenance activities.

Excess Sediment Load Reduction Targets

Based on the reasoning above, we use 225 percent over background, or 390 tons per year, as a target for sediment loading. Since the total loading is 770 tons per year, the load reduction target is 380 tons per year. This converts to about a 50 percent sediment loading reduction.

Surrogate Sediment Load Reduction Targets

If our analysis of the situation is correct, then it is clear that a 390 tons per year target cannot be attained if mass failures are not largely contained. If only road erosion and background sedimentation are considered, then sediment loading is only 370 tons per year. However, since the occurrence of mass failures is episodic depending on weather and, therefore, is not predictable, surrogate targets of mass failures *per se* really aren't measurable. But virtually all the mass failures are associated with roads, and even more are associated with roads on high hazard landtypes (Figure 11). In order to reduce the potential for mass failures during the next major rain-on-snow event, the number miles of roads with high potential for mass failure should be reduced. Reducing the number of miles of roads on high-risk landtypes will, over the long term, reduce sediment from both roads and mass failures.

Of the 42 miles of roads in the Deception Gulch watershed, about half are on high hazard landtypes, and 20 of the 24 mass failures occurred on high hazard landtypes (Figure 11). The CNF has the objective of obliterating approximately one-third of the roads on the forest. In the case of Deception Gulch, in order to reduce the potential of sediment from mass failures as a function of this TMDL, we recommend obliteration of half the 42 miles of roads, concentrating on the roads on hazardous landtypes. In addition, we recommend reducing the mass wasting hazard on roads that will not be obliterated. We recognize that the CNF may need five or more years to accomplish these tasks, which will be dependent on securing funding for the work. Reducing roads by half would reduce road-generated sediment to about 120 tons per year. Based on the fact that about 80 percent of the current mass failures are associated with roads on high hazard landtypes, eliminating roads in high hazard areas should reduce mass failures by 80 percent, or to around 80 tons per year. This would result in a sediment load from background, roads, and mass failures of around 325 tons per year, somewhat under the 390 tons per year TMDL target.

Sediment Reduction Margin of Safety

Throughout this section on sediment loading analysis and reduction targets, we have pointed out where we have made conservative calls. Most conservative of all, we chose a loading target of 225 percent over background, which is almost a 60 percent margin of safety over the CNF's 450 percent over background loading for minimum viable fishery. There are no particular data to suggest that the 450 percent over background loading is not the correct

target. Even at the current loading level of 770 tons per year, BURP/WBAG stream habitat and fish data seem to indicate that beneficial uses are being supported. We chose a lower loading level target specifically to reduce the threat of sediment to water quality and build in a margin of safety based on our knowledge of the subbasin. The background sediment delivery rate used in our calculations is low such that the percentages over background targets are also low. Calculations for mass failure-produced sediment are based on what is probably a worst-case scenario – it is unlikely that the North Fork Clearwater River will be the center of worst occurrence of mass failures in the next rain-on-snow event. Our loading figure from roads is probably high, perhaps by as much as 50 percent. Adherence to our recommendations of obliterating at least half the roads, focusing on roads on high hazard landtypes, and reducing the potential for mass failures on the remaining roads, will reduce sediment delivery potential in the watershed to well below the target.

Seasonal Variation

Sediment loading in Deception Gulch occurs primarily in late winter and early spring during snow melt, rain events, and rain-on-snow events. Some loading may occur during high-intensity rain events in the summer and fall. The management of roads to reduce the risk of mass failures and runoff should account for the situations that occur during these few times out of the year.

Reasonable Assurance

Since all of the load allocation is to nonpoint sources, no reasonable assurance is required for this TMDL. However, the CNF has set itself the goal of reducing roads in Deception Gulch by as much as 60 percent. They are well focused on the roads on the high hazard landtypes. Appendix 15 shows the results of those activities to date.

Background

Wilson et al. (1982) calculated a natural background sediment rate of 25 tons per square mile per year for most of the CNF. Other research we have seen leads us to think this is a conservative estimate for this particular watershed, given the highly weathered and erosive nature of the bedrock. In addition, the watershed is highly susceptible to natural mass failures as a result of dip slopes greater than 100 percent and the bedrock contact between the Wallace and Revett Formations. The area of the Deception Gulch watershed is approximately 4.7 square miles, resulting in a background rate of approximately 120 tons per year for the watershed, using the 25 tons per square mile per year estimate of Wilson et al. (1982).

6.3 Implementation Strategy

"An implementation plan identifies and describes the specific pollution controls or management measures to be undertaken, the mechanisms by which the selected pollution control and management measures will be put into action, and describes the authorities, regulations, permits, contracts, commitments, or other evidence sufficient to ensure that

implementation will take place. The plan also describes when implementation will take place, identifies when various tasks or action items will begin and end, when mid-term and final objectives will be met, and establishes dates for meeting water quality targets," (Dailey et al. 1999, p 67).

Development of the UNFCRS implementation plan will occur through a collaborative process involving a number of entities and interested parties, including landowners, land managers, and resource agencies. Further details on the parties involved, contents, and the timeframe for development of the plan are included in later sections of this strategy. DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

Implementation of the TMDLs presented in this document should occur in an integrated fashion to address the pollutants in a cost effective manner. The major human-caused sediment sources that have been identified in the Deception Gulch include roads, forestry, eroding stream banks, and mass failures. Temperature problems are widespread and occur in many of the same areas with many of the same causes.

Application of effective BMPs is crucial to achieving the pollutant load reductions and targets of the TMDLs. Consequently, the implementation plan, to the extent practicable, must be explicit about which BMPs or systems of BMPs will be employed to achieve the targets, where and when the BMPs will be employed, and how application of the BMPs will achieve the stated targets. The USEPA (1991) guidance specifically identifies several criteria by which BMPs will be judged:

- A data-based analysis showing that the selected BMPs have been demonstrated to be effective in addressing the issue or pollutant in question (i.e., a history of successful application in similar situations);
- An explanation of the mechanisms by which application of the BMPs will be assured; and
- A plan for tracking the implementation and effectiveness of the BMPs.

As implementation progresses, pollutant reductions may be accomplished in a variety of ways at the discretion of the implementing landowners, managers, and agencies.

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

The following are issues with each one of the TMDL pollutants that should be kept in mind while developing an implementation plan.

Temperature

Implementing this TMDL will be a long-term affair while trees reestablish themselves and grow back along the streams to provide the level of shading required to reduce stream temperatures. In that time frame, it is expected that the CNF, IDL, and Potlatch Corporation will reevaluate the condition of these water bodies many times and regularly monitor their progress towards meeting the temperature targets. This TMDL identifies the general locations and magnitudes of the shading problems and sets the targets for percent canopy closure. The land managers will develop and implement the specific plans to attain the percent canopy closure targets.

Shade targets are established in the TMDLs as surrogate measures necessary to achieve temperature criteria. While specific information and direction regarding how these targets are to be implemented will be established in the implementation plan, certain general considerations accompany these targets.

Riparian areas along streams do not naturally exhibit 100 percent canopy cover for the entire length of the streams. Natural events (fires, landslides, wind events) may affect riparian vegetation along small stream segments or entire streams. In addition, larger streams (i.e., Middle Creek, lower Orogrande Creek) have larger stream widths that do not allow for a high canopy closure. Also, colder habitat types typically found at high elevations or in cold air drainages often do not support 100 percent canopy cover. We have not attempted to sort out these site-specific conditions in relation to the CWE predictions, but leave it for the land managers as they develop their implementation plans.

The overall intent is to meet temperature criteria by increasing shade, or in areas where shade targets are already met, to maintain natural shade levels, which incorporate natural disturbance regimes (e.g., fire, mass wasting, insects, disease, etc.). While these shade targets do not preclude management of the riparian zone, only activities that will result in negligible shade reduction, or through careful evaluation will result in long-term benefits in terms of stream temperature, are consistent with the targets.

Application of these targets is expected to be carried out at a stream reach scale. Typically the stream reaches are 0.5 mile in length, but this may vary considerably given the nature and size of the stream. In all cases, a site evaluation will be essential in order to 1) confirm current shade conditions, 2) confirm channel conditions, 3) determine why shade is above or below target values, and 4) establish appropriate BMPs. While the shade targets provide a useful goal for restoration, the key to implementation is to tailor management to the problems unique to each stream reach.

In much of the watershed it is expected that shade targets will be achieved through passive restoration, that is, allowing vegetation to grow to a mature state. In some locations (e.g., dredge mined areas, grazed areas), active restoration through plantings and channel modification may be warranted.

There may be circumstances in which it is necessary to temporarily reduce shade in order to achieve increased shade and ecological health in the long term. For example, active channel restoration or prescribed fire may temporarily reduce existing shade, but lead to long-term temperature benefits. These activities would be consistent with TMDL targets, provided they are carefully evaluated to establish whether or not the long-term temperature benefits outweigh the short-term loss of shade.

In still other areas, it is recognized that it may not be possible to achieve the desired shade due to essentially irreversible human caused changes, such as major roads or railroads adjacent to the stream. In these areas, it is expected that the implementation plan will identify local or other offsetting measures (e.g., plantings along the stream) that would minimize the effects of permanent human-caused shade loss.

Sediment

Specific BMPs for sediment for forestry activities will be identified in the implementation plan. The following are a few examples of the many forest practices that could be implemented to reduce sediment.

- Road improvements including culvert and stream crossing upgrades, sidecast removal or reduction, road removal or closure, stabilizing cut and fill banks, hardening surfaces, and improving maintenance.

- Road decommissioning and obliteration.

- Stabilizing mass failures.

- Land management activities that attenuate water yield, such as wetland and riparian buffer enhancement/development and no-till agriculture.

- Instream habitat restoration in intensively altered areas including reestablishing historic fluvial processes, pool frequency, pool depth etc. through channel reconstruction.

Approach

The implementation plan will be developed jointly through a collaborative process involving landowners, land managers, responsible resource agencies, and other interested parties. Contents of the implementation plan are expected to include:

- A description of how targets are to be attained (e.g., explains details of how to implement CWE targets).
- An identification of BMPs and BMP locations.
- An identification of existing efforts that will help achieve TMDL goals.
- An implementation schedule with milestones based on restoration priorities.
- Provisions to seek funding sources and sponsoring agencies.

Reasonable Assurance

Reasonable assurance of the implementation of nonpoint source control actions is required in a TMDL when point source waste load allocations are made less restrictive as a result of expected reductions from nonpoint source allocations (USEPA 1991). Since no point sources are identified or receive allocations in these TMDLs, reasonable assurance of nonpoint source control actions is not relevant to these TMDLs.

Nonetheless, for forested areas in the UNFCRS, water quality problems caused by nonpoint sources of sediment and heat are improving as a result of work by land managers, federal policies, and the Idaho's FPA. There is no reason to expect that the trend will not continue. The TMDLs identify areas of highest pollutant input and should allow for prioritization of areas for additional work.

Time Frame

Implementation plans are to be developed within 18 months of USEPA approval of the TMDL and are intended to achieve the water quality goals provided in a TMDL package. Implementation of nonpoint source controls has already begun, but is expected to proceed more rapidly once the implementation plan is complete and funds are available. The sources of pollutant loading are nonpoint in origin, and realistically it may take many years if not decades to fully achieve the goals of the TMDL. In order to substantially decrease stream temperatures, mature riparian communities and a stable hydrologic regime and stream channel are needed. In smaller streams and watersheds, significant improvement may be seen in a few years. Realistically though, it is likely to take decades to see such improvement throughout the watershed given the large scale of needed improvements and the time frame needed to for riparian vegetation to grow to maturity.

Participating Parties

Responsible agencies and interest groups are expected to play an important role in developing and implementing restoration measures. The primary responsible agencies are the CNF, Potlatch Corporation, IDL, and DEQ. Other organizations or entities that may be interested in participating are the Clearwater County Soil and Water Conservation District, the Idaho Department of Water Resources, USEPA, Idaho Fish and Game, USFWS, the Nez Perce Tribe, local highway districts, industries, local county government, environmental groups, and local landowners.

Monitoring Strategy

Monitoring needs include continued monitoring of in-stream temperatures and monitoring to establish reach-specific shade targets. Monitoring for stream temperature trends and standards attainment should occur near the mouths of each of the water bodies. A total of 18 monitoring points should be established in the UNFCRS, primarily at the mouths of each of the water bodies for which a TMDL has been written. Stream temperature should be monitored using a device that at a minimum can make hourly recordings over the course of

six months, encompassing the critical months of July and August. Monitoring should occur every summer until such time as the water quality standards are attained, or until this TMDL is revised and another plan established.

As with temperature, improvements in sediment conditions in Deception Gulch should be monitored. One to several types of data should be monitored to see whether control measures are being put in place. The implementation plan will identify how monitoring data will be acquired, organized, and maintained.

Surrogate targets for sediment have been set for percent reduction in road miles and associated percent reduction of road miles on high mass failure hazard landtypes. Documentation of these activities should be acquired and maintained by the CNF.

It is recommended as well that the CNF monitor in-stream habitat in Deception Gulch for an improving trend. It is recommended that the CNF will establish long-term monitoring sites for cobble embeddedness and/or several habitat parameters at two locations in Deception Gulch. In addition to reduced loading as documented by the above surrogate targets, the TMDL will be successful only if a statistically significant improving trend of stream habitat is demonstrated. This trend monitoring is a measure of BMP effectiveness.

6.4 Summary and Conclusions

This subbasin assessment and TMDLs have been developed to comply with Idaho's water quality standards and TMDL schedule. The first part of this document, the subbasin assessment, describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the UNFCRS located in north-central Idaho. The starting point for the assessment was Idaho's 1998 303(d) list of water quality limited water bodies. Nineteen stream segments in the UNFCRS were included on this list. The subbasin assessment portion of this document examines the current status of 303(d) listed waters. It defines the extent of impairment and causes of water quality limitation throughout the subbasin.

Temperature analyses were conducted of all the 303(d) listed streams in light of an extensive database indicating that no stream in the UNFCRS, not even those in relatively pristine condition, meets the Idaho numeric temperature criteria for salmonid spawning. However, the Idaho water quality standards recognize that stream temperatures may naturally exceed numeric criteria and that pollution control measures should only address the human-caused increases in temperature. The nonpoint temperature assessments assumed that the human-caused effects were increased solar insolation, primarily a result of reduced streamside vegetation and, secondarily, a result of increased stream width. Shading analyses were conducted on all 303(d) listed streams in the subbasin. The human-caused stream temperature increase was quantified in terms of the percent decrease in stream shade. Targets were set based on best estimates of natural conditions for stream shade and stream width.

Sediment loading in Deception Gulch was determined to be threatening beneficial uses of the water body. Excessive loading was identified as coming from road erosion and mass failures associated with roads. Loading rates were compared to several very similar watersheds, and targets were set for reducing sediment loading in Deception Gulch to levels that support beneficial uses in all the other water bodies compared.

Implementation of nonpoint source controls has already begun, but is expected to proceed in earnest once the implementation plan is complete and funds are available. The sources of temperature and sediment loading are nonpoint in origin, and realistically it may take many years, if not decades, to fully achieve the goals of the TMDL. In order to improve stream temperature, restored riparian communities and stream channels are needed. In smaller streams and watersheds, for example, significant improvement may be seen in several years. It is likely to take decades to see such improvement throughout the watershed given the large scale of needed improvements and the time needed for riparian vegetation to grow to maturity.

It is expected that implementation of the TMDLs as presented in this document will result in full restoration of the waters of the UNFCRS to meet the Idaho water quality standards. Further, this restoration will contribute substantially to improved habitat for threatened and endangered aquatic species in the subbasin.

References Cited

Adams, T.N. and K. Sullivan, 1990. The Physics of Forest Stream Heating: 1) A Simple Model. Weyerhaeuser Tech. Rep. 044-5002/90/1. Weyerhaeuser Co., Tacoma, WA. 30+p.

Alt, D.D. and D.W. Hyndman, 1989. Roadside Geology of the Northern Rockies. Mountain Press Publishing Company, Missoula, MT. 280 pp.

American Geological Institute, 1962. Dictionary of Geological Terms. Doubleday and Company, Garden City, NY. 545 pp.

Armantrout, N.B., compiler, 1998. Glossary of Aquatic Habitat Inventory Terminology. American Fisheries Society, Bethesda, MD. 136 pp.

Bartholow, J., 1997. Stream Segment Temperature Model (SSTEMP) Version 3.9 Program and Documentation Revised September 1997. Temperature Model Technical Note #2. U.S.G.S. River Systems Management Section, Midcontinent Ecological Science Center, Fort Collins, CO. 14 pp.

Batt, P.E., 1996. Governor Philip E. Batt's Idaho Bull Trout Conservation Plan. State of Idaho, Office of the Governor, Boise, ID. 20 pp + appendices.

Beschta, R.L. and J. Weatherred, 1984. A Computer Model for Predicting Stream Temperatures Resulting from the Management of Streamside Vegetation. USDA Forest Service. WSDG-AD-00009.

Boyd, M.S., 1996. *Heat Source*; Stream Temperature Prediction. Master's Thesis, Dept. Of Civil and Bioresource Engineering, Oregon State Univ. Corvallis, OR.

Brennan, T.S., A.M. Campbell, A.K. Lehmann, and I. O'Dell, 1999. Water Resources Data, Idaho, Water Year 1999: Volume 2. Upper Columbia River Basin and Snake River Basin below King Hill. Water-Data Report ID-99-2. USDI/USGS. 440 pp.

Brown, G.W., 1971 Water Temperature in Small Streams as Influenced by Environmental Factors and Logging. Proceedings: Symposium for Land Uses and Stream Environment. Oregon State University, Oct. 19-21, 1970. pp. 175-181.

Caswell, James L., 1997. Written Communication to Bill Clark, DEQ Boise, Discussing 1996 WQLS Listed Streams Proposed for Removal from the 1998 303(d) List. 13 pp.

Clean Water Act (Federal Water Pollution Control Act), U.S.C. § 1251-1387 (1972).

Clearwater Basin Bull Trout Technical Advisory Team, 1998. North Fork Clearwater River Basin Bull Trout Problem Assessment. Prepared for the State of Idaho. 68 pp.

Clearwater Biostudies, Inc., 2003. Habitat Conditions and Salmonid Abundance in Deception Gulch, North Fork Ranger District, Summer 2002. Prepared for USDA Forest Service, Clearwater National Forest, Orofino, Idaho. Contract No. 53-0276-8-98. 22 pp + app.

Clearwater Biostudies, Inc., 1999. Habitat Conditions and Salmonid Abundance in Selected Streams in the Quartz Creek Drainage, North Fork Ranger District, Summer 1998. Prepared for USDA Forest Service, Clearwater National Forest, Orofino, Idaho. Contract No. 53-0276-7-88. 69 pp + app.

Clearwater Biostudies, Inc., 1998a. Habitat Conditions and Salmonid Abundance in Selected Streams within the Orogrande Creek Drainage, Pierce Ranger District, Summer 1997. Prepared for USDA Forest Service, Clearwater National Forest, Orofino, Idaho. Contract No. 53-0276-7-88. 130 pp + app.

Clearwater Biostudies, Inc., 1998b. Habitat Conditions and Salmonid Abundance in Selected Streams within the Washington Creek Drainage, North Fork Ranger District, Summer 1997. Prepared for USDA Forest Service, Clearwater National Forest, Orofino, Idaho. Contract No. 53-0276-7-88. 80 pp + app.

Clearwater Biostudies, Inc., 1997. Habitat Conditions and Salmonid Abundance in Selected Streams within the Cold Springs Drainage, North Fork Ranger District, Summer 1996. Prepared for USDA Forest Service, Clearwater National Forest, Orofino, Idaho. Contract No. 53-0276-6-30. 38 pp + app.

Clearwater Biostudies, Inc., 1995a. Habitat Conditions and Salmonid Abundance in China and Laundry Creeks, North Fork Ranger District, Summer 1994. Prepared for USDA Forest Service, Clearwater National Forest, Orofino, Idaho. Contract No. 53-0276-3-46. 26 pp + app.

Clearwater Biostudies, Inc., 1995b. Habitat Conditions and Salmonid Abundance in the Sheep and Sneak Creek Drainages, North Fork Ranger District, Summer 1994. Prepared for USDA Forest Service, Clearwater National Forest, Orofino, Idaho. Contract No. 53-0276-3-46. 30 pp + app.

Clearwater Biostudies, Inc., 1989. Stream Conditions and Salmonid Abundance in Swamp Ridge Area, North Fork Ranger District, Summer 1989. Prepared for USDA Forest Service, Clearwater National Forest, Orofino, Idaho.

Dailey, G., C. Bidondo, and T. Maguire, 1999. Idaho Nonpoint Source Management Plan. Water Quality Program, Division of Environmental Quality, State of Idaho, Boise ID. 120 pp + 7 app.

[DEQ] Idaho Division of Environmental Quality, 1999. Idaho Division of Environmental Quality 1998 303(d) List, 5 chaps.

[DEQ] Idaho Division of Environmental Quality, 1996. 1996 Water Body Assessment Guidance: A Stream to Standards Process. Prepared for the State of Idaho by the IDEQ Watershed Monitoring and Analysis Bureau. 109 pp.

Espinosa, F.A., J.J. Rhodes, and D.A. McCullough, 1997. The Failure of Existing Plans to Protect Salmon Habitat in the Clearwater National Forest in Idaho. J. of Environmental Management, 49:205-230.

Furniss, M.J., T.D. Roelofs, and C.S. Yee, 1991. Road Construction and Maintenance. Chapter 8 in William R. Meehan's Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. Am. Fisheries Soc. Special Pub. No. 19.

Grafe C.S., C.A. Mebane, M.J. McIntyre, D.A. Essig, D.H. Brandt, and D.T. Mosier, 2002. The Idaho Department of Environmental Quality Water Body Assessment Guidance, second ed. Department of Environmental Quality, Boise, ID. 114 pp.

Greenborg A.E., L.S. Clescevi, and A.D. Eaton AD, editors, 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, Washington, DC. 900 pp.

Hughes R.M., 1995. Defining Acceptable Biological Status by Comparing with Reference Condition. In: Davis WS, Simon TP, editors. Biological Assessment and Criteria: Tools or Water Resource Planning. CRC Press, Boca Raton, FL. pp 31-48.

Idaho Code § 39.3611. Development and Implementation of Total Maximum Daily Load or Equivalent Processes.

Idaho Code § 3615. Creation of Watershed Advisory Groups.

IDAPA 58.01.02. Idaho Water Quality Standards and Wastewater Treatment Requirements.

[IDL] Idaho Department of Lands, 2000. Forest Practices Cumulative Watershed Effects Process for Idaho. Idaho Department of Lands, Boise, ID. Chaps. A – J + 2 app.

[IDL] Idaho Department of Lands, 1998. Rules Pertaining to the Idaho Forest Practices Act, Title 38, Chapter 13, Idaho Code (and) the Idaho Forestry Act and Fire Hazard Reduction Laws, Title 38, Chapters 1 and 4, Idaho Code. Idaho Department of Lands, Boise, ID. Variously numbered.

Isabella Wildlife Works, 1998a. Aquatic Survey Report, Gravey Creek Drainage, Powell Ranger District, Clearwater National Forest. Contract #53-0276-5-19.

Isabella Wildlife Works, 1998b. Aquatic Survey Report, Middle Creek Drainage, Pierce Ranger District, Clearwater National Forest. Contract #53-0276-7-87. 280 pp.

Isabella Wildlife Works, 1996. Fisheries Survey Report, Osier Creek Drainage, North Fork Ranger District, Clearwater National Forest. Contract 53-0276-5-17. 229 pp

Jones, R.M., 1999. Stream Channel Morphology and Water Quality Monitoring Results: A Comparison of a Managed and Unmanaged Watershed. Swamp and Osier Creeks, North Fork Ranger District, Clearwater National Forest, Orofino, Idaho. 32 pp.

Jones, R.M., J. Mital, and P.K. Murphy, 1997. Watershed Sensitivity: Clearwater National Forest. Clearwater National Forest, Orofino, Idaho, 23 pp.

Jones, R.M. and P.K. Murphy, 2000. Personal communication. Hydrologist and Fisheries Biologist, respectively, Clearwater National Forest, Orofino, Idaho.

Jones, R.M. and P.K. Murphy, 1997. Watershed Condition Clearwater National Forest. Clearwater National Forest, Orofino, Idaho. 49 pp.

Karr JR. 1991. Biological Integrity: A Long-neglected Aspect of Water Resource Management. Ecological Applications 1:66-84.

Lewis, R.S., 2000. Personal Communication. Staff Geologist of the Idaho Geological Survey, Moscow, ID.

Lewis, R.S., R.F. Burmester, M.D. McFaddan, B.A. Eversmeyer, C.A. Wallace, and E.H. Bennett, 1992. Geologic Map of the Upper North Fork of the Clearwater River Area, Northern Idaho. Idaho Geologic Survey Press, Moscow, ID. Geologic Map Series, Scale 1:100,000.

McClelland D.E., R.B. Foltz, W.D. Wilson, T.W. Cundy, R. Heinemann, J.A. Saurbier, and R.L. Schuster, 1997. Assessment of the 1995 & 1996 Floods and Landslides on the Clearwater National Forest, Part 1: Landslide Assessment. A Report to the Regional Forester, Northern Region, USFS, Missoula, Montana.

McGreer, D. and D. Schult, 1998. Forest Road Sediment Control for 303(d) Watersheds Listed for Sediment: A Proposed Approach. Intermountain Forest Industries, Coeur d'Alene, ID.

Murphy, P.K., R.M. Jones, and J.M. Mital, 2000. Clearwater National Forest Watershed and Fisheries Monitoring Plan, 1999. Clearwater National Forest, Orofino, ID. 67 pp.

National Climatic Data Center - ClimVis Regional Data Summaries, at website: http://www.ncdc.noaa.gov/onlineprod/drought/xmgrg3.html

[NRCS] USDA Natural Resources Conservation Service. Western Climatic Center Data. HTTP://www.wcc.nrcs.usda.gov/

Patten, R., 1989. Watershed Response Model for Forest Management. WATBAL Technical Users Guide. Clearwater National Forest, Orofino, Idaho.

Pfankuch, D. 1978. Stream Reach and Channel Stability Evaluation. USDA Forest Service, Region 1, Missoula, Montana. 26 pp.

Psyk, Christine, Manager, Watershed Restoration Unit, USEPA, Region 10, Seattle, WA. Letter dated October 12, 2001 *to:* David Mabe, Administrator, State Water Quality Programs, Idaho Department of Environmental Quality, Boise, Idaho. *Re:* Approach for developing temperature Total Maximum Daily Loads (TMDL) for Idaho waterbodies on 303(d) List. 2 pp.

Rand G.W., editor, 1995. Fundamentals of Aquatic Toxicology: Effects, Environmental Fate, and Risk Assessment, Second Edition. Washington, DC: Taylor and Francis. 1125 p.

Rosgen, David, 1994. A Classification of Natural Rivers. Catena 22:169-199.

Seaber, P.R., F.P. Kapinos, and G.L. Knapp, 1984. State Hydrologic Unit Maps. U.S. Geological Survey Open-File Report 84-708. 22 pp + app.

SNOTEL data. Snow Telemetry Stations Data. HTTP://idsnow.id.nrcs.usda.gov/

Strahler A.N., 1957. Quantitative Analysis of Watershed Geomorphology. American Geophysical Union Transactions 38:913-920.

Sugden, B.D., T.W. Hillman, J.E. Cladwell, and R.J. Ryel, 1998. Stream Temperature Considerations in the Development of Plum Creek's Native Fish Habitat Conservation Plan. Plum Creek Timber Company, Columbia Falls, Montana. 57 pp. + attachments.

Sullivan, K. and T.N. Adams, 1990. The Physics of Forest Stream Heating: 2) An Analysis of Temperature Patterns in Stream Environments Based on Physical Principles and Field Data. Weyerhaeuser Tech. Rep. 044-5002/90/1. Weyerhaeuser Co., Tacoma, Washington. 50+p.

Theurer, F.D., K.A. Voos and W.J. Miller, 1984. Instream Water Temperature Model. Instream Flow Information Paper No. 16. USDI Fish and Wildlife Service. FWS/OBS-84/15.

University of Idaho Meteorological Data. HTTP//www.uidaho.edu/~climate

U.S. Bureau of Mines, US Geological Survey, Idaho Geological Survey, 1993. 1990-92 Evaluation of the Mineral Resources of the Upper North Fork of the Clearwater River.

U.S. Congress, 1968. Public Law 90-542, Wild and Scenic Rivers Act. 90th United States Congress, S.119.

U.S. Congress, 1977. Public Law 95-217: Federal Water Pollution Control Act as Amended by the Clean Water Act of 1977.

[USFS] USDA Forest Service, 1999a. Final Environmental Impact Statement, Upper North Fork Clearwater Face, North Fork Ranger District, Clearwater National Forest, Orofino, Idaho. 15 pp.

[USFS] USDA Forest Service, 1999b. North Fork Big Game Habitat Restoration on a Watershed Scale (BHROWS Assessment). North Fork Ranger District, Clearwater National Forest, Orofino, Idaho. 129 pp + app.

[USFS] USDA Forest Service, 1999c. Removing Roads and Restoring Watersheds on the Clearwater National Forest: Clearwater National Forest Briefing Paper. Clearwater National Forest, Orofino, Idaho.

[USFS] USDA Forest Service, 1997. An Assessment of Ecosystem Components in the Columbia Basin and Portions of the Klamath and Great Basins, Volume III. Pacific Northwest Research Station. PNW-GTR-405.

[USFS] USDA Forest Service, 1996. Integrated Scientific Assessment for Ecosystem Management in the Interior Columbia Basin. Pacific Northwest Research Station. PNW-GTR-382.

[USFS] USDA Forest Service, 1995. Inland Native Fish Strategy Environmental Assessment. Decision Notice and Finding of No Significant Impact. Intermountain, Northern, and Pacific Northwest Regions.

[USFS] USDA Forest Service, 1987. Forest Plan. Clearwater National Forest, Orofino, Idaho. 5 chap + app.

[USDA/NRCS] USDA Natural Resources Conservation Service, 1998. Idaho Annual Precipitation. National Cartography and Geospatial Center, Fort Worth, TX. 1 map.

[USEPA] U.S. Environmental Protection Agency, 1997. 21 July 1997 Amendment to 40 CFR Part 131, Section 131.33.

[USEPA] U.S. Environmental Protection Agency, 1997. Guidelines for Preparation of the Comprehensive State Water Quality Assessments (305(b) reports) and Electronic Updates: Supplement. EPA-841-B-97-002B. Washington, DC: U.S. Environmental Protection Agency. 105 p.

[USEPA] U.S. Environmental Protection Agency, 1996. Biological Criteria: Technical Guidance for Streams and Small Rivers. EPA 822-B-96-001. Washington, DC: U.S. Environmental Protection Agency, Office of Water. 162 p.

[USEPA] U.S. Environmental Protection Agency, 1995. Code of Federal Regulations, Title 40, Protection of Environment, Chapter 1, Subchapter D, Part 130, Section 130.7.

[USEPA] U.S. Environmental Protection Agency, 1991. Guidance for Water Quality-based Decisions: The TMDL Process, EPA 440/4-91-001, Office of Water (WH-553), Washington, D.C.

[USGS] U.S. Geological Survey, 1987. Hydrologic Unit Maps. Denver, CO: United States Geological Survey. Water Supply Paper 2294. 63 p.

Water Pollution Control Federation. 1987. The Clean Water Act of 1987. Alexandria, VA: Water Pollution Control Federation. 318 p.

Water Quality Act of 1987, Public Law 100-4 (1987).

Water Quality Planning and Management, 40 CFR 130.

Western Regional Climatic Center. HTTP://www.wrcc.dri.edu/

Wilson, W.D., R. Patten, and W.F. Megahan, 1982. Systematic Watershed Analysis Procedure for Clearwater National Forest. Transportation Research Record 892. National Academy of Sciences, National Research Council, Transportation Research Board: 50-56.

Wilson, D., J. Coyner, and T. Deckert, 1983. Land System Inventory of the Clearwater National Forest (First Review Draft). Clearwater National Forest, Orofino, Idaho. 398 pp.

Zwieniecki, M.A. and M. Newton, 1999. Influence of Streamside Cover and Stream Features on Temperature Trends in Forested Streams of Western Oregon. Western J. App. Forestry 14(2):106-113.

GIS Coverages:

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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 waterbodies 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.
Adsorption	The adhesion of one substance to the surface of another. Clays, for example, can adsorb phosphorus and organic molecules
Aeration	A process by which water becomes charged with air directly from the atmosphere. Dissolved gases, such as oxygen, are then available for reactions in water.
Aerobic	Describes life, processes, or conditions that require the presence of oxygen.
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 waterbodies, 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.

Adjunct	In the context of water quality, adjunct refers to areas directly adjacent to focal or refuge habitats that have been degraded by human or natural disturbances and do not presently support high diversity or abundance of native species.
Alevin	A newly hatched, incompletely developed fish (usually a salmonid) still in nest or inactive on the bottom of a waterbody, living off stored yolk.
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.
Anoxia	The condition of oxygen absence or deficiency.
Anthropogenic	Relating to, or resulting from, the influence of human beings on nature.
Anti-Degradation	Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.56).

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 waterbody; for example, a fish assemblage, or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996).
Assimilative Capacity	The ability to process or dissipate pollutants without ill effect to beneficial uses.
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 waterbodies 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 waterbody
Benthic Organic Matter.	The organic matter on the bottom of a waterbody.
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.
Biochemical Oxygen Demand (BOD)	The amount of dissolved oxygen used by organisms during the decomposition (respiration) of organic matter, expressed as mass of oxygen per volume of water, over some specified period of time.
Biological Integrity	1) The condition of an aquatic community inhabiting unimpaired waterbodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).
Biomass	The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often expressed as grams per square meter.
Biota	The animal and plant life of a given region.
Biotic	A term applied to the living components of an area.
Clean Water Act (CWA)	The Federal Water Pollution Control Act (commonly known as as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.
Coliform Bacteria	A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria).
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 waterbody.
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 or Existing Use	A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02).
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 pathogens (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. 2002).
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 waterbodies 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.
Hydrology	The science dealing with the properties, distribution, and circulation of water.
Impervious	Describes a surface, such as pavement, that water cannot penetrate.
Influent	A tributary stream.
Inorganic	Materials not derived from biological sources.
Instantaneous	A condition or measurement at a moment (instant) in time.
Intergravel Dissolved Oxygen	The concentration of dissolved oxygen within spawning gravel. Consideration for determining spawning gravel includes species, water depth, velocity, and substrate.
Intermittent Stream	1) A stream that flows only part of the year, such as when the ground water table is high or when the stream receives water from springs or from surface sources such as melting snow in mountainous areas. The stream ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. 2) A stream that has a period of zero flow for at least one week during most years.
Interstate Waters	Waters that flow across or form part of state or international boundaries, including boundaries with Indian nations.

Irrigation Return Flow	Surface (and subsurface) water that leaves a field following the application of irrigation water and eventually flows into streams.
Key Watershed	A watershed that has been designated in Idaho Governor Batt's *State of Idaho Bull Trout Conservation Plan* (1996) as critical to the long-term persistence of regionally important trout populations.
Knickpoint	Any interruption or break of slope.
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 waterbody'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 waterbody 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 waterbody, 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 waterbody's loading capacity set aside to allow the uncertainly about the relationship between the pollutant loads and the quality of the receiving waterbody. 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).
Million gallons per day (MGD)	A unit of measure for the rate of discharge of water, often used to measure flow at wastewater treatment plants. One MGD is equal to 1.547 cubic feet per second.
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 waterbody.
Mouth	The location where flowing water enters into a larger waterbody.
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 silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.
Not Assessed (NA)	A concept and an assessment category describing waterbodies that have been studied, but are missing critical information needed to complete an assessment.

Not Attainable	A concept and an assessment category describing waterbodies 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. 2002).
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.
Orthophosphate	A form of soluble inorganic phosphorus most readily used for algal growth.
Oxygen-Demanding Materials	Those materials, mainly organic matter, in a waterbody that consume oxygen during decomposition.
Parameter	A variable, measurable property whose value is a determinant of the characteristics of a system, such as temperature, dissolved oxygen, and fish populations are parameters of a stream or lake.

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.
Pathogens	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 waterbody or on submerged substrates, including larger plants.
Pesticide	Substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.
pH	The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.
Phased TMDL	A total maximum daily load (TMDL) that identifies interim load allocations and details further monitoring to gauge the success of management actions in achieving load reduction goals and the effect of actual load reductions on the water quality of a waterbody. Under a phased TMDL, a refinement of load allocations, wasteload allocations, and the margin of safety is planned at the outset.
Phosphorus	An element essential to plant growth, often in limited supply, and thus considered a nutrient.
Physiochemical	In the context of bioassessment, the term is commonly used to mean the physical and chemical factors of the water column that relate to aquatic biota. Examples in bioassessment usage include saturation of dissolved gases, temperature, pH, conductivity, dissolved or suspended solids, forms of nitrogen, and phosphorus. This term is used interchangeable with the terms "physical/chemical" and "physicochemical."

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 waterbody that is minimally impaired and is representative of reference conditions for similar waterbodies.
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 waterbody.

Riparian Habitat Conservation Area (RHCA)	A U.S. Forest Service description of land within the following number of feet up-slope of each of the banks of streams: - 300 feet from perennial fish-bearing streams - 150 feet from perennial non-fish-bearing streams - 100 feet from intermittent streams, wetlands, and ponds in priority watersheds.
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.
Settleable Solids	The volume of material that settles out of one liter of water in one hour.
Species	1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.
Spring	Ground water seeping out of the earth where the water table intersects the ground surface.
Stagnation	The absence of mixing in a waterbody.
Stenothermal	Unable to tolerate a wide temperature range.
Stratification	A 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.
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 4th 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 6th 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 waterbody'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 + Wasteload 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 waterbodies 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.
Vadose Zone	The unsaturated region from the soil surface to the ground water table.
Wasteload Allocation (WLA)	The portion of receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. Wasteload allocations specify how much pollutant each point source may release to a waterbody.
Waterbody	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 waterbodies 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 waterbodies. The standards prescribe the use of the waterbody 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 waterbody.
Waterbody Identification Number (WBID)	A number that uniquely identifies a waterbody 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 1. Assessment Units

Appendix 1. Assessment Units

Assessment Units for the Upper North Fork Clearwater River Subbasin TMDLs

The Upper North Fork Clearwater River Subbasin TMDLs are written for water bodies and water quality listed segment on the 1998 303(d) list. However, the state of Idaho is moving towards a water quality accounting system based on assessment units. One water body may contain one or more assessment units. Table 1-1 shows the assessment units accounted for by the TMDLs in this document and their relation to the 303(d) list.

The assessment unit code contains information that can be used to relate the assessment units to water bodies, hydrologic units, and the state as follows: the ID prefix indicates the state of Idaho, the number 17060307 is the hydrologic unit code for the Upper North Fork Clearwater River Subbasin, CL001 through CL048 are the water bodies in the Upper North Fork Clearwater River Subbasin, and the last numbers identify the assessment unit within the water body.

For the individual assessment unit identifiers, the rationale for the particular numbers and letters are as follows: 02 indicates first and second order streams, 03 indicates third order streams, 04 indicates fourth order streams, 05 indicates fifth order streams, “a” and “b” indicate subdivisions of the water body for any characteristic thought to be important to water quality assessment.

Table 1-1. Assessment units, TMDL water bodies, and 1998 303(d) list water quality limited segments.

Assess-ment Unit	TMDL Stream Name(s)	TMDL WQLS[1] No(s).	WBID[2]	Water Body Boundaries	Listed Pollutant	TMDLs Completed	Proposed Delisting
ID17060307 CL001_02a	Sneak Creek	5178	001	North Fork Clearwater River - Skull Creek to Beaver Creek	Channel Stability	Temperature	Channel Stability
ID17060307 CL003_02a	Tumble Creek	5200	003	Washington Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL005_02	Lower Orogrande Creek	3215	005	Orogrande Creek - French Creek to mouth	Sediment	none	Sediment
ID17060307 CL005_02a	Tamarack Creek	5193	005	Orogrande Creek - French Creek to mouth	Sediment	Temperature.	Sediment
ID17060307 CL005_04	Lower Orogrande Creek	3215	005	Orogrande Creek - French Creek to mouth	Sediment	Temperature	Sediment
ID17060307 CL006_02	Upper Orogrande Creek	3215	006	Orogrande Creek - source to French Creek	Sediment	Temperature	Sediment
ID17060307 CL006_03	Upper Orogrande Creek	3215	006	Orogrande Creek - source to French Creek	Sediment	Temperature	Sediment
ID17060307 CL007_02a	Sylvan Creek	5192	007	French Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL007_02b	Hem Creek	5093	007	French Creek - source to mouth	Sediment	none	Sediment
ID17060307 CL012_02	Middle Creek	5123	012	Middle Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL012_02a	Middle Creek	5123	012	Middle Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL012_03	Middle Creek	5123	012	Middle Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL012_03a	Middle Creek	5123	012	Middle Creek - source to mouth	Sediment	Temperature	Sediment

Assess-ment Unit	TMDL Stream Name(s)	TMDL WQLS[1] No(s).	WBID[2]	Water Body Boundaries	Listed Pollutant	TMDLs Completed	Proposed Delisting
ID17060307 CL021_02	Gravey Creek	3229	021	Gravey Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL021_02a	Marten Creek	5119	021	Gravey Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL021_02b	Gravey Creek	3229	021	Gravey Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL021_03	Gravey Creek	3229	021	Gravey Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL021_03a	Gravey Creek	3229	021	Gravey Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL030_02	Osier, China, and Laundry Creeks	3225, 5040, 5104	030	Osier Creek - source to mouth	Sediment Temperature	Temperature	Sediment
ID17060307 CL030_02a	Swamp and Sugar Creeks	5189, 5190	030	Osier Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL030_03	Swamp Creek	5190	030	Osier Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL032_02a	Deception Gulch	5059	032	North Fork Clearwater River - Lake Creek to Kelly Creek	Sediment	Sediment Temperature	None
ID17060307 CL040_02	Cold Springs and Cool Creeks	5045, 5047	040	Cold Springs Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL044_02a	Grizzly Creek	5088	044	Quartz Creek - source to mouth	Sediment	Temperature	Sediment
ID17060307 CL045_02	Cougar Creek	5049	045	Cougar Creek - source to mouth	Sediment	Temperature	Sediment

[1] WQLS = water quality limited segment
[2] WBID = water body identification number

Appendix 2. Data Charts

Appendix 2. Data Charts

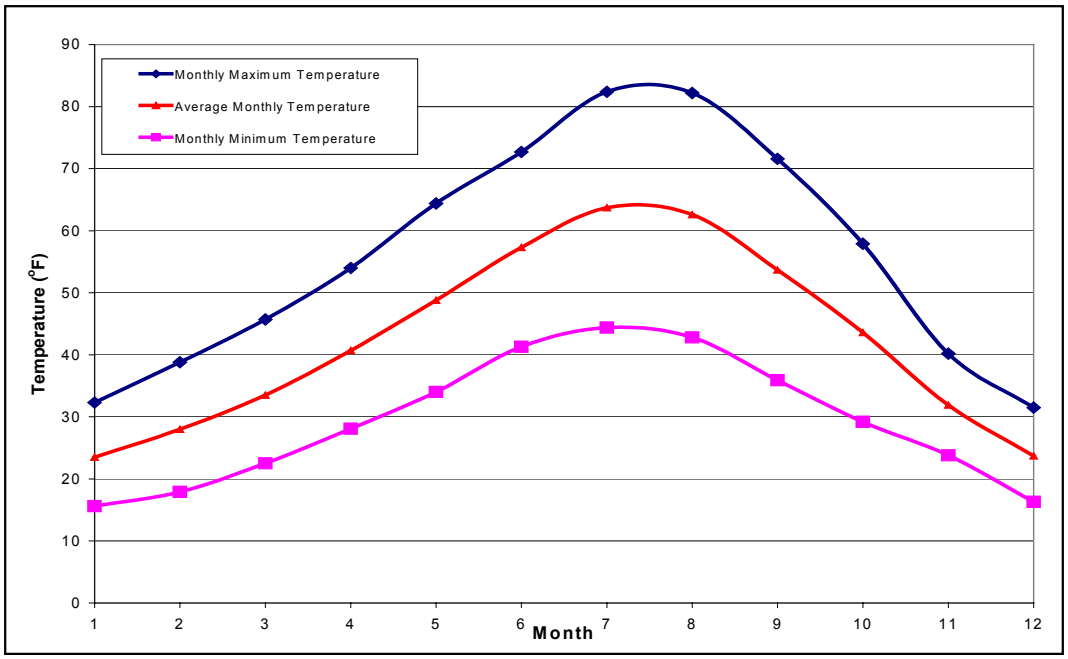


Figure 2-1. Powell Ranger Station National Weather Service 29-Year Mean Monthly Temperatures

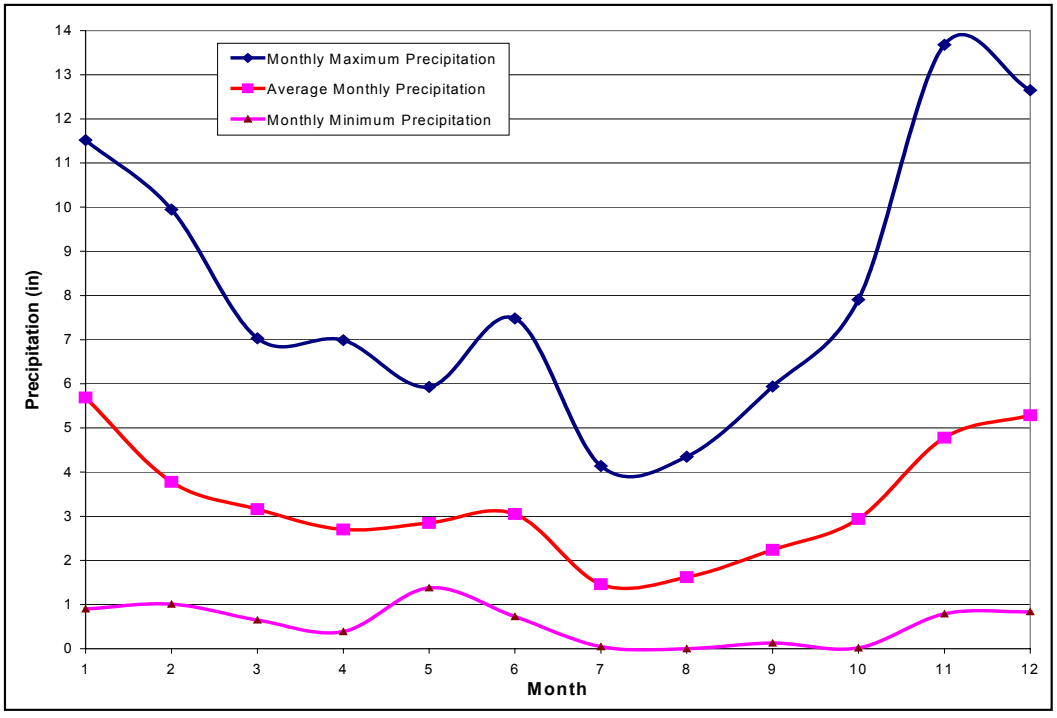


Figure 2-2. Powell Ranger Station National Weather Service 36-Year Mean Monthly Precipitation

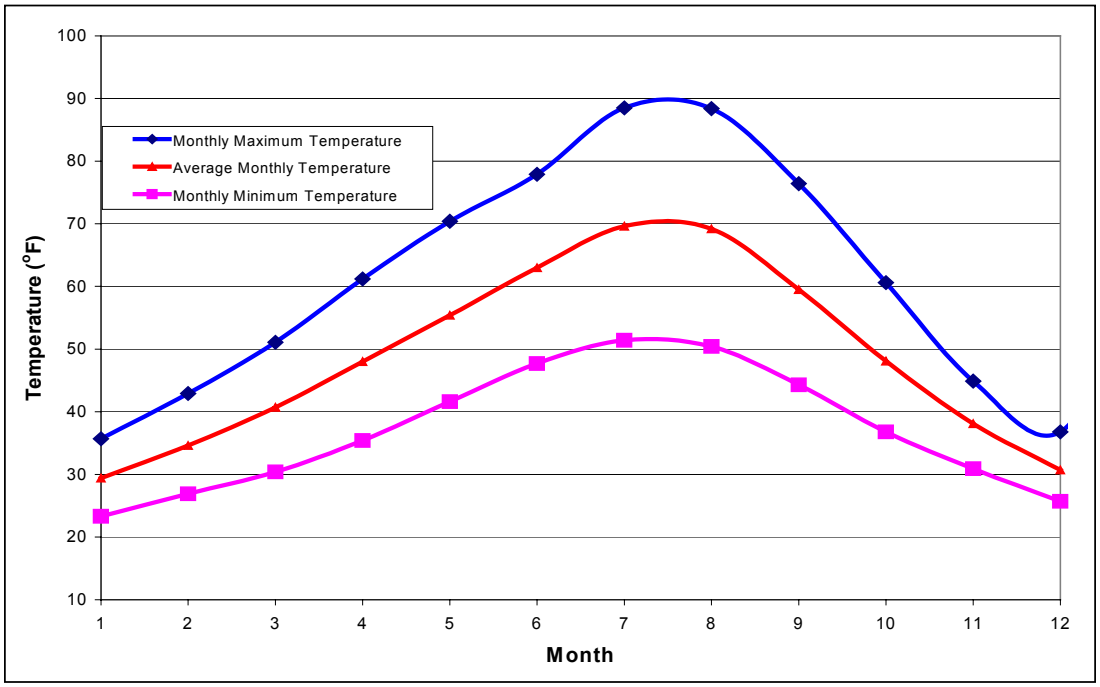


Figure 2-3. Fenn Ranger Station National Weather Service 30-Year Mean Monthly Temperatures

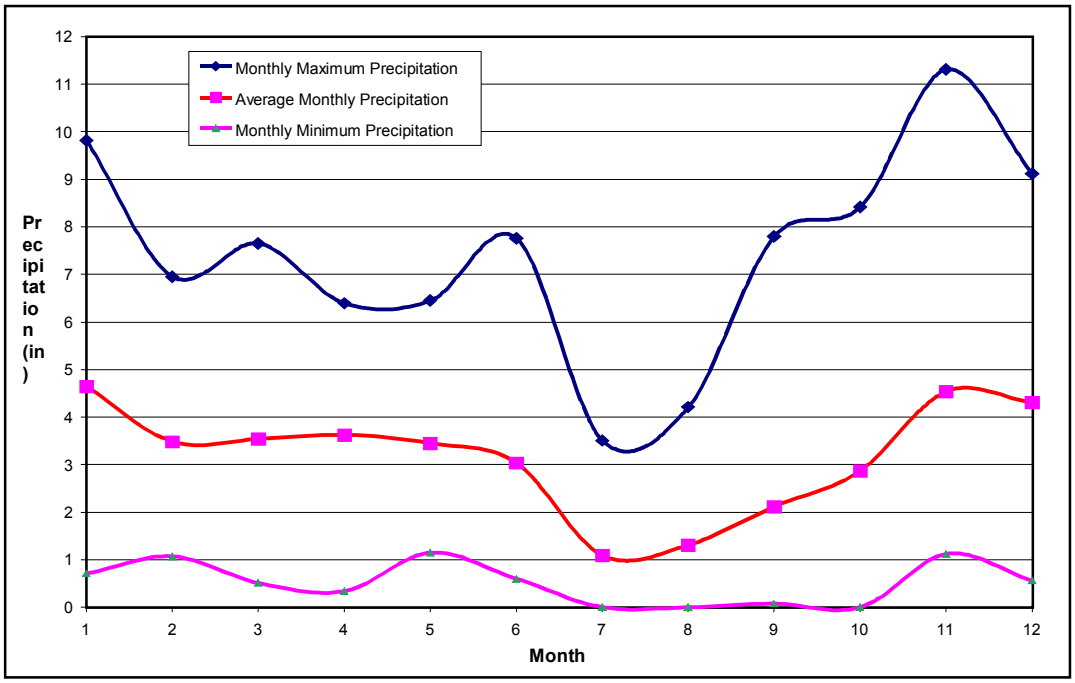


Figure 2-4. Fenn Ranger Station National Weather Service 47-Year Mean Monthly Precipitation

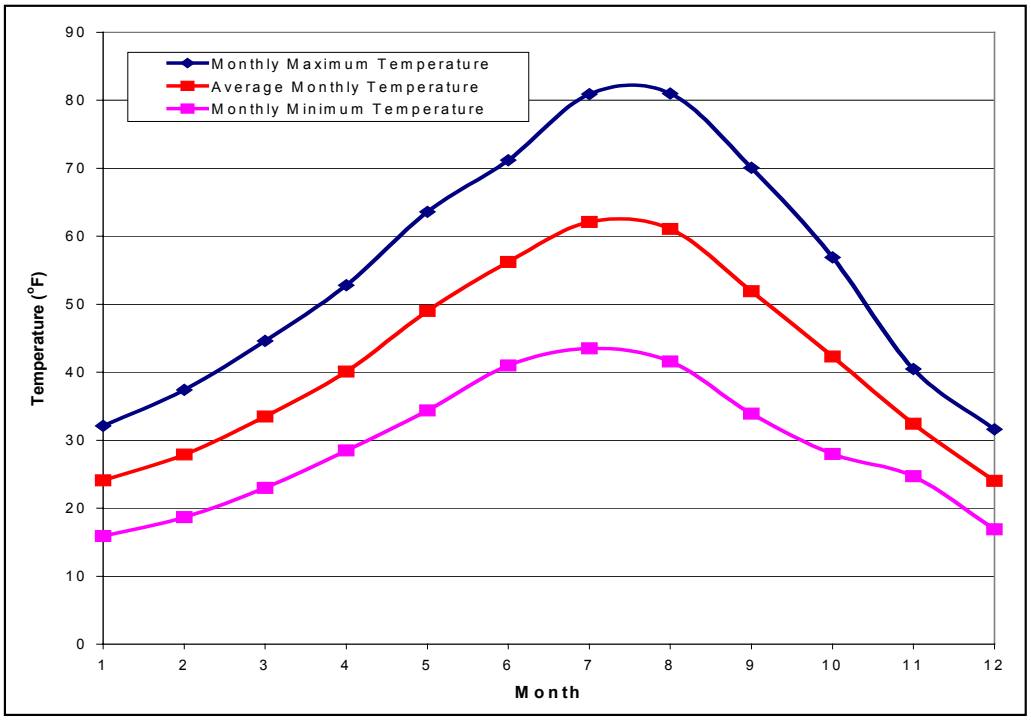


Figure 2-5. Pierce Ranger Station National Weather Service 28-Year Mean Monthly Temperature

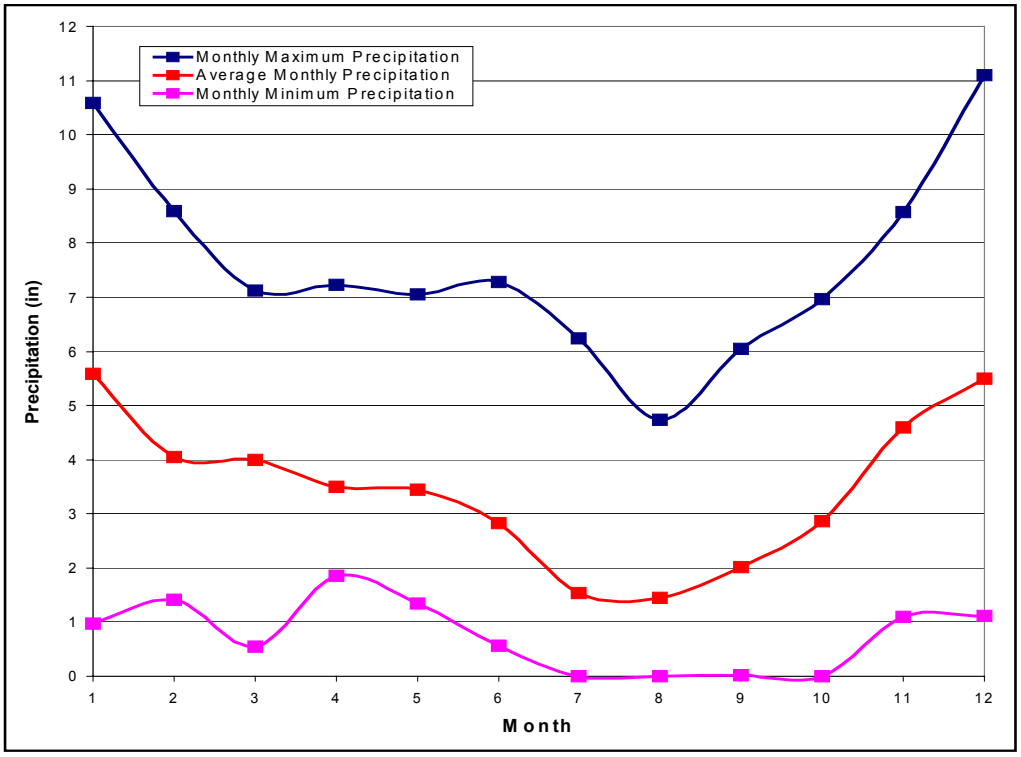


Figure 2-6. Pierce Ranger Station National Weather Service 23-Year Mean Monthly Precipitation

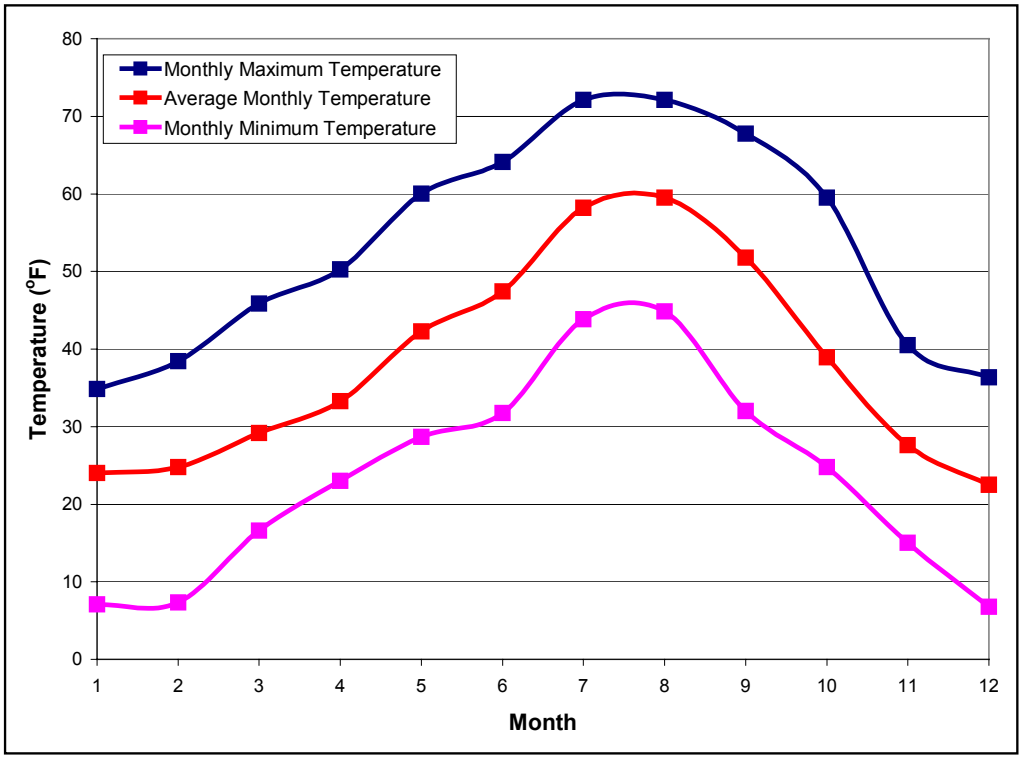


Figure 2-7. Hemlock Butte SNOTEL Station 7-Year Mean Monthly Temperature

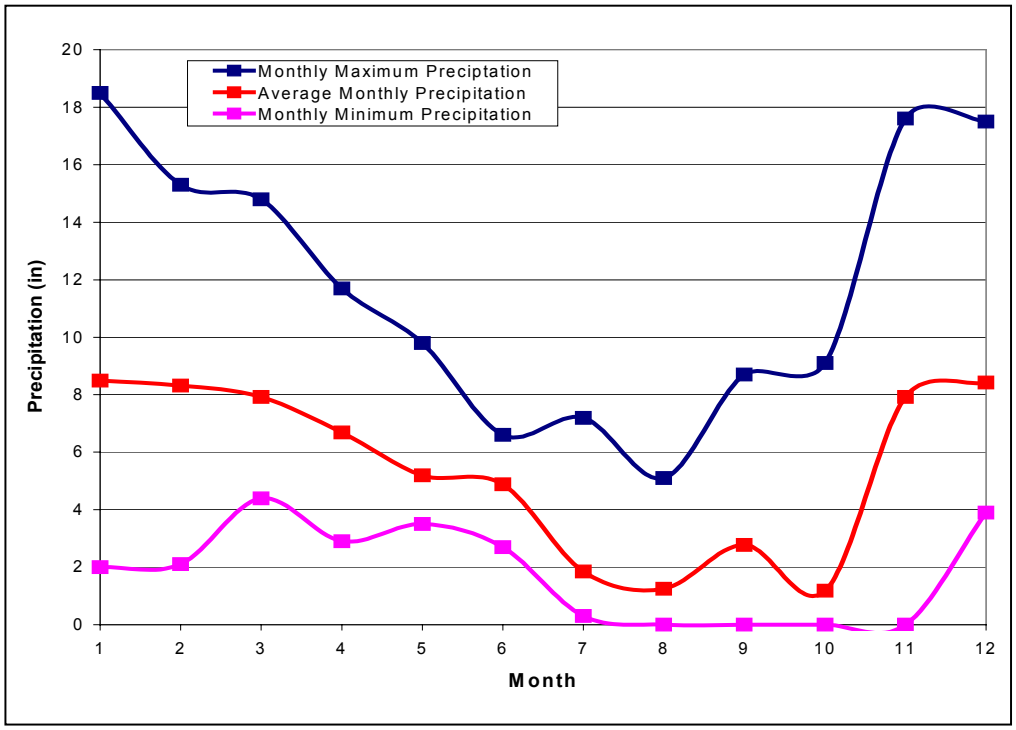


Figure 2-8. Hemlock Butte SNOTEL Station 16-Year Mean Monthly Precipitation

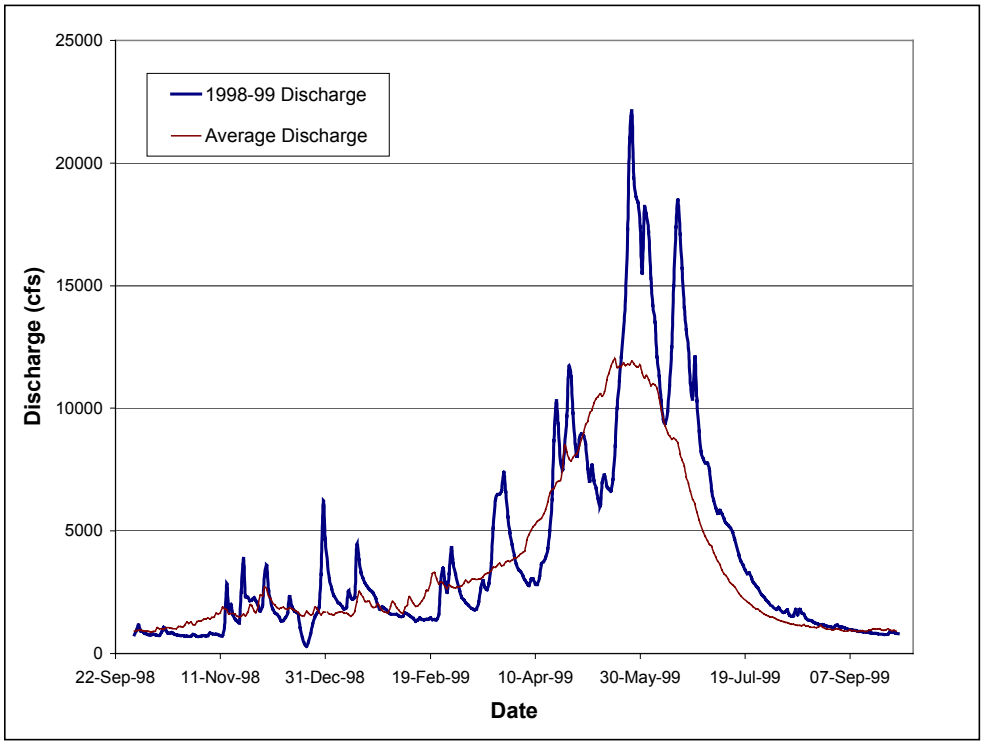


Figure 2-9. Discharge for 1998-99 and Average Discharge for the North Fork Clearwater River Near Canyon Ranger Station

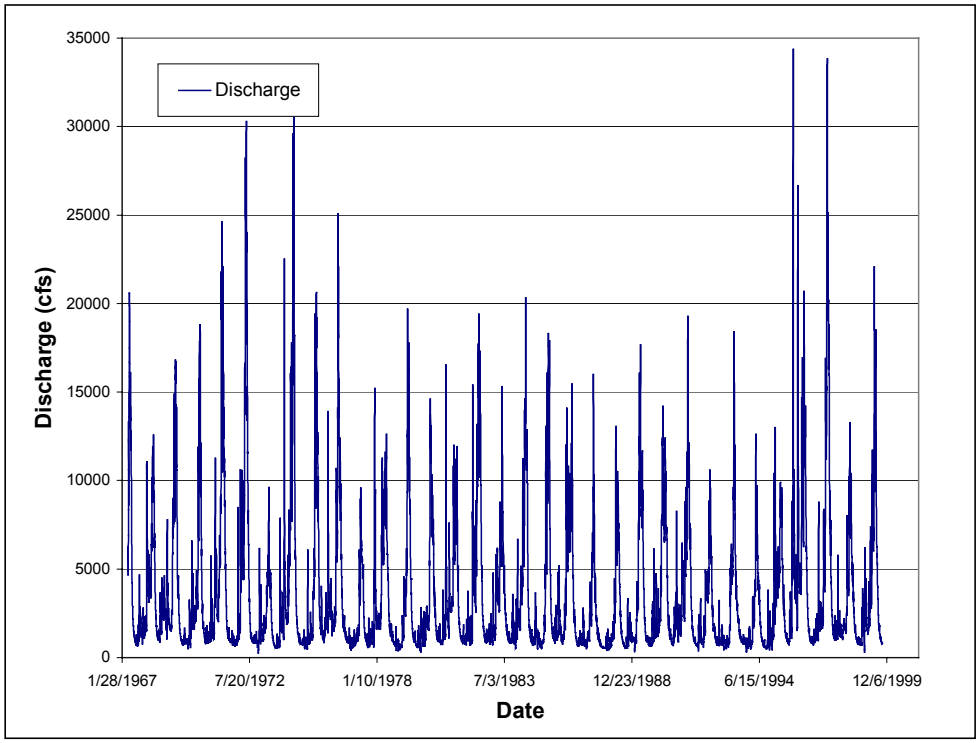


Figure 2-10. Daily Mean Discharge for the North Fork Clearwater River near Canyon Ranger Station, Idaho

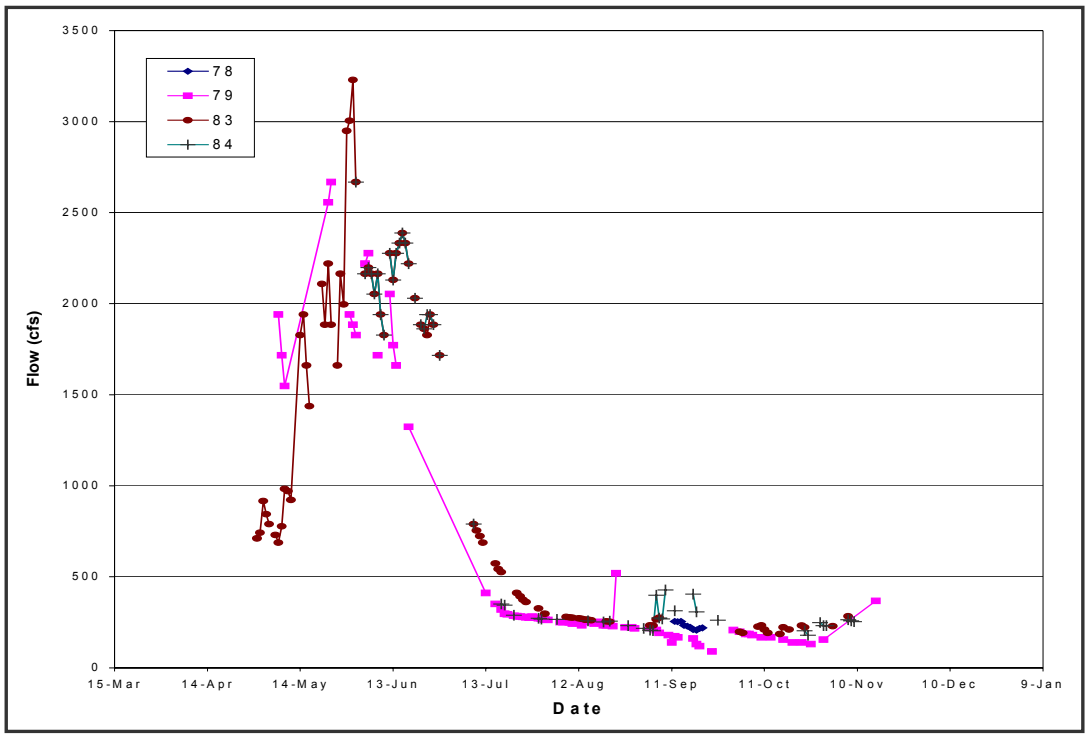


Figure 2-11. Kelly Creek North Fork Clearwater Flow Data

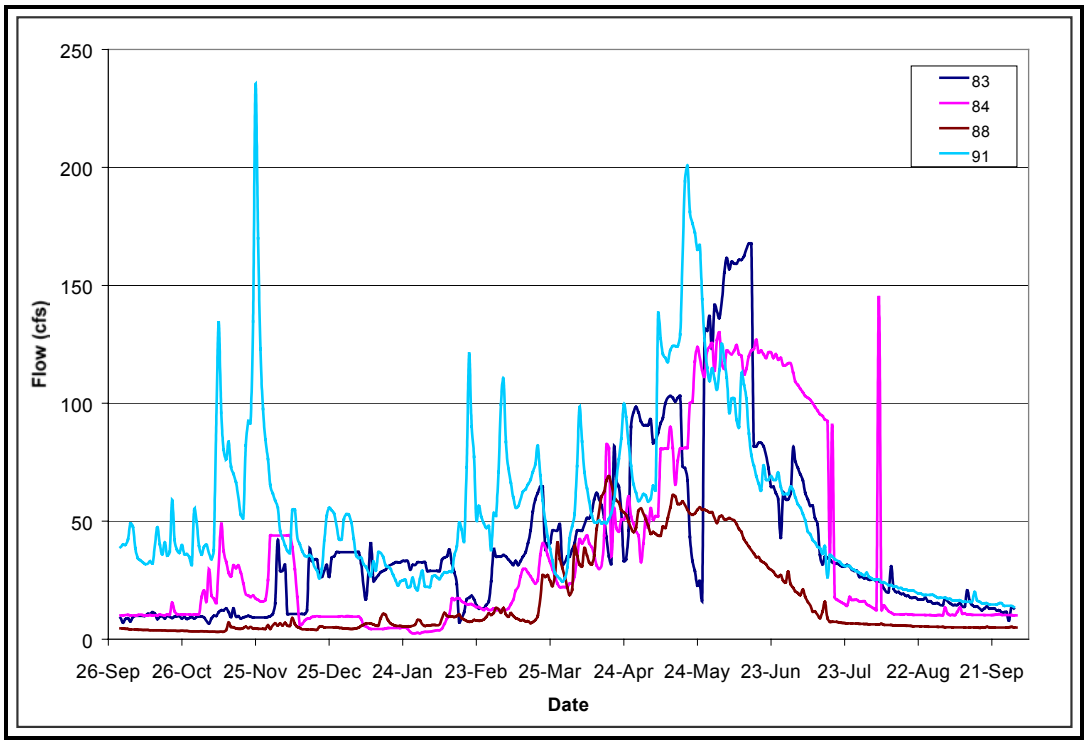


Figure 2-12. Cold Springs Creek Flow Data

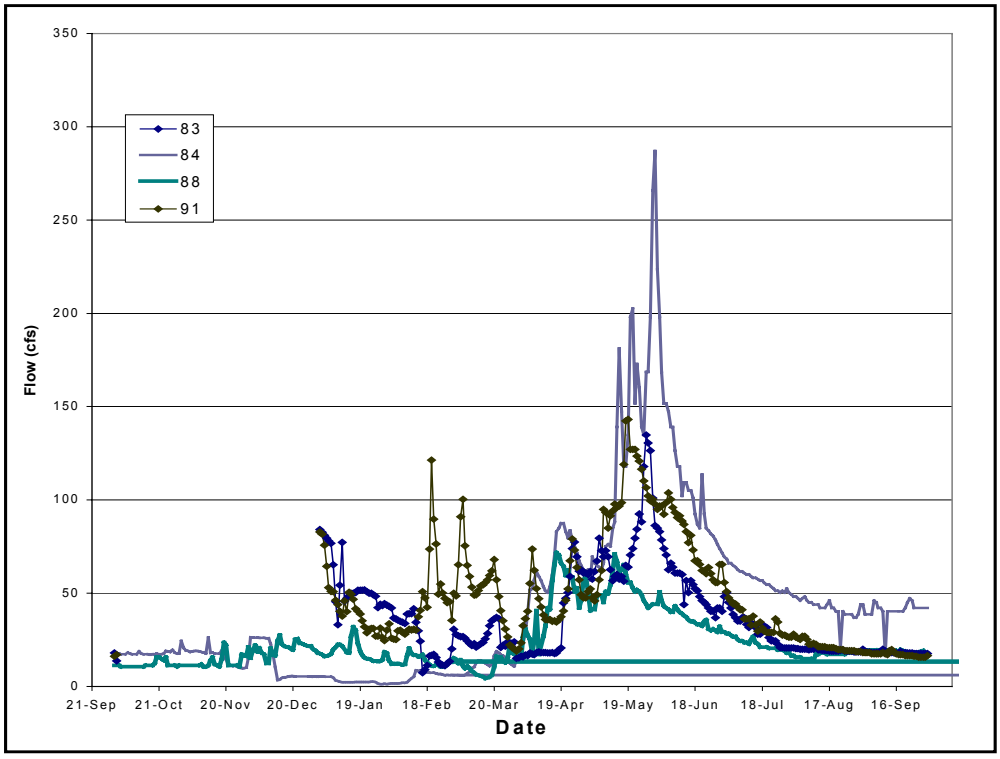


Figure 2-13. Swamp Creek Flow Data

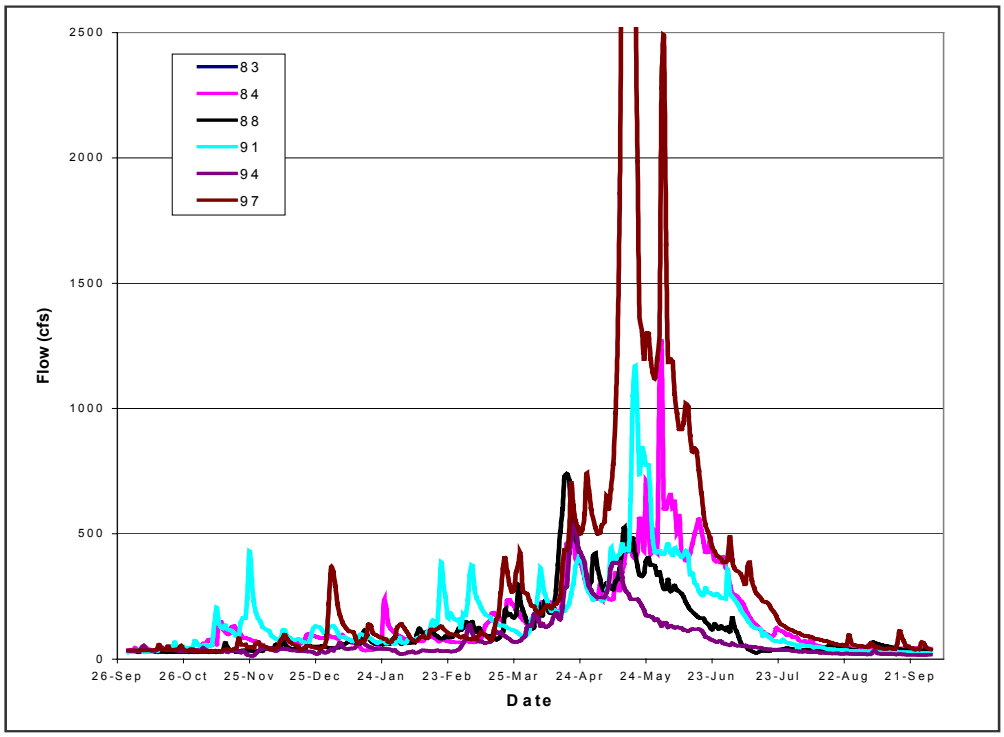


Figure 2-14. Quartz Creek Flow Data

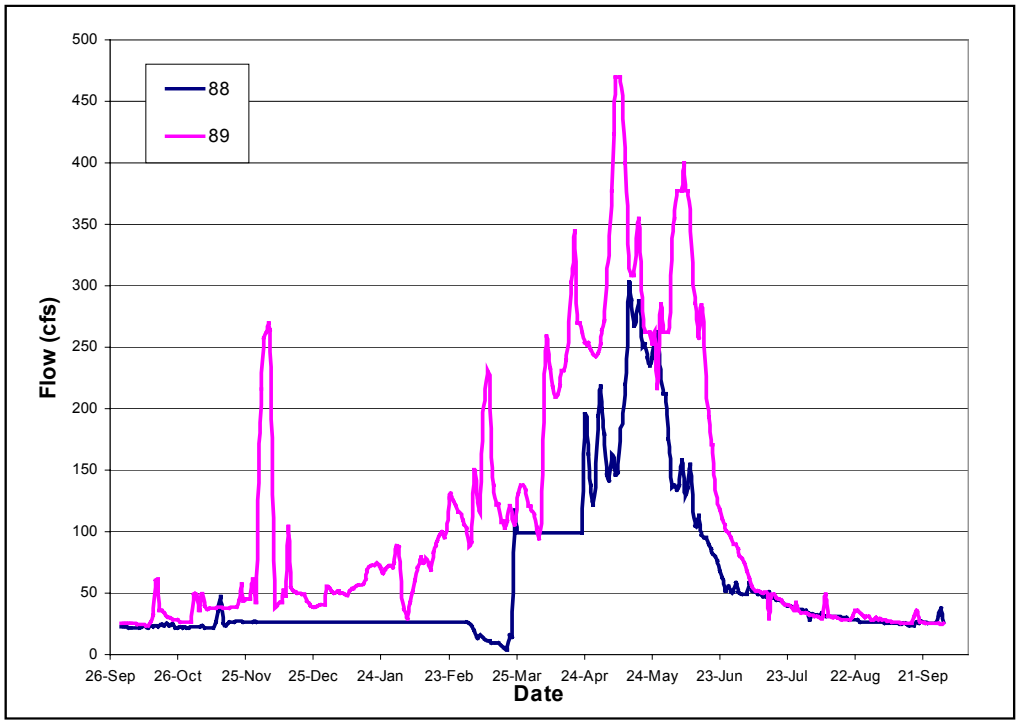


Figure 2-15. Gravey Creek Flow Data

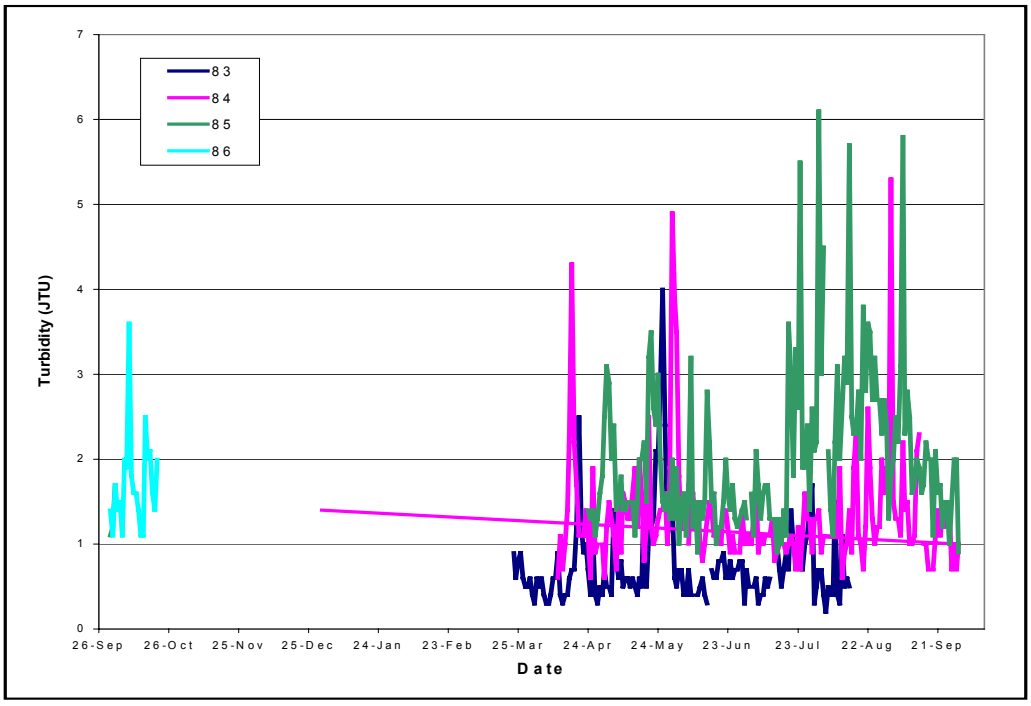


Figure 2-16. Cold Springs Creek Turbidity Data

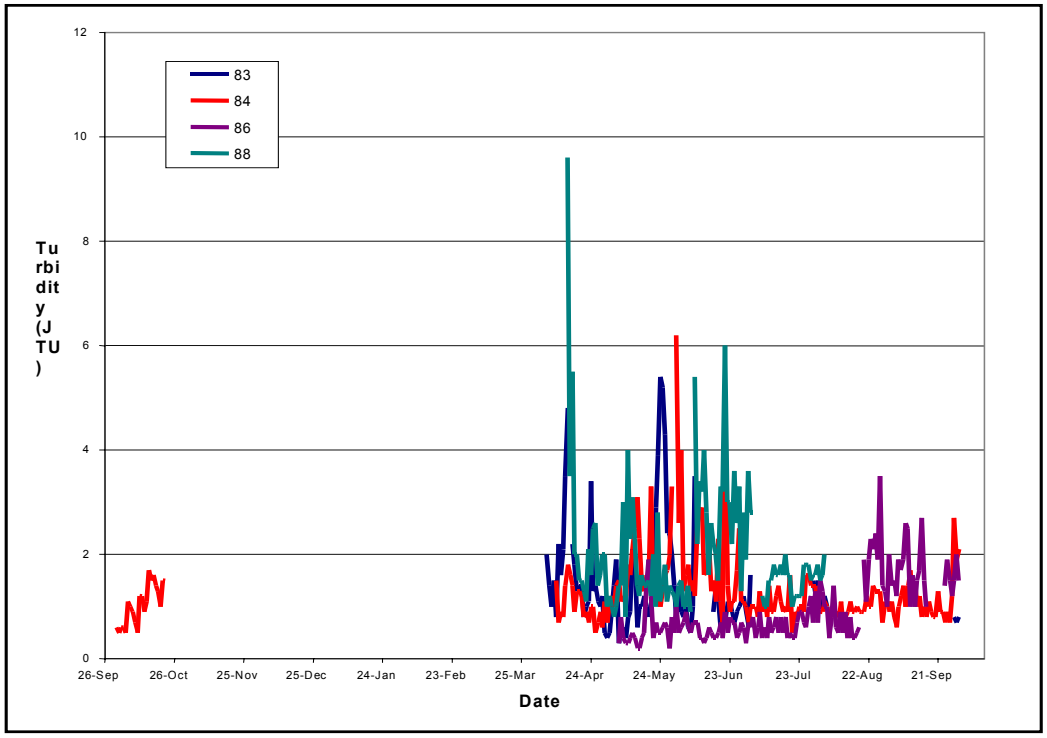


Figure 2-17. Swamp Creek Turbidity Data

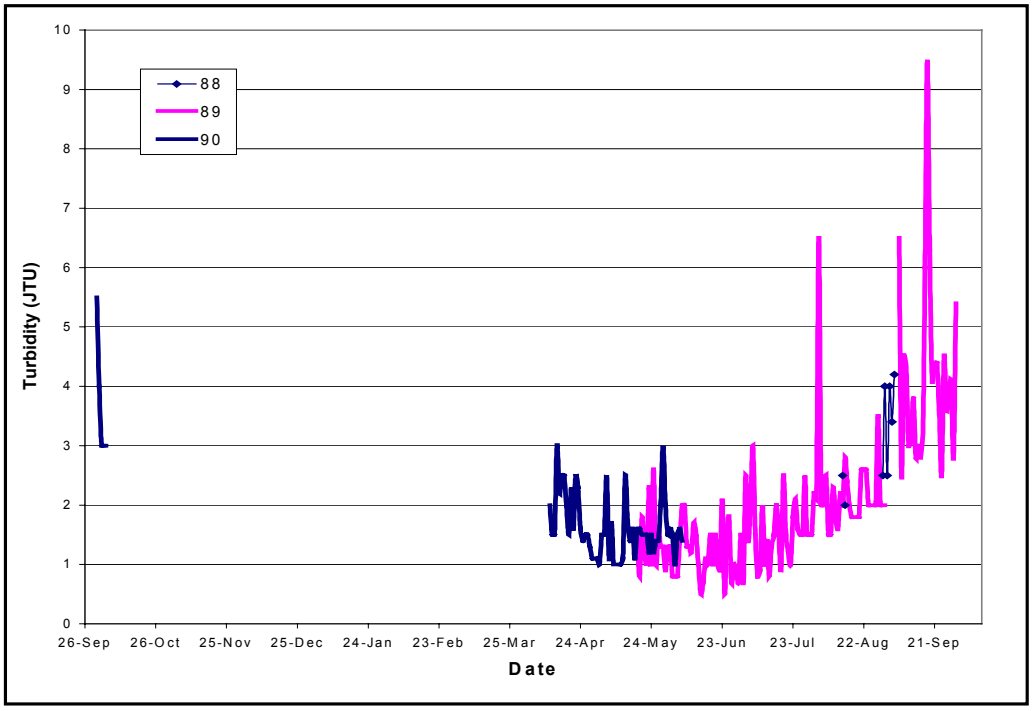


Figure 2-18. Quartz Creek Turbidity Data

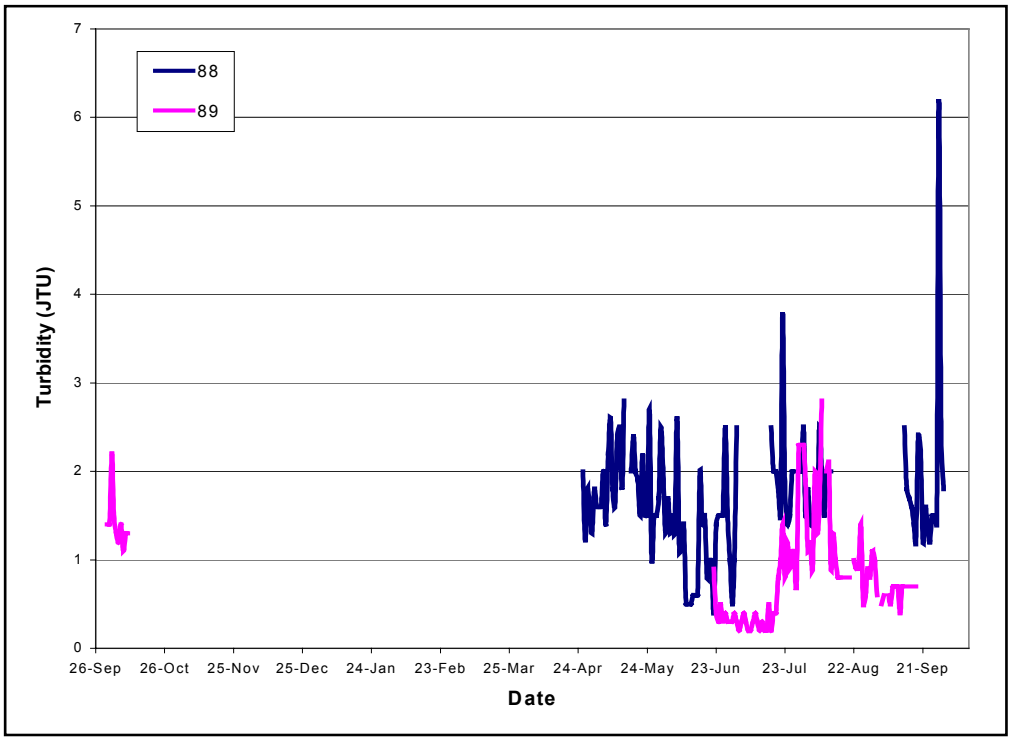


Figure 2-19. Gravey Creek Turbidity Data

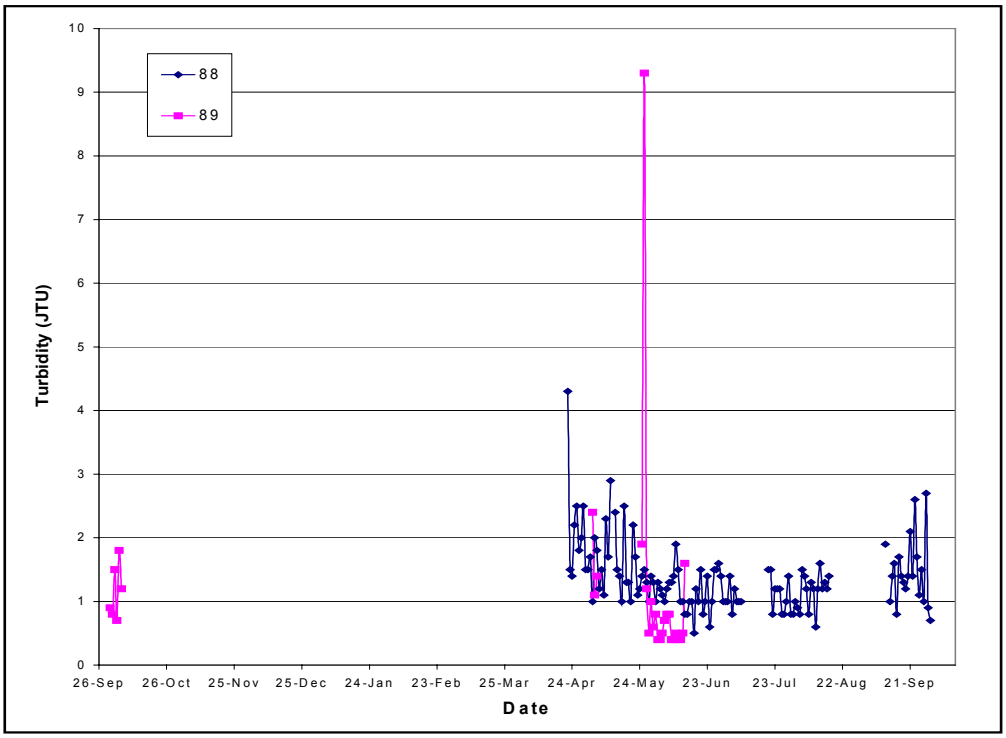


Figure 2-20. Marten Creek Turbidity Data

Appendix 3. Stream Temperature Data

Appendix 3. Stream Temperature Data

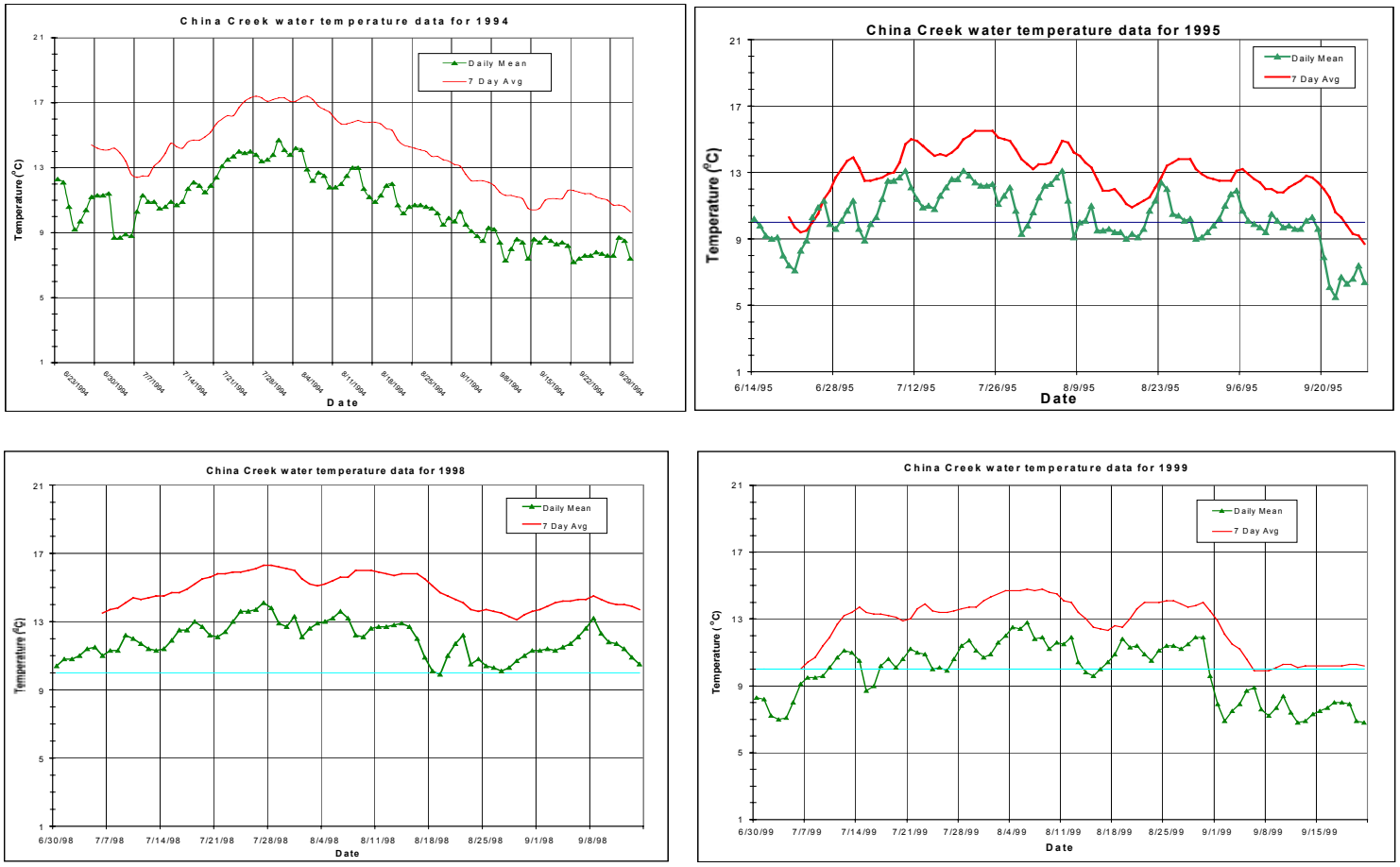
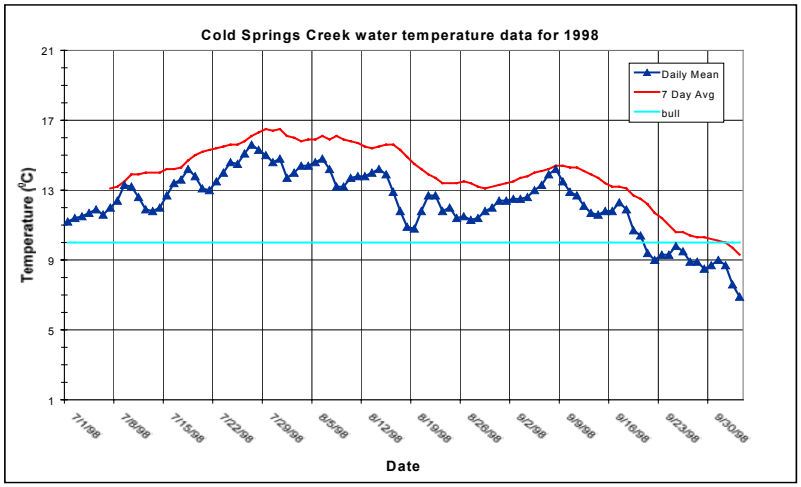


Figure 3-1. Selected Temperature Data for China Creek



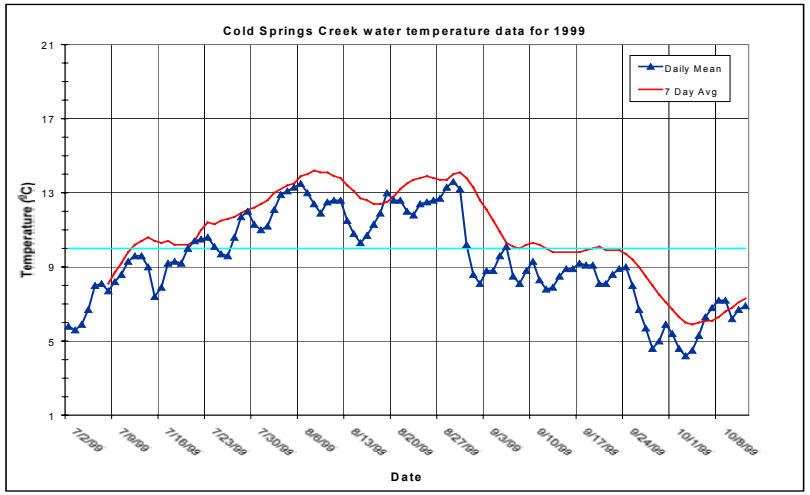
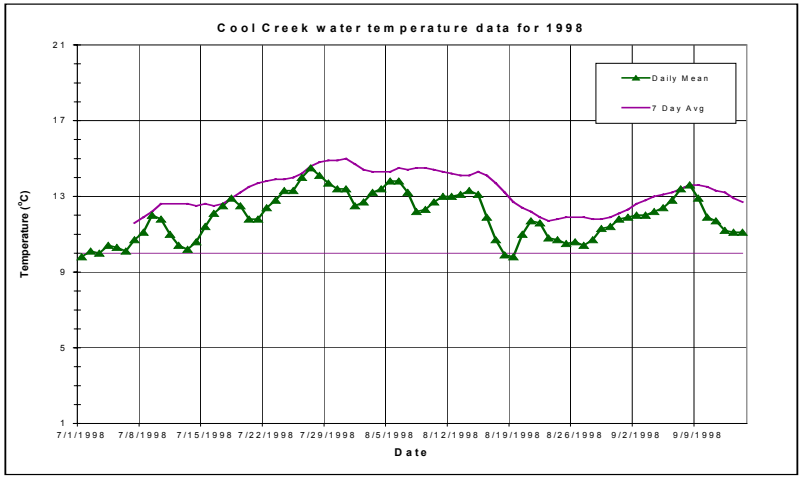
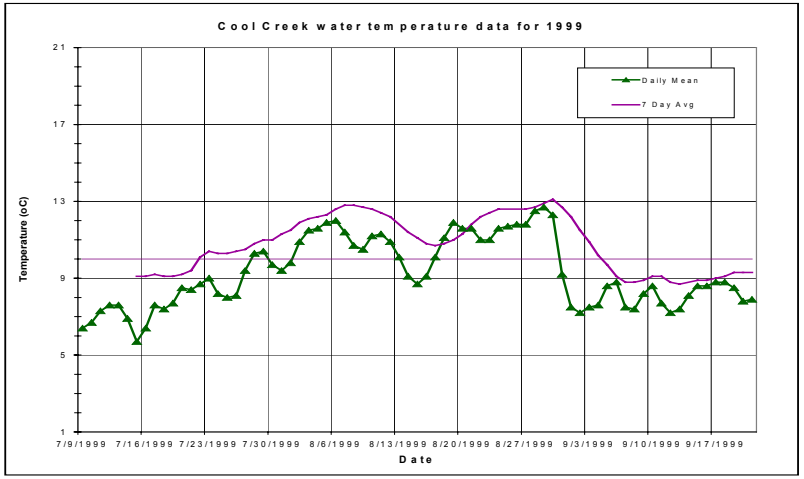


Figure 3-2. Selected Temperature Data for Cold Springs Creek





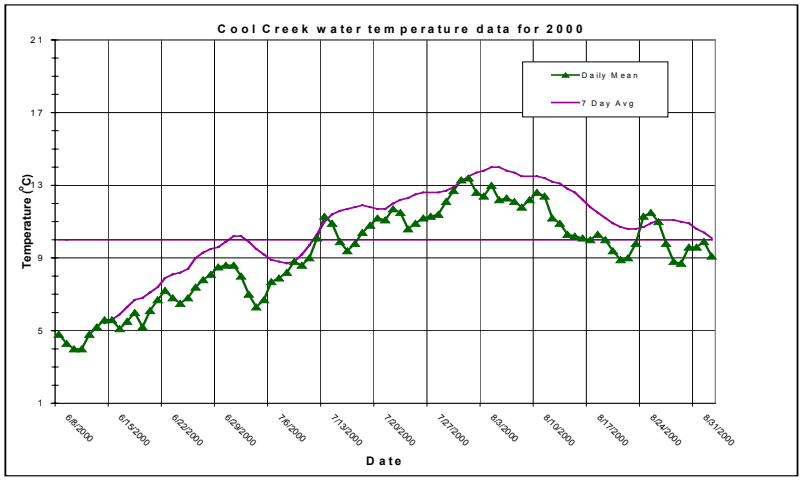
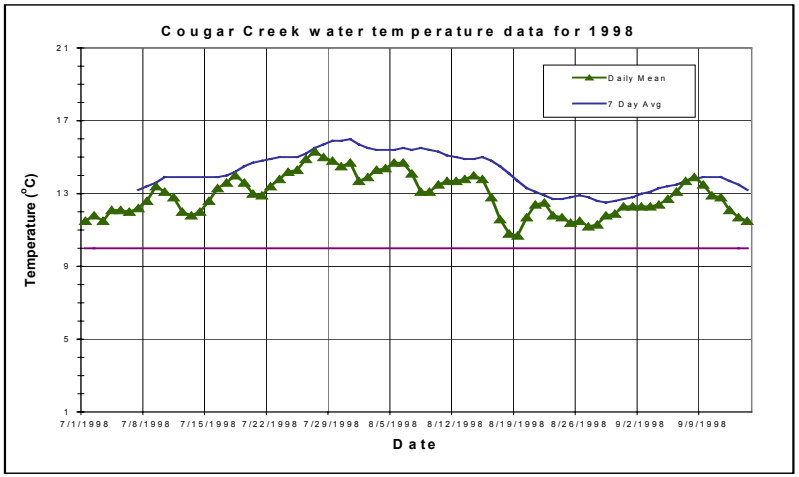
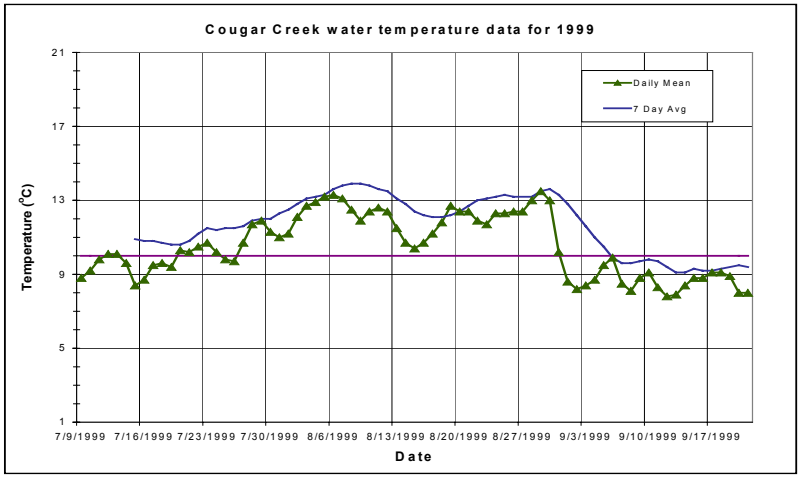


Figure 3-3. Selected Temperature Data for Cool Creek





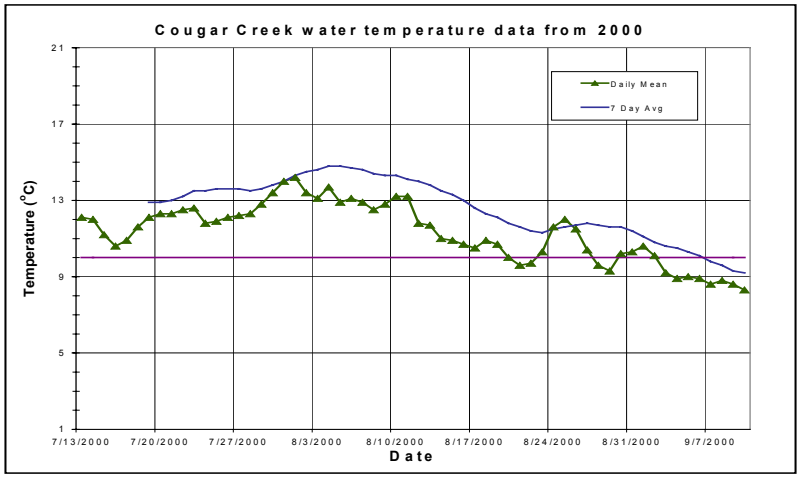


Figure 3-4. Selected Temperature Data for Cougar Creek

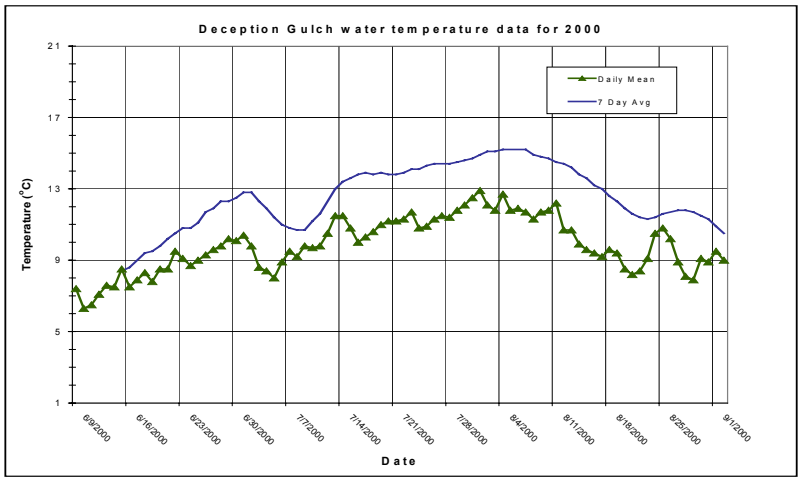


Figure 3-5. Selected Temperature Data for Deception Gulch

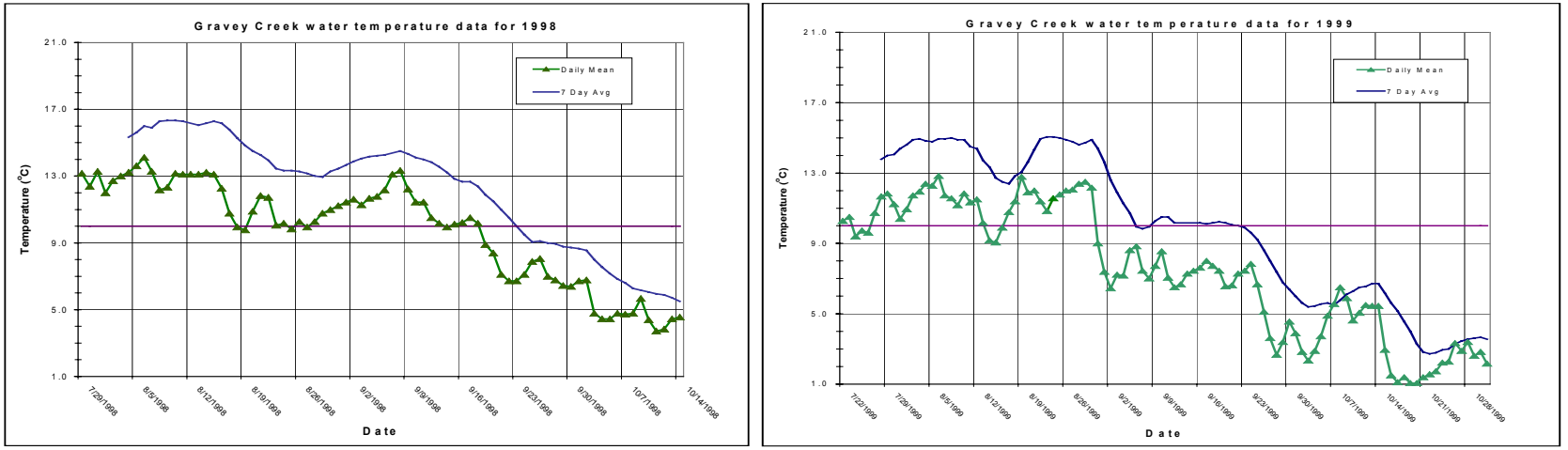


Figure 3-6. Selected Temperature Data for Gravey Creek

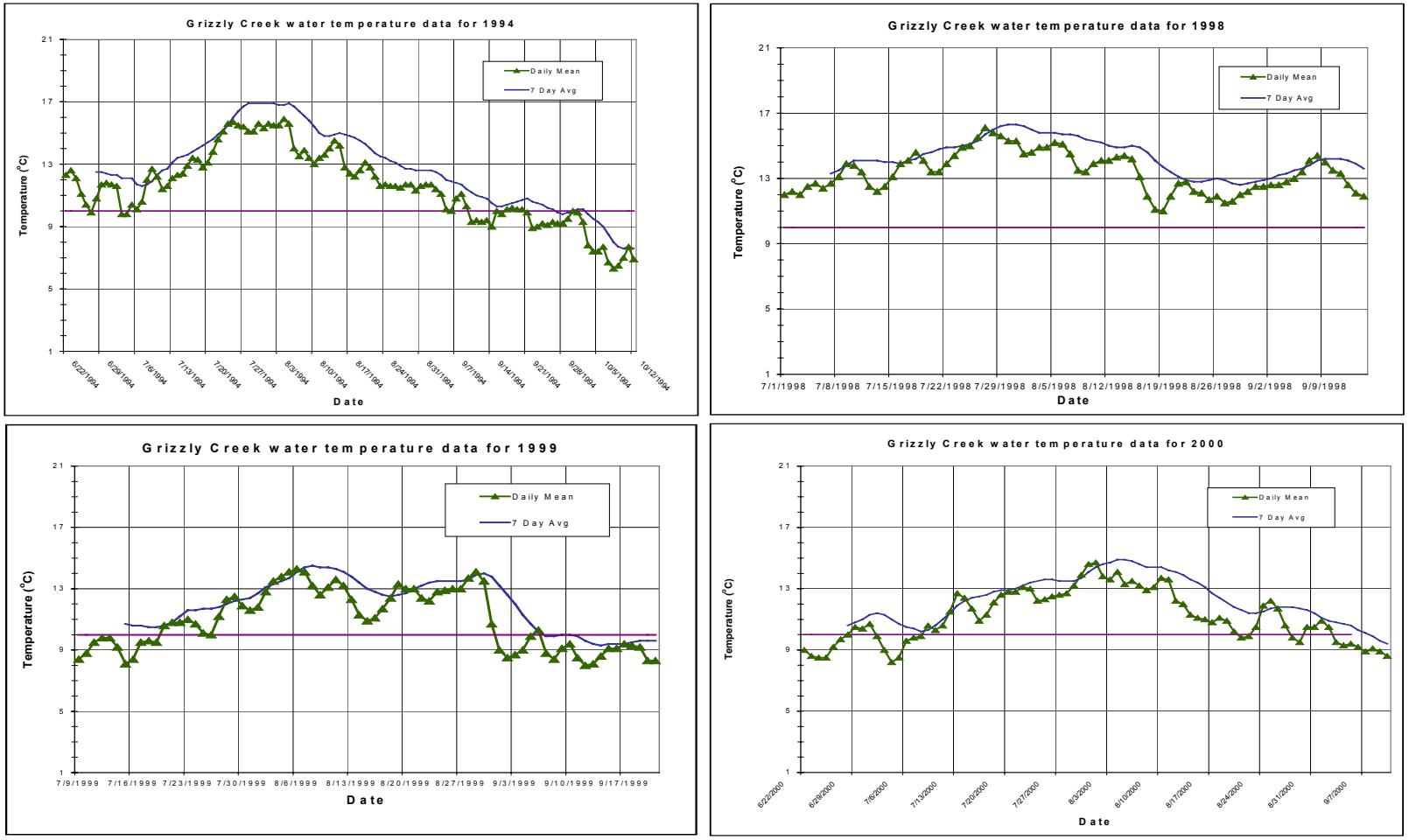


Figure 3-7. Selected Temperature Data for Grizzly Creek

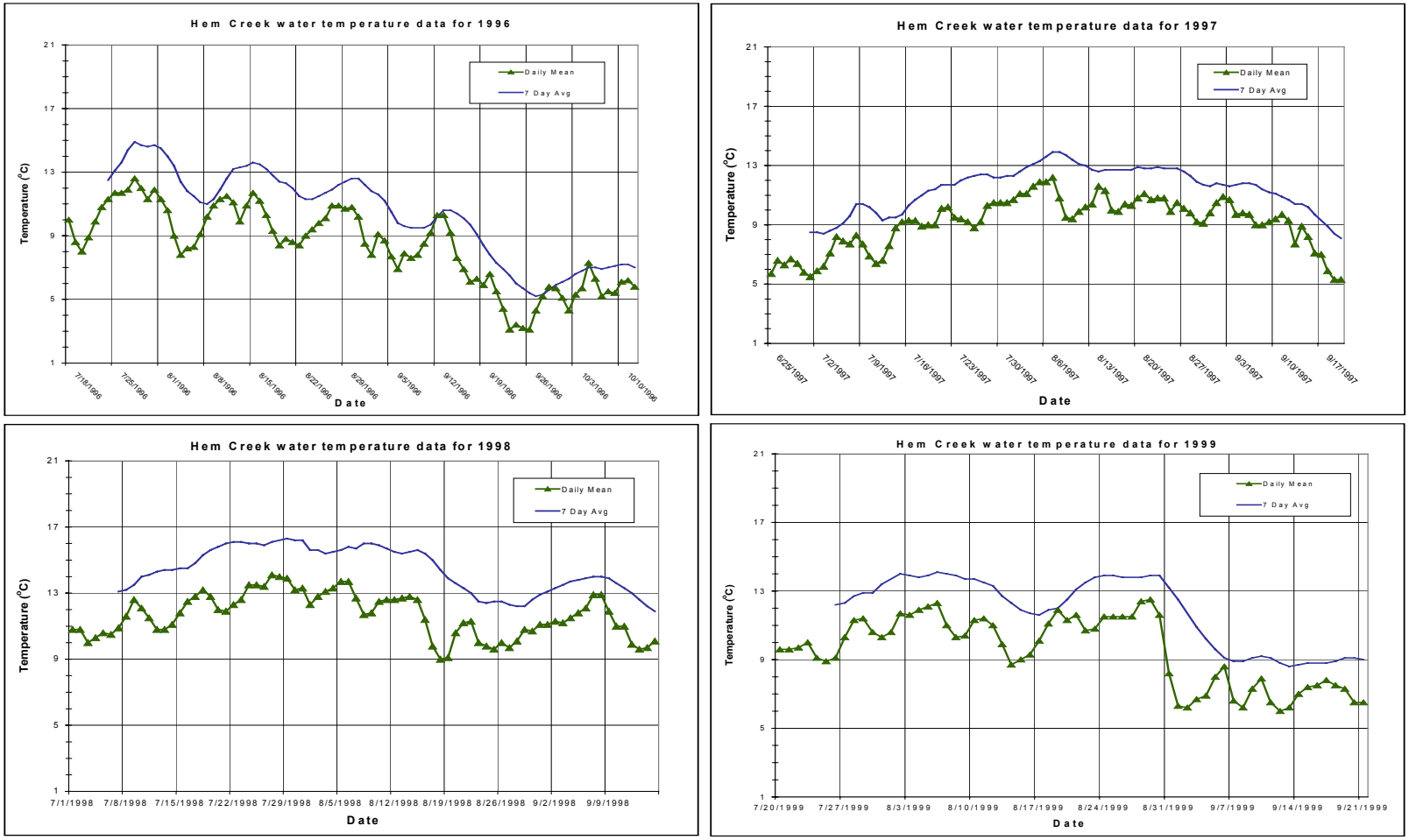
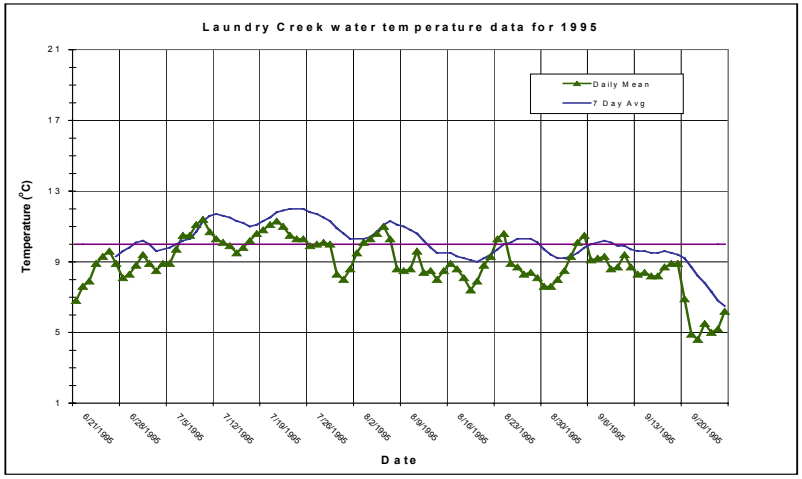
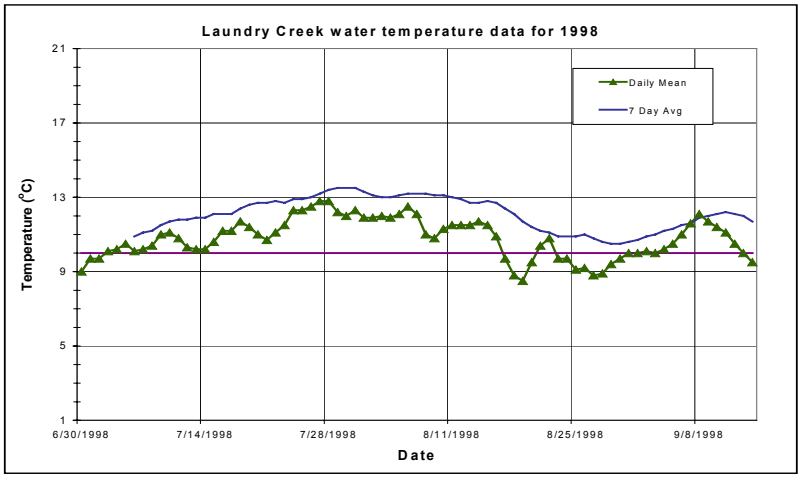


Figure 3-8. Selected Temperature Data for Hem Creek





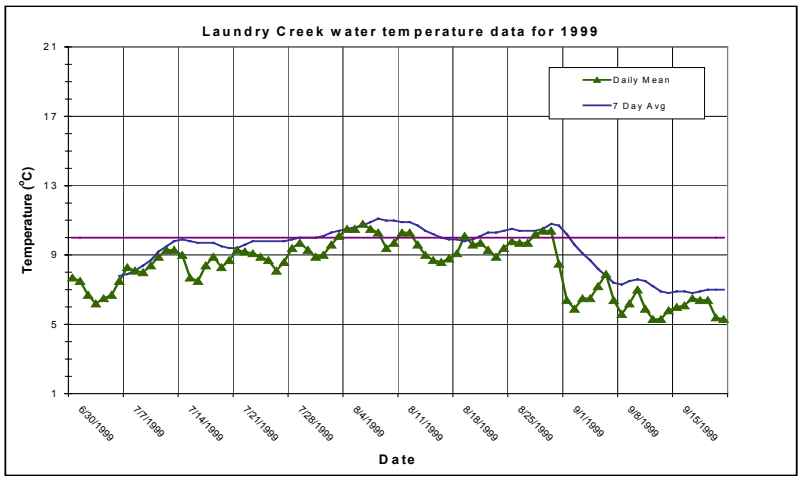


Figure 3-9. Selected Temperature Data for Laundry Creek

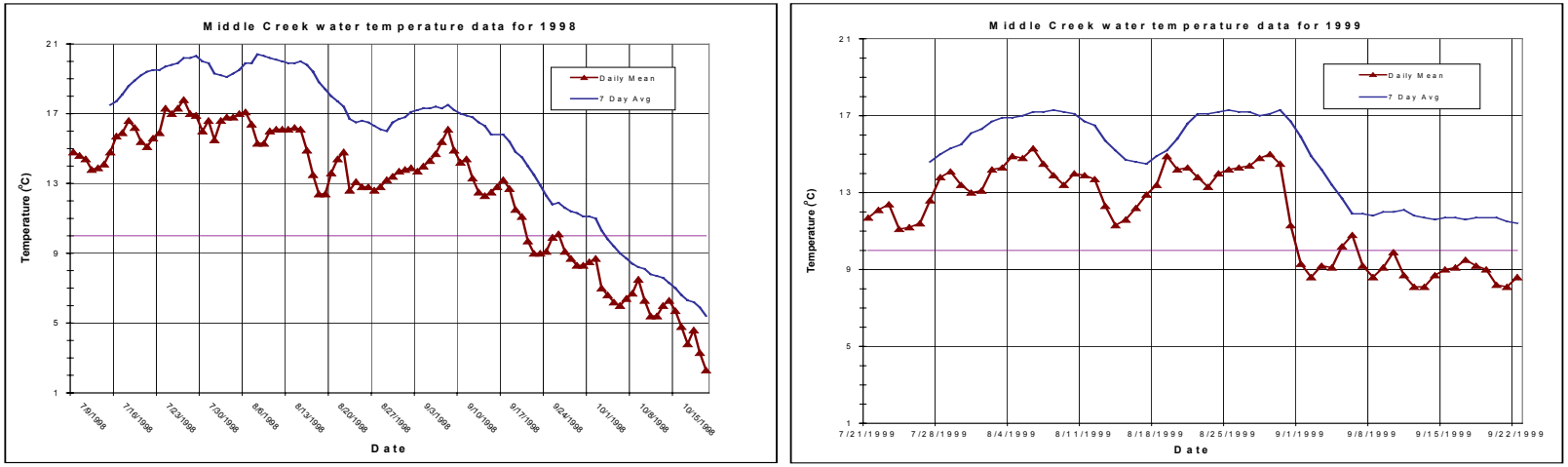


Figure 3-10. Selected Temperature Data for Middle Creek

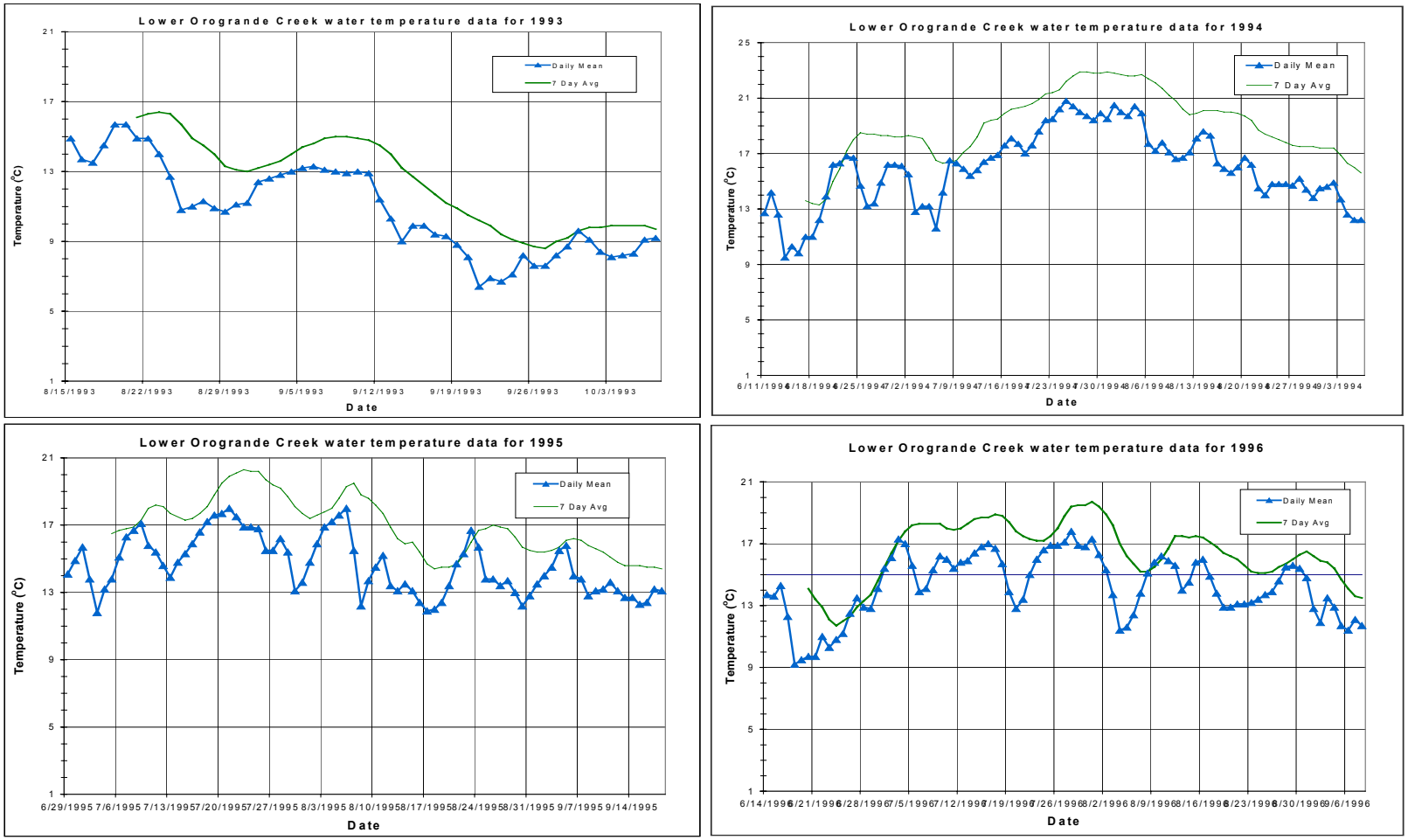


Figure 3-11. Selected Temperature Data for Lower Orogrande Creek

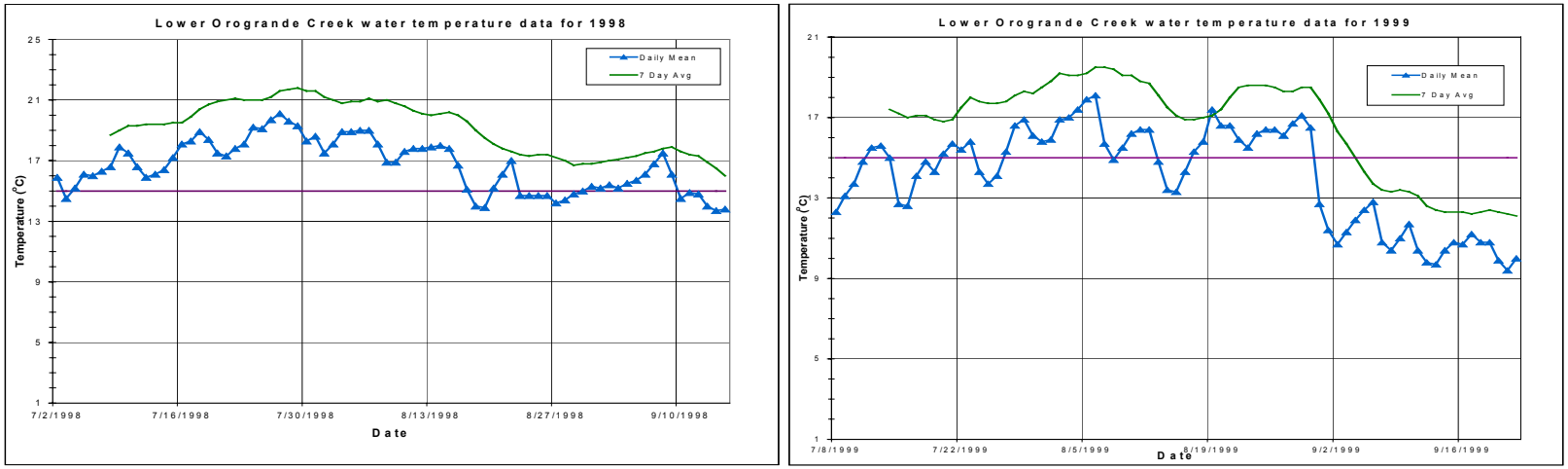


Figure 3-11 (continued). Selected Temperature Data for Lower Orogrande Creek

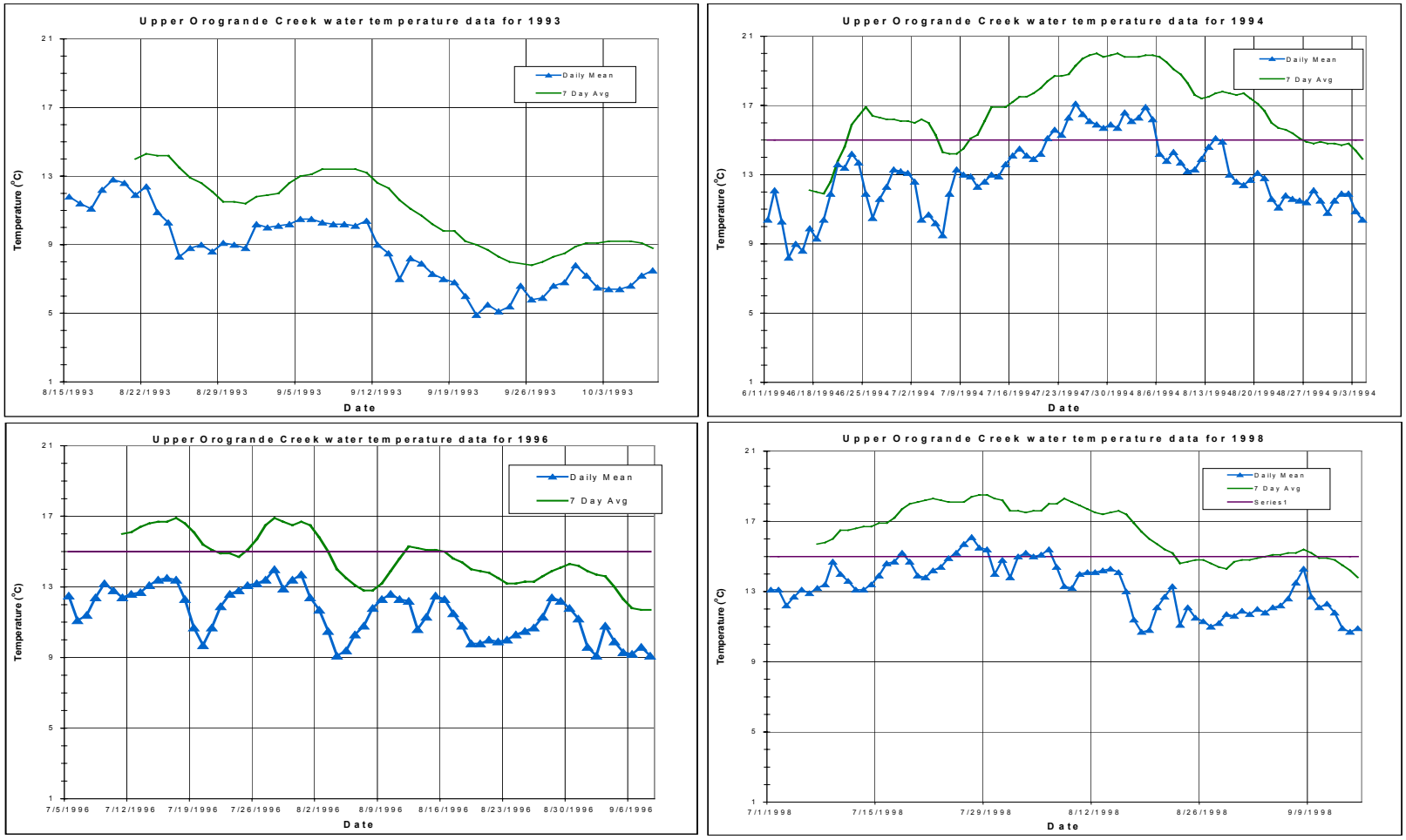


Figure 3-12. Selected Temperature Data for Upper Orogrande Creek

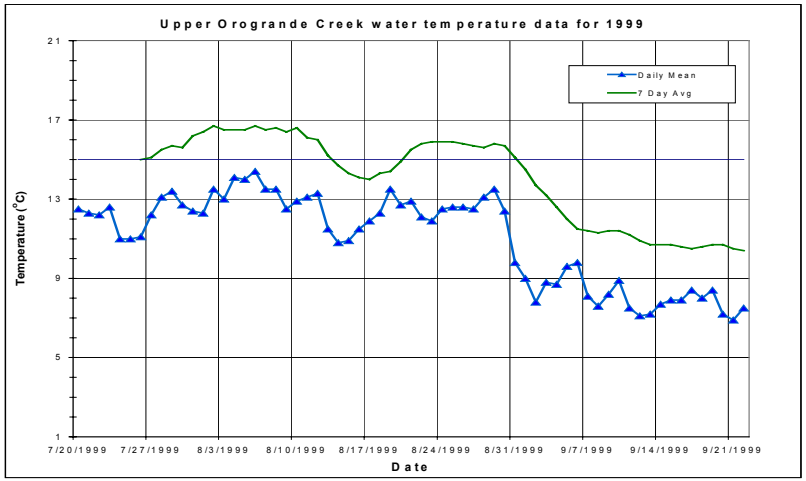


Figure 3-12 (continued). Selected Temperature Data for Upper Orogrande Creek

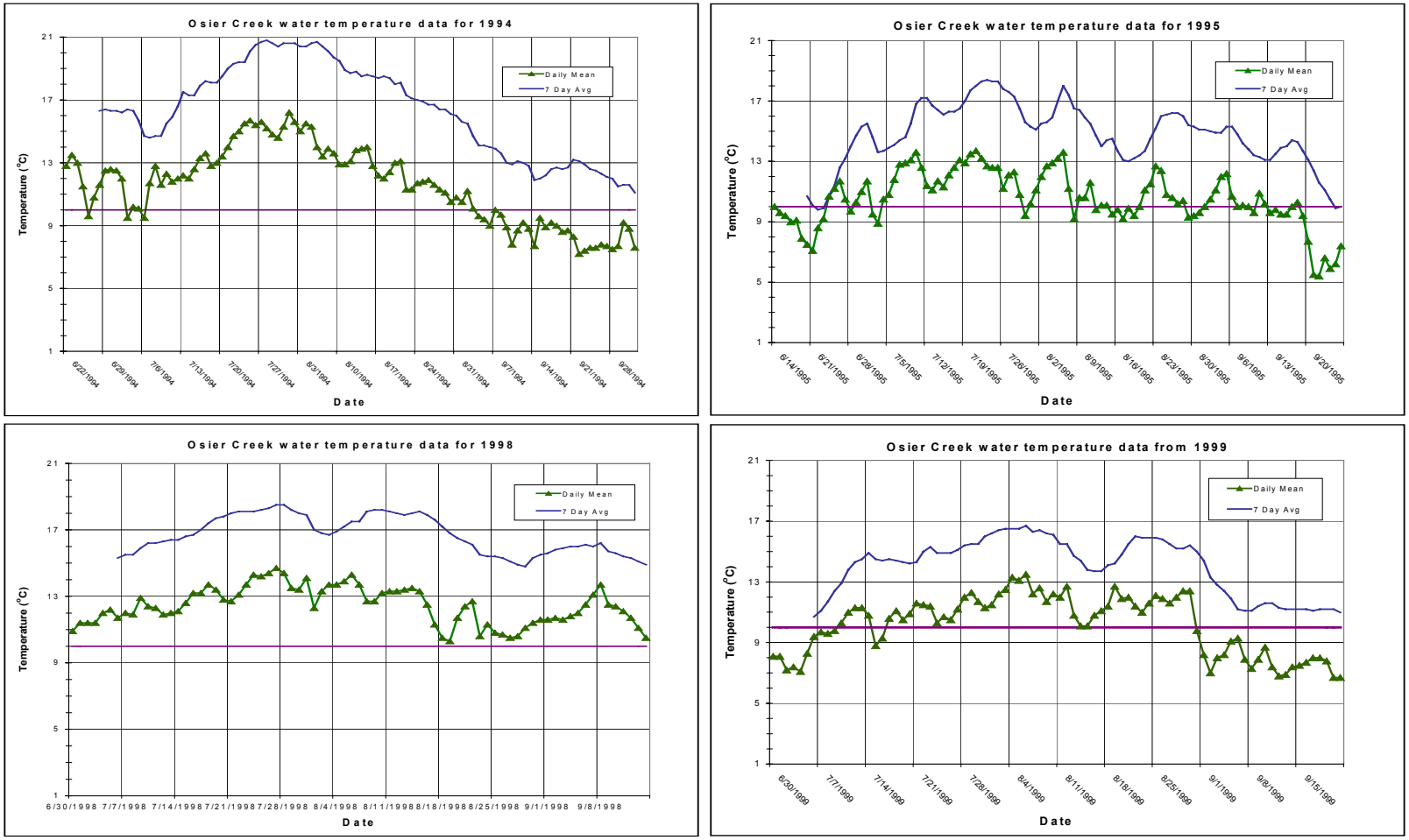


Figure 3-13. Selected Temperature Data for Osier Creek

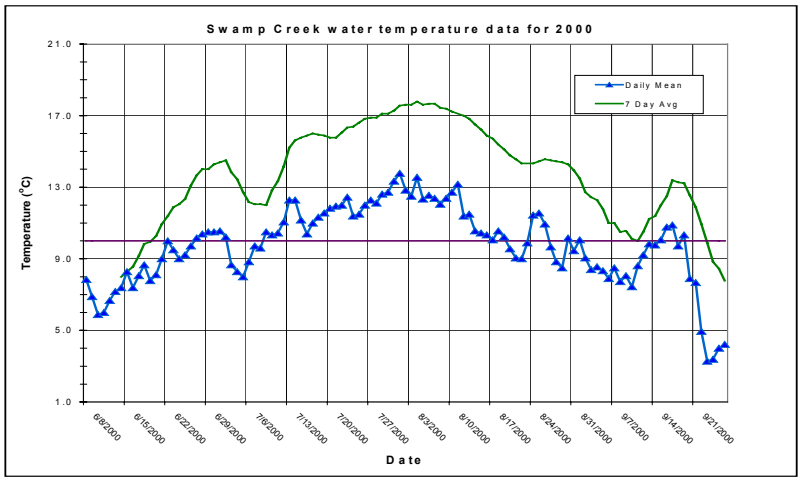


Figure 3-14. Selected Temperature Data for Swamp Creek

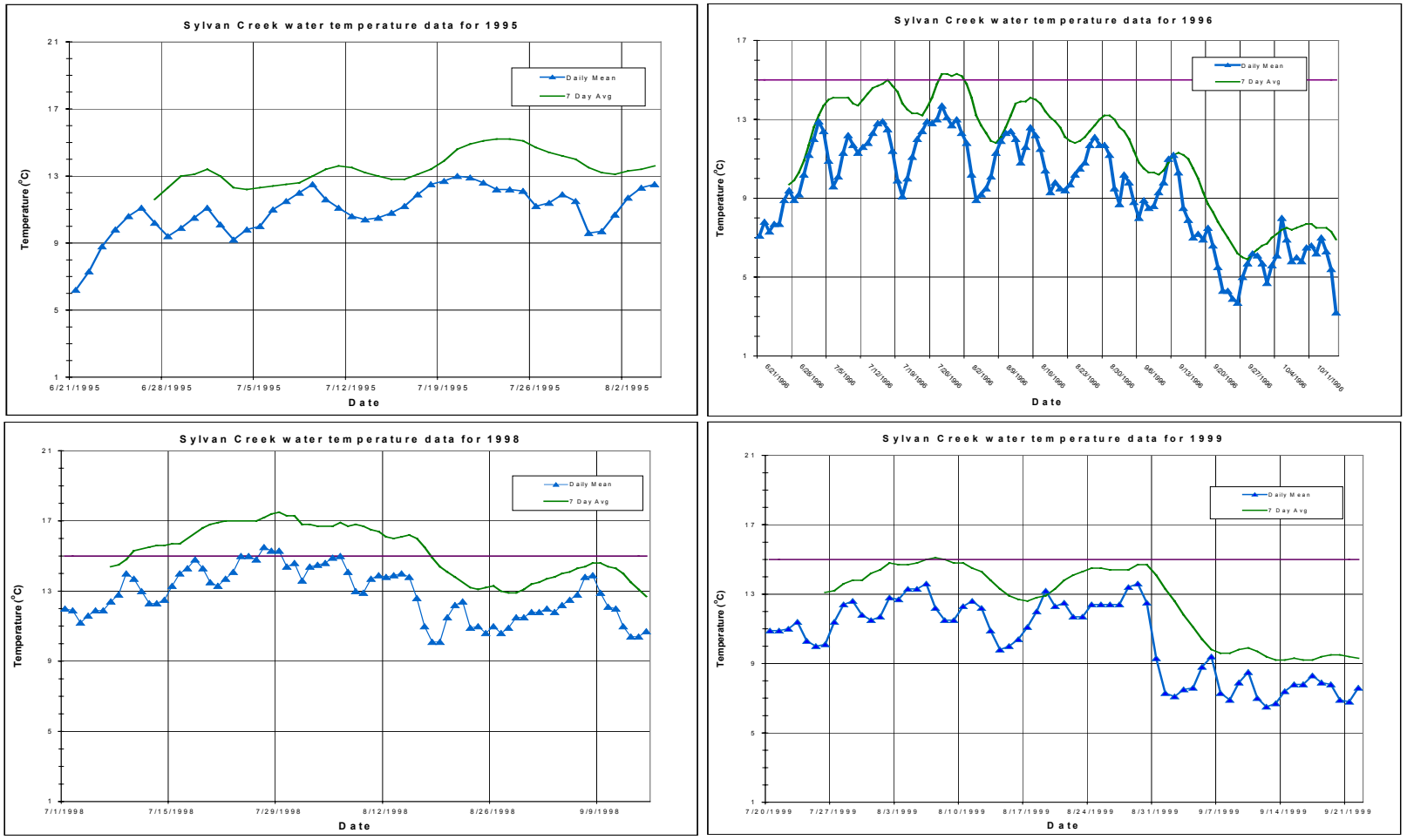


Figure 3-15. Selected Temperature Data for Sylvan Creek

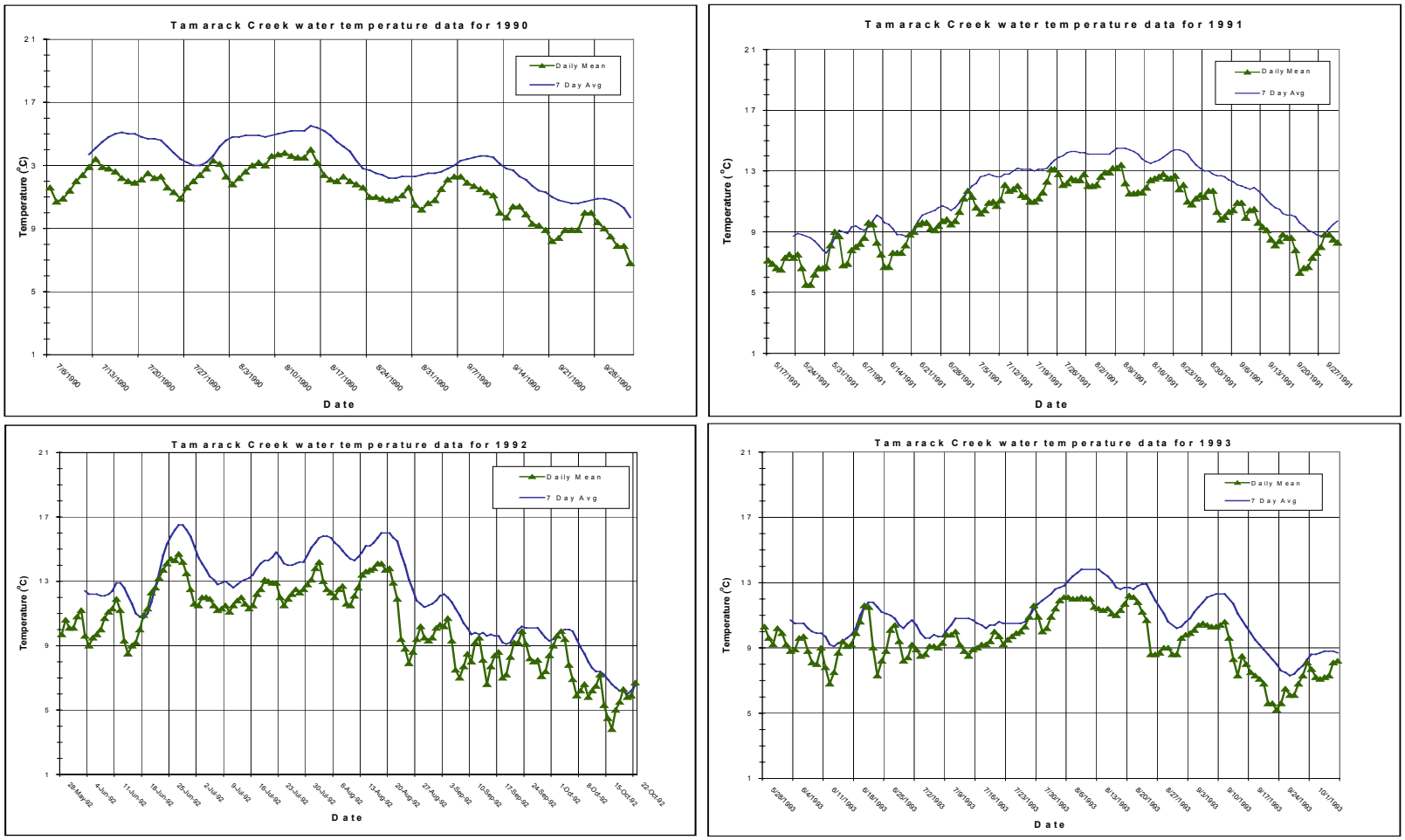
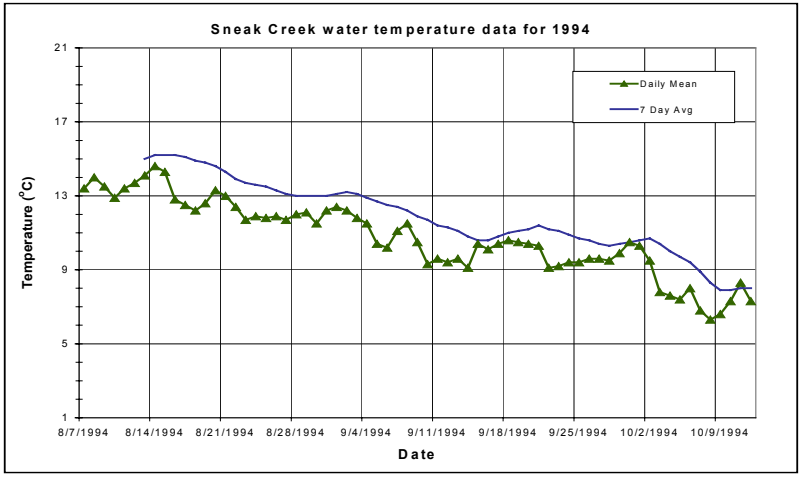
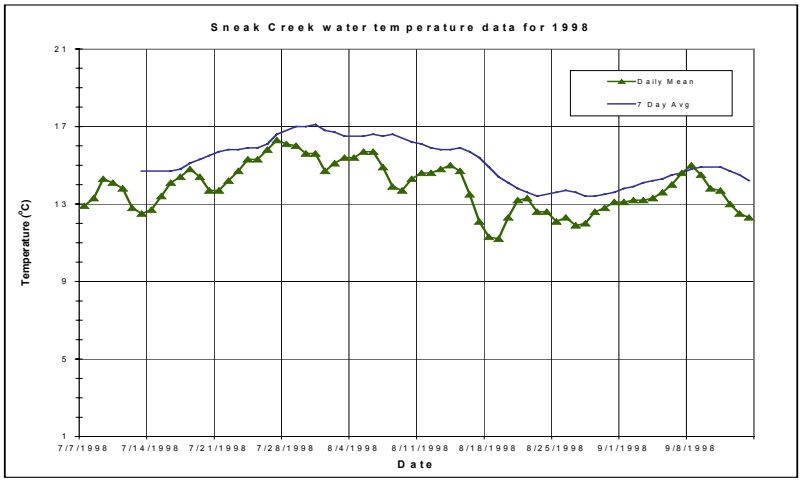


Figure 3-16. Selected Temperature Data for Tamarack Creek





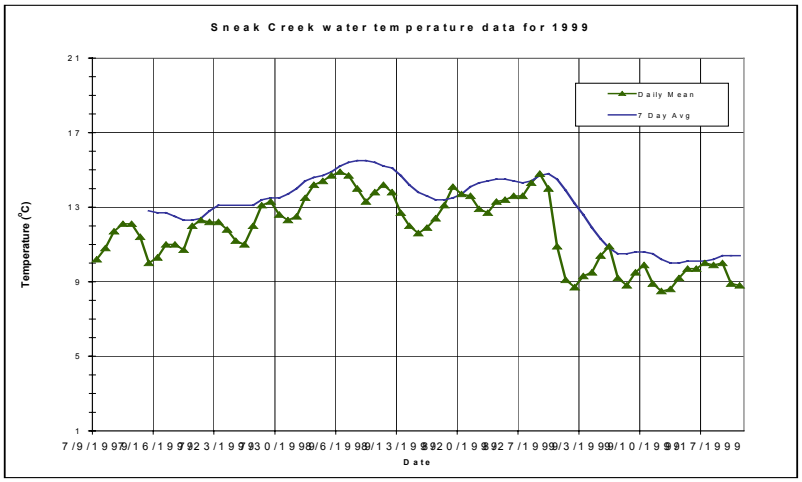


Figure 3-17. Selected Temperature Data for Sneak Creek

Appendix 4. Orogrande Creek Watershed Temperature TMDLs (includes Upper Orogrande Creek, Lower Orogrande Creek, Tamarack Creek, and Sylvan Creek)

An ArcView shapefile of
these data is on the diskette
located in the back of this document

Appendix 4. Orogrande Creek Watershed Temperature TMDLs (includes Upper Orogrande Creek, Lower Orogrande Creek, Tamarack Creek, and Sylvan Creek)

This appendix, along with ArcView shapefile data included on the enclosed diskette, constitute the temperature TMDLs for upper Orogrande Creek, lower Orogrande Creek, Tamarack Creek, and Sylvan Creek. Figure 4-1 shows the distribution of stream segements needing increased percent canopy closure to meet the TMDLs targets. Table 4-1 presents the loading calculations data on a stream reach by stream reach basis. The location of each stream reach can be ascertained using the ArcView shapefile. The ArcView shapefile contains all the data used to create the percent canopy closure increase targets in Figure 4-1 and the data presented in Table 4-1.

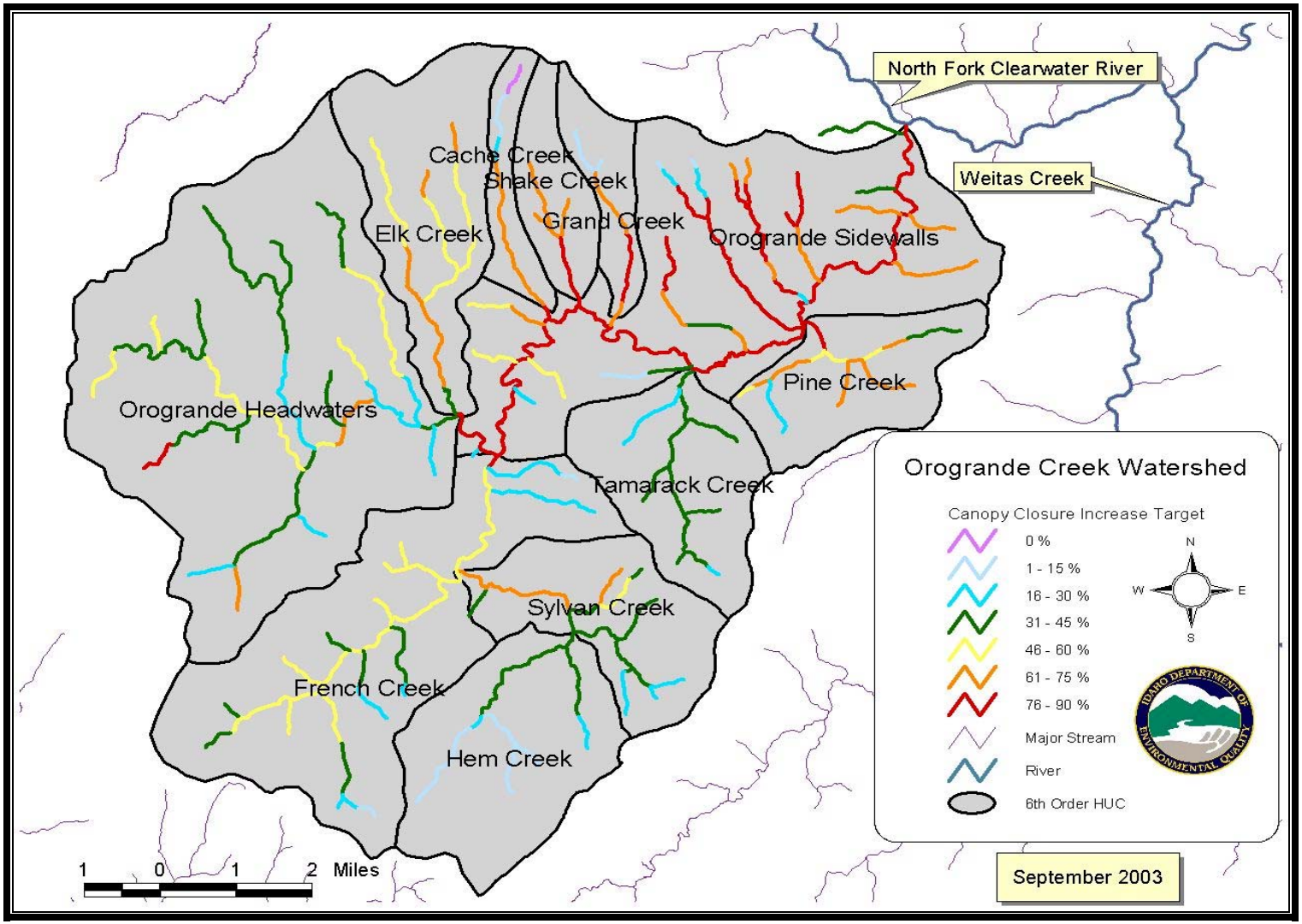


Figure 4-1. Targeted Percent Canopy Closure Increases for the Orogrande Creek Watershed

Table 4-1. Orogrande Creek watershed temperature TMDLs, stream reach by stream reach (includes TMDLs for upper Orogrande Creek, lower Orogrande Creek, Tamarack Creek, and Sylvan Creek).

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Bailey Gulch	1,844	3,400	75	120	100	25	70	17	76
Bailey Gulch	2,146	3,600	50	114	100	50	122	17	86
Bailey Gulch	1,746	3,800	50	108	100	50	122	17	86
Breakfast Creek	1,263	3,400	45	120	100	55	146	18	88
Breakfast Creek	5,674	3,600	45	114	100	55	146	18	88
Breakfast Creek	640	3,800	60	108	100	40	111	18	84
Breakfast Creek	7,078	3,800	45	108	100	55	146	18	88
Breakfast Creek	5,408	3,800	60	108	100	40	111	18	84
Breakfast Creek	1,865	3,800	60	108	100	40	111	18	84
Breakfast Creek	4,787	3,800	60	108	100	40	111	18	84
Breakfast Creek	3,512	4,000	40	101	100	60	157	18	89
Breakfast Creek	2,513	4,000	60	101	100	40	111	18	84
Breakfast Creek	4,312	4,000	40	101	100	60	157	18	89
Cache Creek	1,253	3,000	20	132	100	80	185	17	91
Cache Creek	1,777	3,200	30	126	100	70	164	17	90
Cache Creek	2,454	3,400	30	120	100	70	164	17	90

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Cache Creek	2,704	3,600	30	114	100	70	164	17	90
Cache Creek	2,953	3,800	30	108	100	70	164	17	90
Cache Creek	2,289	4,000	30	101	100	70	164	17	90
Cache Creek	1,840	4,200	75	95	95	20	70	28	60
Cache Creek	1,395	4,400	75	89	89	14	70	40	43
Cache Creek	1,056	4,600	75	83	83	8	70	53	24
Cache Creek	1,123	4,800	75	77	77	2	70	65	7
Cache Creek	1,335	5,000	75	71	75	0	70	78	0
Cache Creek	974	5,200	75	64	75	0	70	93	0
China Gulch	1,625	4,400	45	89	89	44	146	43	71
Copper Creek	1,829	3,600	45	114	100	55	133	17	87
Copper Creek	4,620	3,800	45	108	100	55	133	17	87
Copper Creek	2,019	4,000	30	101	100	70	164	17	90
Cottonwood Creek	2,018	3,000	30	132	100	70	181	18	90
Cottonwood Creek	1,249	3,000	60	132	100	40	111	18	84
Cottonwood Creek	1,973	3,200	60	126	100	40	111	18	84
Cottonwood Creek	1,522	3,400	30	120	100	70	181	18	90
Cottonwood Creek	1,618	3,600	30	114	100	70	181	18	90
Cottonwood Creek	4,794	3,800	20	108	100	80	204	18	91

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Crystal Creek	1,054	3,400	70	120	100	30	80	17	79
Crystal Creek	7,600	3,600	70	114	100	30	80	17	79
Crystal Creek	4,603	3,800	60	108	100	40	101	17	83
Crystal Creek	4,988	4,000	60	101	100	40	101	17	83
Crystal Creek	11,319	4,000	60	101	100	40	101	17	83
E.F. Elk Creek	3,717	3,600	45	114	100	55	133	17	87
E.F. Elk Creek	3,070	3,600	45	114	100	55	133	17	87
E.F. Elk Creek	6,719	3,800	45	108	100	55	133	17	87
E.F. Elk Creek	2,327	4,000	30	101	100	70	164	17	90
E.F. French Creek	4,623	4,000	45	101	100	55	133	17	87
E.F. French Creek	4,109	4,200	60	95	95	35	101	28	72
E.F. French Creek	924	4,400	60	89	89	29	101	40	60
E.F. French Creek	252	4,400	60	89	89	29	101	40	60
E.F. French Creek	1,268	4,400	60	89	89	29	101	40	60
E.F. French Creek	1,562	4,600	80	83	83	3	59	53	10
Elk Creek	2,874	3,200	60	126	100	40	101	17	83
Elk Creek	1,781	3,400	30	120	100	70	164	17	90
Elk Creek	3,367	3,400	30	120	100	70	164	17	90
Elk Creek	1,938	3,600	30	114	100	70	164	17	90

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Fidelity Gulch	3,750	4,000	45	101	100	55	133	17	87
Fir Creek	1,409	2,800	45	139	100	55	146	18	88
Fir Creek	3,248	3,000	30	132	100	70	181	18	90
Fir Creek	1,283	3,200	30	126	100	70	181	18	90
Fir Creek	1,750	3,200	75	126	100	25	76	18	76
Fir Creek	1,270	3,400	45	120	100	55	146	18	88
Fir Creek	1,436	3,400	75	120	100	25	76	18	76
Fir Creek	1,204	3,600	75	114	100	25	76	18	76
French Creek	1,172	3,200	20	126	100	80	204	18	91
French Creek	1,932	3,200	45	126	100	55	146	18	88
French Creek	3,187	3,200	45	126	100	55	146	18	88
French Creek	1,306	3,400	75	120	100	25	76	18	76
French Creek	1,486	3,400	75	120	100	25	76	18	76
French Creek	5,107	3,400	50	120	100	50	134	18	87
French Creek	5,869	3,600	50	114	100	50	134	18	87
French Creek	2,063	3,600	50	114	100	50	134	18	87
French Creek	462	3,600	75	114	100	25	76	18	76
French Creek	625	3,600	75	114	100	25	76	18	76
French Creek	782	3,800	45	108	100	55	146	18	88

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
French Creek	2,915	3,800	45	108	100	55	146	18	88
French Creek	894	3,800	45	108	100	55	146	18	88
French Creek	3,238	3,800	45	108	100	55	146	18	88
French Creek	436	3,800	45	108	100	55	146	18	88
French Creek	2,261	3,800	65	108	100	35	99	18	82
French Creek	2,145	3,800	50	108	100	50	134	18	87
French Creek	957	3,800	75	108	100	25	76	18	76
French Creek	2,013	3,800	75	108	100	25	76	18	76
French Creek	1,138	3,800	60	108	100	40	111	18	84
French Creek	1,193	3,800	50	108	100	50	134	18	87
French Creek	2,634	4,000	45	101	100	55	146	18	88
French Creek	2,001	4,000	50	101	100	50	134	18	87
French Creek	1,934	4,000	50	101	100	50	134	18	87
French Creek	2,249	4,000	45	101	100	55	146	18	88
French Creek	1,790	4,000	75	101	100	25	76	18	76
French Creek	1,611	4,000	75	101	100	25	76	18	76
French Creek	2,465	4,000	60	101	100	40	111	18	84
French Creek	2,899	4,000	65	101	100	35	99	18	82
French Creek	1,611	4,000	50	101	100	50	134	18	87

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
French Creek	4,180	4,200	45	95	95	50	146	29	80
French Creek	1,486	4,200	75	95	95	20	76	29	62
French Creek	2,165	4,200	75	95	95	20	76	29	62
French Creek	1,832	4,200	60	95	95	35	111	29	74
French Creek	1,519	4,200	65	95	95	30	99	29	71
French Creek	1,393	4,200	45	95	95	50	146	29	80
French Creek	1,159	4,400	75	89	89	14	76	43	43
French Creek	2,232	4,400	45	89	89	44	146	43	71
French Creek	940	4,600	60	83	83	23	111	57	49
French Creek	1,734	4,600	65	83	83	18	99	57	42
Fuzzy Creek	911	2,600	30	145	100	70	197	18	91
Fuzzy Creek	841	2,800	30	139	100	70	197	18	91
Fuzzy Creek	1,383	3,000	30	132	100	70	197	18	91
Fuzzy Creek	1,770	3,200	30	126	100	70	197	18	91
Fuzzy Creek	1,596	3,600	30	114	100	70	197	18	91
Grand Creek	656	3,000	30	132	100	70	164	17	90
Grand Creek	1,274	3,200	30	126	100	70	164	17	90
Grand Creek	2,488	3,400	20	120	100	80	185	17	91
Grand Creek	1,687	3,600	20	114	100	80	185	17	91

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Grand Creek	1,372	3,800	20	108	100	80	185	17	91
Grand Creek	1,386	4,000	30	101	100	70	164	17	90
Grand Creek	3,809	4,200	30	95	95	65	164	28	83
Grand Creek	977	4,400	75	89	89	14	70	40	43
Grand Creek	2,036	4,400	75	89	89	14	70	40	43
Grand Creek	1,604	4,600	75	83	83	8	70	53	24
Hem Creek	1,304	3,800	60	108	100	40	111	18	84
Hem Creek	4,087	4,000	60	101	100	40	111	18	84
Hem Creek	5,418	4,200	60	95	95	35	111	29	74
Hem Creek	1,226	4,200	75	95	95	20	76	29	62
Hem Creek	3,146	4,400	75	89	89	14	76	43	43
Hem Creek	4,643	4,400	75	89	89	14	76	43	43
Hem Creek	447	4,600	75	83	83	8	76	57	25
Hem Creek	1,395	4,600	75	83	83	8	76	57	25
Hem Creek	1,805	4,600	75	83	83	8	76	57	25
Hem Creek	2,437	4,600	75	83	83	8	76	57	25
Hem Creek	938	4,800	75	77	77	2	76	71	7
Hem Creek	2,081	4,800	75	77	77	2	76	71	7
Hook Creek	2,808	2,800	20	139	100	80	185	17	91

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Hook Creek	2,402	3,000	10	132	100	90	206	17	92
Hook Creek	1,530	3,200	10	126	100	90	206	17	92
Hook Creek	3,280	3,400	20	120	100	80	185	17	91
Hook Creek	1,634	3,600	10	114	100	90	206	17	92
Hook Creek	1,439	3,800	10	108	100	90	206	17	92
Hook Creek	1,727	3,800	10	108	100	90	206	17	92
Hook Creek	2,117	4,000	10	101	100	90	206	17	92
Hook Creek	1,439	4,000	75	101	100	25	70	17	76
Hook Creek	1,667	4,200	75	95	95	20	70	28	60
Hook Creek	1,104	4,200	75	95	95	20	70	28	60
Hook Creek	763	4,400	75	89	89	14	70	40	43
Hook Creek	618	4,400	75	89	89	14	70	40	43
Irish Creek	1,095	3,400	60	120	100	40	101	17	83
Irish Creek	3,623	3,600	60	114	100	40	101	17	83
Jazz Creek	585	2,800	30	139	100	70	164	17	90
Jazz Creek	1,578	3,000	30	132	100	70	164	17	90
Jazz Creek	1,144	3,200	30	126	100	70	164	17	90
Jazz Creek	1,475	3,400	30	120	100	70	164	17	90
Jazz Creek	1,259	3,600	20	114	100	80	185	17	91

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Jazz Creek	908	3,600	20	114	100	80	185	17	91
Jazz Creek	1,452	3,800	20	108	100	80	185	17	91
Jazz Creek	1,863	4,000	20	101	100	80	185	17	91
Joy Creek	3,168	4,000	60	101	100	40	101	17	83
Joy Creek	2,471	4,200	60	95	95	35	101	28	72
Joy Creek	2,644	4,400	60	89	89	29	101	40	60
Knute Creek	1,063	2,800	75	139	100	25	70	17	76
Knute Creek	1,190	3,000	10	132	100	90	206	17	92
Knute Creek	897	3,200	10	126	100	90	206	17	92
Knute Creek	671	3,400	30	120	100	70	164	17	90
Knute Creek	919	3,600	30	114	100	70	164	17	90
Knute Creek	4,645	3,800	20	108	100	80	185	17	91
Knute Creek	2,711	4,000	20	101	100	80	185	17	91
Knute Creek	1,965	4,000	20	101	100	80	185	17	91
Knute Creek	1,222	4,200	20	95	95	75	185	28	85
Knute Creek	1,966	4,200	20	95	95	75	185	28	85
L. Orogrande Creek	890	2,200	60	157	100	40	111	18	84
L. Orogrande Creek	3,191	2,200	20	157	100	80	204	18	91
L. Orogrande Creek	693	2,200	20	157	100	80	204	18	91

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
L. Orogrande Creek	4,109	2,400	20	151	100	80	204	18	91
L. Orogrande Creek	648	2,400	20	151	100	80	204	18	91
L. Orogrande Creek	2,914	2,400	20	151	100	80	204	18	91
L. Orogrande Creek	1,366	2,400	60	151	100	40	111	18	84
L. Orogrande Creek	2,236	2,400	20	151	100	80	204	18	91
L. Orogrande Creek	447	2,400	60	151	100	40	111	18	84
L. Orogrande Creek	6,748	2,600	20	145	100	80	204	18	91
L. Orogrande Creek	847	2,600	60	145	100	40	111	18	84
L. Orogrande Creek	792	2,600	30	145	100	70	181	18	90
L. Orogrande Creek	546	2,600	60	145	100	40	111	18	84
L. Orogrande Creek	2,101	2,800	20	139	100	80	204	18	91
L. Orogrande Creek	2,225	2,800	20	139	100	80	204	18	91
L. Orogrande Creek	495	2,800	20	139	100	80	204	18	91
L. Orogrande Creek	413	2,800	60	139	100	40	111	18	84
L. Orogrande Creek	963	2,800	20	139	100	80	204	18	91
L. Orogrande Creek	492	2,800	30	139	100	70	181	18	90
L. Orogrande Creek	455	2,800	60	139	100	40	111	18	84
L. Orogrande Creek	918	3,000	10	132	100	90	227	18	92
L. Orogrande Creek	4,056	3,000	10	132	100	90	227	18	92

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
L. Orogrande Creek	374	3,000	10	132	100	90	227	18	92
L. Orogrande Creek	2,996	3,000	10	132	100	90	227	18	92
L. Orogrande Creek	555	3,000	10	132	100	90	227	18	92
L. Orogrande Creek	3,015	3,000	20	132	100	80	204	18	91
L. Orogrande Creek	250	3,000	10	132	100	90	227	18	92
L. Orogrande Creek	5,110	3,000	10	132	100	90	227	18	92
L. Orogrande Creek	10,082	3,000	20	132	100	80	204	18	91
L. Orogrande Creek	6,173	3,000	10	132	100	90	227	18	92
L. Orogrande Creek	6,530	3,000	20	132	100	80	204	18	91
L. Orogrande Creek	351	3,000	60	132	100	40	111	18	84
L. Orogrande Creek	4,099	3,000	10	132	100	90	227	18	92
L. Orogrande Creek	1,952	3,000	60	132	100	40	111	18	84
L. Orogrande Creek	1,072	3,000	60	132	100	40	111	18	84
L. Orogrande Creek	1,252	3,000	30	132	100	70	181	18	90
L. Orogrande Creek	515	3,000	30	132	100	70	181	18	90
L. Orogrande Creek	485	3,000	60	132	100	40	111	18	84
L. Orogrande Creek	1,341	3,200	20	126	100	80	204	18	91
L. Orogrande Creek	419	3,200	60	126	100	40	111	18	84
L. Orogrande Creek	2,133	3,200	90	126	100	10	41	18	56

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
L. Orogrande Creek	2,022	3,200	45	126	100	55	146	18	88
L. Orogrande Creek	1,240	3,200	75	126	100	25	76	18	76
L. Orogrande Creek	1,493	3,200	30	126	100	70	181	18	90
L. Orogrande Creek	963	3,200	30	126	100	70	181	18	90
L. Orogrande Creek	668	3,200	60	126	100	40	111	18	84
L. Orogrande Creek	1,212	3,200	45	126	100	55	146	18	88
L. Orogrande Creek	4,498	3,200	20	126	100	80	204	18	91
L. Orogrande Creek	919	3,400	75	120	100	25	76	18	76
L. Orogrande Creek	639	3,400	60	120	100	40	111	18	84
L. Orogrande Creek	1,360	3,400	90	120	100	10	41	18	56
L. Orogrande Creek	1,090	3,400	45	120	100	55	146	18	88
L. Orogrande Creek	596	3,400	75	120	100	25	76	18	76
L. Orogrande Creek	1,800	3,400	45	120	100	55	146	18	88
L. Orogrande Creek	518	3,400	30	120	100	70	181	18	90
L. Orogrande Creek	228	3,400	60	120	100	40	111	18	84
L. Orogrande Creek	847	3,400	45	120	100	55	146	18	88
L. Orogrande Creek	1,060	3,600	60	114	100	40	111	18	84
L. Orogrande Creek	557	3,600	45	114	100	55	146	18	88
L. Orogrande Creek	1,357	3,600	45	114	100	55	146	18	88

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
L. Orogrande Creek	568	3,600	30	114	100	70	181	18	90
L. Orogrande Creek	1,450	3,600	50	114	100	50	134	18	87
L. Orogrande Creek	675	3,800	60	108	100	40	111	18	84
L. Orogrande Creek	589	3,800	50	108	100	50	134	18	87
L. Orogrande Creek	598	3,800	30	108	100	70	181	18	90
L. Orogrande Creek	317	4,000	30	101	100	70	181	18	90
Mill Creek	1,169	2,600	30	145	100	70	197	18	91
Mill Creek	1,220	2,800	30	139	100	70	197	18	91
Mill Creek	1,287	3,200	30	126	100	70	197	18	91
Pine Creek	2,003	2,800	45	139	100	55	159	18	89
Pine Creek	2,979	2,800	20	139	100	80	223	18	92
Pine Creek	1,733	3,000	45	132	100	55	159	18	89
Pine Creek	947	3,000	30	132	100	70	197	18	91
Pine Creek	154	3,000	30	132	100	70	197	18	91
Pine Creek	1,960	3,000	30	132	100	70	197	18	91
Pine Creek	1,874	3,000	30	132	100	70	197	18	91
Pine Creek	1,652	3,200	30	126	100	70	197	18	91
Pine Creek	662	3,200	30	126	100	70	197	18	91
Pine Creek	998	3,200	30	126	100	70	197	18	91

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Pine Creek	1,709	3,200	30	126	100	70	197	18	91
Pine Creek	1,309	3,400	30	120	100	70	197	18	91
Pine Creek	1,665	3,400	60	120	100	40	120	18	85
Pine Creek	2,212	3,600	60	114	100	40	120	18	85
S.F. Breakfast Creek	1,130	3,800	60	108	100	40	111	18	84
S.F. Breakfast Creek	1,412	3,800	60	108	100	40	111	18	84
S.F. Breakfast Creek	6,047	3,800	60	108	100	40	111	18	84
S.F. Breakfast Creek	3,055	4,000	20	101	100	80	204	18	91
Shake Creek	1,617	3,000	20	132	100	80	185	17	91
Shake Creek	1,551	3,200	20	126	100	80	185	17	91
Shake Creek	897	3,400	30	120	100	70	164	17	90
Shake Creek	2,241	3,400	20	120	100	80	185	17	91
Shake Creek	1,722	3,600	30	114	100	70	164	17	90
Shake Creek	3,041	3,600	30	114	100	70	164	17	90
Shake Creek	3,439	3,600	30	114	100	70	164	17	90
Shake Creek	1,991	3,800	30	108	100	70	164	17	90
Silver Creek	4,348	3,400	75	120	100	25	70	17	76
Silver Creek	10,656	3,600	50	114	100	50	122	17	86
Silver Creek	6,952	3,800	55	108	100	45	112	17	85

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Sylvan Creek	507	3,600	60	114	100	40	111	18	84
Sylvan Creek	2,688	3,600	30	114	100	70	181	18	90
Sylvan Creek	3,063	3,600	30	114	100	70	181	18	90
Sylvan Creek	1,996	3,800	60	108	100	40	111	18	84
Sylvan Creek	1,672	3,800	60	108	100	40	111	18	84
Sylvan Creek	4,230	3,800	30	108	100	70	181	18	90
Sylvan Creek	1,122	3,800	60	108	100	40	111	18	84
Sylvan Creek	3,900	4,000	60	101	100	40	111	18	84
Sylvan Creek	1,386	4,000	60	101	100	40	111	18	84
Sylvan Creek	1,478	4,000	30	101	100	70	181	18	90
Sylvan Creek	1,101	4,000	45	101	100	55	146	18	88
Sylvan Creek	1,568	4,000	60	101	100	40	111	18	84
Sylvan Creek	1,960	4,200	60	95	95	35	111	29	74
Sylvan Creek	4,374	4,200	50	95	95	45	134	29	78
Sylvan Creek	1,742	4,200	30	95	95	65	181	29	84
Sylvan Creek	2,196	4,200	45	95	95	50	146	29	80
Sylvan Creek	1,089	4,200	60	95	95	35	111	29	74
Sylvan Creek	665	4,200	60	95	95	35	111	29	74
Sylvan Creek	2,445	4,400	60	89	89	29	111	43	61

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Sylvan Creek	1,025	4,400	60	89	89	29	111	43	61
Sylvan Creek	1,177	4,400	45	89	89	44	146	43	71
Sylvan Creek	1,743	4,400	60	89	89	29	111	43	61
Sylvan Creek	1,648	4,600	60	83	83	23	111	57	49
Tamarack Creek	2,001	3,000	60	132	100	40	101	17	83
Tamarack Creek	2,711	3,000	60	132	100	40	101	17	83
Tamarack Creek	2,774	3,000	75	132	100	25	70	17	76
Tamarack Creek	1,969	3,200	60	126	100	40	101	17	83
Tamarack Creek	1,757	3,200	60	126	100	40	101	17	83
Tamarack Creek	2,269	3,200	75	126	100	25	70	17	76
Tamarack Creek	2,136	3,400	60	120	100	40	101	17	83
Tamarack Creek	1,208	3,400	60	120	100	40	101	17	83
Tamarack Creek	1,252	3,400	60	120	100	40	101	17	83
Tamarack Creek	2,639	3,400	60	120	100	40	101	17	83
Tamarack Creek	1,135	3,400	60	120	100	40	101	17	83
Tamarack Creek	1,059	3,400	75	120	100	25	70	17	76
Tamarack Creek	1,037	3,600	60	114	100	40	101	17	83
Tamarack Creek	1,048	3,600	60	114	100	40	101	17	83
Tamarack Creek	1,193	3,800	60	108	100	40	101	17	83

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Tamarack Creek	965	3,800	60	108	100	40	101	17	83
Tamarack Creek	2,437	3,800	60	108	100	40	101	17	83
Tamarack Creek	991	4,000	60	101	100	40	101	17	83
Tamarack Creek	857	4,000	60	101	100	40	101	17	83
Tamarack Creek	903	4,000	60	101	100	40	101	17	83
Tamarack Creek	827	4,000	60	101	100	40	101	17	83
Tamarack Creek	830	4,200	60	95	95	35	101	28	72
Tamarack Creek	1,172	4,200	60	95	95	35	101	28	72
Tamarack Creek	1,019	4,400	60	89	89	29	101	40	60
U. Orogrande Creek	1,940	3,200	60	126	100	40	111	18	84
U. Orogrande Creek	3,494	3,400	30	120	100	70	181	18	90
U. Orogrande Creek	1,839	3,400	30	120	100	70	181	18	90
U. Orogrande Creek	4,256	3,400	75	120	100	25	76	18	76
U. Orogrande Creek	1,096	3,400	60	120	100	40	111	18	84
U. Orogrande Creek	1,514	3,400	45	120	100	55	146	18	88
U. Orogrande Creek	1,853	3,400	60	120	100	40	111	18	84
U. Orogrande Creek	1,817	3,400	75	120	100	25	76	18	76
U. Orogrande Creek	1,348	3,400	60	120	100	40	111	18	84
U. Orogrande Creek	94	3,600	75	114	100	25	76	18	76

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
U. Orogrande Creek	1,033	3,600	75	114	100	25	76	18	76
U. Orogrande Creek	2,224	3,600	60	114	100	40	111	18	84
U. Orogrande Creek	2,153	3,600	55	114	100	45	122	18	85
U. Orogrande Creek	2,746	3,800	75	108	100	25	76	18	76
U. Orogrande Creek	866	3,800	75	108	100	25	76	18	76
U. Orogrande Creek	3,918	3,800	65	108	100	35	99	18	82
U. Orogrande Creek	3,474	4,000	35	101	100	65	169	18	89
U. Orogrande Creek	3,407	4,000	80	101	100	20	64	18	72
W.F. Elk Creek	9,081	3,800	50	108	100	50	122	17	86
W.F. Elk Creek	5,231	3,600	30	114	100	70	164	17	90

[1]More than one segment of a named water body may occur in the same 200-foot elevation zone. Generally this is because unnamed perennial tributaries are included in the analysis, a reach is split because of a radical percent canopy closure change, or a reach is split at the confluence of two tributaries (see map). The only way to know which data apply to which reach on the ground is to use the ArcView data set included with this report.

[2]Current Canopy Closure (%) is estimated from recent 1:15,840 stereo aerial photographs.

[3]CWE Modeled Canopy Closure (%) is the percent canopy closure predicted by the CWE temperature model as needed to protect stream temperatures for salmonid spawning and/or bull trout.

Appendix 5. Osier Creek Watershed Temperature TMDLs (includes Swamp Creek, China Creek, Sugar Creek, and Laundry Creek)

An ArcView shapefile of
these data is on the diskette
located in the back of this document

Appendix 5. Osier Creek Watershed Temperature TMDLs (includes Swamp Creek, China Creek, Sugar Creek and Laundry Creek)

This appendix, along with ArcView shapefile data included on the enclosed diskette, constitutes the temperature TMDLs for Osier Creek, Swamp Creek, China Creek, Sugar Creek, and Laundry Creek. Figure 5-1 shows the distribution of stream segements needing increased percent canopy closure to meet the TMDLs targets. Table 5-1 presents the loading calculations data on a stream reach by stream reach basis. The location of each stream reach can be ascertained using the ArcView shapefile. The ArcView shapefile contains all the data used to create the percent canopy closure increase targets in Figure 5-1 and the data presented in Table 5-1.

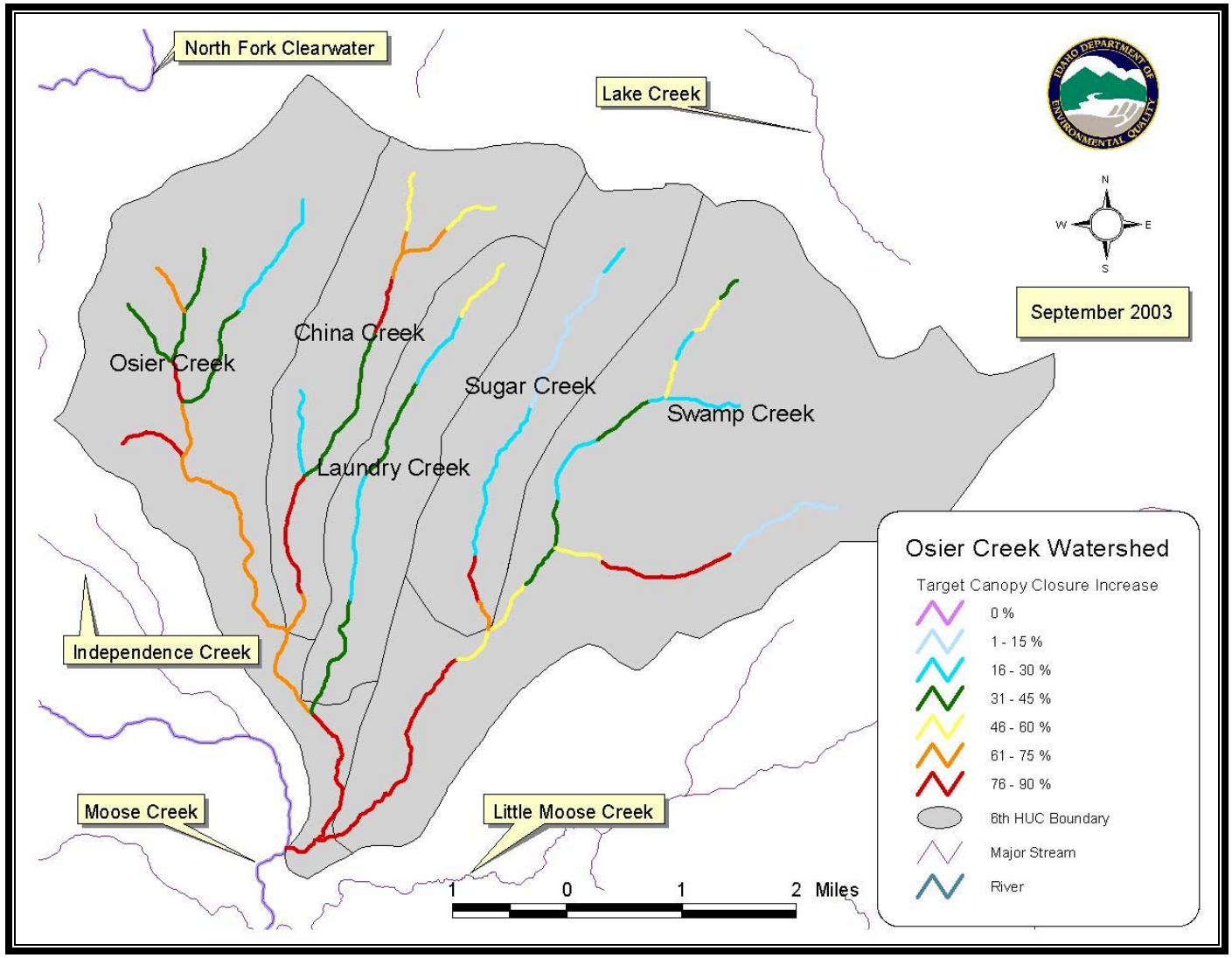


Figure 5-1. Targeted Percent Canopy Closure Increases for the Osier Creek Watershed

Table 5-1. Osier Creek watershed temperature TMDLs, stream reach by stream reach (includes TMDLs for Swamp Creek, China Creek, Sugar Creek, and Laundry Creek).

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
China Creek	2,130	3,600	30	114	100	70	164	17	90
China Creek	1,526	3,600	15	114	100	85	196	17	91
China Creek	4,230	3,800	15	108	100	85	196	17	91
China Creek	4,149	4,000	75	101	100	25	70	17	76
China Creek	7,741	4,000	60	101	100	40	101	17	83
China Creek	2,666	4,200	15	95	95	80	196	28	86
China Creek	1,263	4,200	30	95	95	65	164	28	83
China Creek	1,085	4,200	30	95	95	65	164	28	83
China Creek	2,466	4,200	30	95	95	65	164	28	83
China Creek	2,745	4,400	30	89	89	59	164	40	76
China Creek	2,659	4,400	30	89	89	59	164	40	76
Laundry Creek	3,512	3,600	60	114	100	40	101	17	83
Laundry Creek	2,618	3,800	60	108	100	40	101	17	83
Laundry Creek	3,141	3,800	75	108	100	25	70	17	76
Laundry Creek	2,851	4,000	75	101	100	25	70	17	76
Laundry Creek	2,221	4,000	60	101	100	40	101	17	83
Laundry Creek	2,707	4,200	60	95	95	35	101	28	72

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Laundry Creek	3,740	4,400	60	89	89	29	101	40	60
Laundry Creek	2,199	4,600	30	83	83	53	164	53	68
Laundry Creek	1,059	4,800	30	77	77	47	164	65	60
Osier Creek	1,806	3,200	15	126	100	85	196	17	91
Osier Creek	4,628	3,200	15	126	100	85	196	17	91
Osier Creek	4,624	3,400	30	120	100	70	164	17	90
Osier Creek	2,488	3,400	15	120	100	85	196	17	91
Osier Creek	5,180	3,600	30	114	100	70	164	17	90
Osier Creek	4,141	3,800	30	108	100	70	164	17	90
Osier Creek	2,715	3,800	30	108	100	70	164	17	90
Osier Creek	1,768	3,800	30	108	100	70	164	17	90
Osier Creek	5,524	4,000	60	101	100	40	101	17	83
Osier Creek	6,076	4,200	75	95	95	20	70	28	60
Pioneer Gulch	3,449	4,000	15	101	100	85	196	17	91
Pollock Creek	2,370	3,800	45	108	100	55	146	18	88
Pollock Creek	4,470	4,000	15	101	100	85	216	18	92
Pollock Creek	1,882	4,200	15	95	95	80	216	29	87
Pollock Creek	2,528	4,400	75	89	89	14	76	43	43
Pollock Creek	2,329	4,600	75	83	83	8	76	57	25

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Pollock Creek	1,078	4,800	75	77	77	2	76	71	7
Sugar Creek	1,453	3,600	30	114	100	70	164	17	90
Sugar Creek	1,313	3,800	75	108	100	25	70	17	76
Sugar Creek	2,217	3,800	15	108	100	85	196	17	91
Sugar Creek	2,119	4,000	75	101	100	25	70	17	76
Sugar Creek	842	4,000	75	101	100	25	70	17	76
Sugar Creek	3,550	4,200	75	95	95	20	70	28	60
Sugar Creek	4,031	4,400	75	89	89	14	70	40	43
Sugar Creek	3,411	4,600	75	83	83	8	70	53	24
Sugar Creek	1,414	4,800	50	77	77	27	122	65	47
Swamp Creek	2,385	3,200	15	126	100	85	216	18	92
Swamp Creek	7,814	3,400	15	120	100	85	216	18	92
Swamp Creek	1,687	3,600	15	114	100	85	216	18	92
Swamp Creek	2,267	3,600	45	114	100	55	146	18	88
Swamp Creek	2,856	3,600	45	114	100	55	146	18	88
Swamp Creek	2,200	3,800	60	108	100	40	111	18	84
Swamp Creek	2,351	3,800	60	108	100	40	111	18	84
Swamp Creek	3,678	4,000	75	101	100	25	76	18	76
Swamp Creek	3,073	4,200	60	95	95	35	111	29	74

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Swamp Creek	757	4,400	60	89	89	29	111	43	61
Swamp Creek	1,692	4,400	60	89	89	29	111	43	61
Swamp Creek	1,832	4,400	30	89	89	59	181	43	76
Swamp Creek	1,470	4,600	60	83	83	23	111	57	49
Swamp Creek	1,888	4,800	60	77	77	17	111	71	36
Swamp Creek	2,125	4,800	30	77	77	47	181	71	61
Swamp Creek	1,173	5,000	30	71	71	41	181	85	53
WF Osier Creek	2,442	4,000	60	101	100	40	101	17	83
WF Osier Creek	3,459	4,000	60	101	100	40	101	17	83
WF Osier Creek	2,014	4,000	15	101	100	85	196	17	91
WF Osier Creek	3,105	4,200	60	95	95	35	101	28	72
WF Osier Creek	2,455	4,200	30	95	95	65	164	28	83

[1]More than one segment of a named water body may occur in the same 200-foot elevation zone. Generally this is because unnamed perennial tributaries are included in the analysis, a reach is split at the confluence of two tributaries (see map), or a reach is split because of a radical percent canopy closure change. The only way to know which data apply to which reach on the ground is to use the ArcView data set included with this report.

[2]Current Canopy Closure (%) is estimated from recent 1:15,840 stereo aerial photographs.

[3]CWE Modeled Canopy Closure (%) is the percent canopy closure predicted by the CWE temperature model as needed to protect stream temperatures for salmonid spawning and/or bull trout.

Appendix 6. Cold Springs Creek and Cool Creek Temperature TMDLs

An ArcView shapefile of
these data is on the diskette
located in the back of this document

Appendix 6. Cold Springs Creek and Cool Creek Temperature TMDLs

This appendix, along with ArcView shapefile data included on the enclosed diskette, constitutes the temperature TMDLs for Cold Springs Creek and Cool Creek. Figure 6-1 shows the distribution of stream segements needing increased percent canopy closure to meet the TMDLs targets. Tables 6-1 and 6-2 present the loading calculations data on a stream reach by stream reach basis. The location of each stream reach can be ascertained using the ArcView shapefile. The ArcView shapefile contains all the data used to create the percent canopy closure increase targets in Figure 6-1 and the data presented in Tables 6-1 and 6-2.

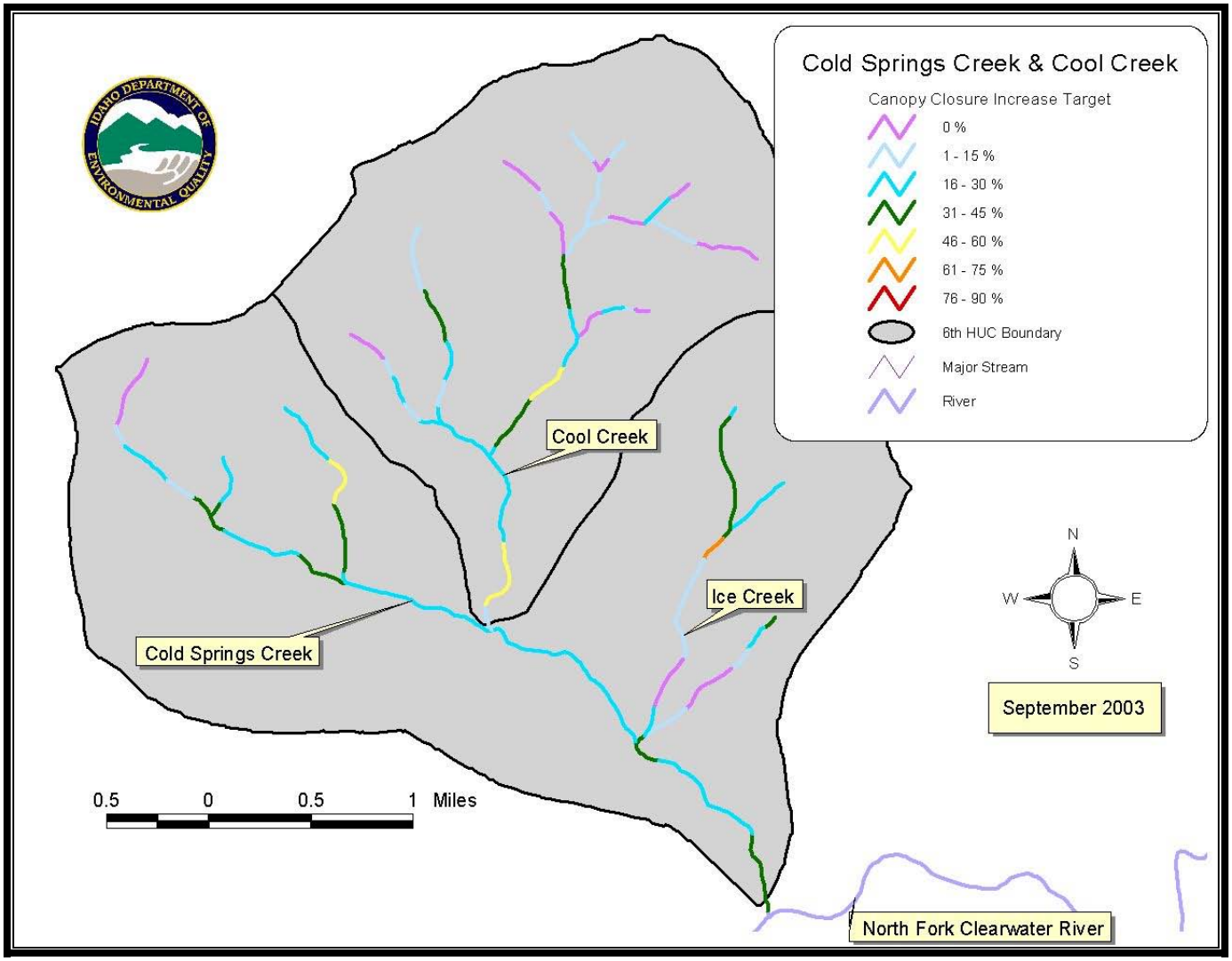


Figure 6-1. Targeted Percent Canopy Closure Increases for Cold Springs Creek and Cool Creek

Table 6-1. Cold Springs Creek temperature TMDL, stream reach by stream reach.

Stream Name	Elevation[1]	Segment Length	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Cold Springs Creek	2,600	2,888	60	145	100	40	111	18	84
Cold Springs Creek	2,800	3,233	75	139	100	25	76	18	76
Cold Springs Creek	3,000	2,655	75	132	100	25	76	18	76
Cold Springs Creek	3,200	3,164	75	126	100	25	76	18	76
Cold Springs Creek	3,400	2,005	75	120	100	25	76	18	76
Cold Springs Creek	3,600	699	60	114	100	40	111	18	84
Cold Springs Creek	3,600	655	45	114	100	55	146	18	88
Cold Springs Creek	3,600	342	75	114	100	25	76	18	76
Cold Springs Creek	3,600	1,451	75	114	100	25	76	18	76
Cold Springs Creek	3,800	894	60	108	100	40	111	18	84
Cold Springs Creek	3,800	815	60	108	100	40	111	18	84
Cold Springs Creek	3,800	595	75	108	100	25	76	18	76
Cold Springs Creek	4,000	1,483	75	101	100	25	76	18	76
Cold Springs Creek	4,000	928	60	101	100	40	111	18	84
Cold Springs Creek	4,200	538	60	95	95	35	111	29	74
Cold Springs Creek	4,200	719	60	95	95	35	111	29	74
Cold Springs Creek	4,200	783	45	95	95	50	146	29	80
Cold Springs Creek	4,200	400	60	95	95	35	111	29	74

Stream Name	Elevation[1]	Segment Length	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Cold Springs Creek	4,400	788	75	89	89	14	76	43	43
Cold Springs Creek	4,400	677	60	89	89	29	111	43	61
Cold Springs Creek	4,600	700	60	83	83	23	111	57	49
Cold Springs Creek	4,600	676	60	83	83	23	111	57	49
Cold Springs Creek	4,600	720	60	83	83	23	111	57	49
Cold Springs Creek	4,800	741	60	77	77	17	111	71	36
Cold Springs Creek	4,800	632	60	77	77	17	111	71	36
Cold Springs Creek	5,000	577	60	71	71	11	111	85	23
Cold Springs Creek	5,000	406	45	71	71	26	146	85	42
Cold Springs Creek	5,200	545	75	64	75	0	76	101	0
Cold Springs Creek	5,400	790	75	58	75	0	76	115	0
Cold Springs Creek	5,600	585	75	52	75	0	76	129	0
Ice Creek	3,000	325	60	132	100	40	101	17	83
Ice Creek	3,000	483	90	132	100	10	38	17	55
Ice Creek	3,000	835	75	132	100	25	70	17	76
Ice Creek	3,200	802	90	126	100	10	38	17	55
Ice Creek	3,200	1,410	100	126	100	0	17	17	0
Ice Creek	3,400	1,370	90	120	100	10	38	17	55
Ice Creek	3,400	784	100	120	100	0	17	17	0

Stream Name	Elevat-ion[1]	Segment Length	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Ice Creek	3,600	767	90	114	100	10	38	17	55
Ice Creek	3,600	825	100	114	100	0	17	17	0
Ice Creek	3,800	719	90	108	100	10	38	17	55
Ice Creek	3,800	689	90	108	100	10	38	17	55
Ice Creek	4,000	738	30	101	100	70	164	17	90
Ice Creek	4,000	685	75	101	100	25	70	17	76
Ice Creek	4,200	326	60	95	95	35	101	28	72
Ice Creek	4,200	507	60	95	95	35	101	28	72
Ice Creek	4,200	425	60	95	95	35	101	28	72
Ice Creek	4,400	755	60	89	89	29	101	40	60
Ice Creek	4,400	1,080	45	89	89	44	133	40	70
Ice Creek	4,600	575	60	83	83	23	101	53	48
Ice Creek	4,600	864	45	83	83	38	133	53	60
Ice Creek	4,800	470	60	77	77	17	101	65	36
Ice Creek	4,800	576	45	77	77	32	133	65	51
Ice Creek	5,000	275	45	71	71	26	133	78	41

[1]More than one segment of a named water body may occur in the same 200-foot elevation zone. Generally this is because unnamed perennial tributaries are included in the analysis, a reach is split because of a radical percent canopy closure change, or a reach is split at the confluence of two tributaries (see map). The only way to know which data apply to which reach on the ground is to use the ArcView data set included with this report.

[2]Current Canopy Closure (%) is estimated from recent 1:15,840 stereo aerial photographs.

[3]CWE Modeled Canopy Closure (%) is the percent canopy closure predicted by the CWE temperature model as needed to protect stream temperatures for salmonid spawning and/or bull trout.

Table 6-2. Cool Creek temperature TMDL, stream reach by stream reach.

Stream Name	Elevat-ion[1]	Segment Length	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Cool Creek	3,400	694	90	120	100	10	38	17	55
Cool Creek	3,400	1,987	45	120	100	55	133	17	87
Cool Creek	3,600	1,575	75	114	100	25	70	17	76
Cool Creek	3,800	812	75	108	100	25	70	17	76
Cool Creek	4,000	1,502	75	101	100	25	70	17	76
Cool Creek	4,000	323	75	101	100	25	70	17	76
Cool Creek	4,000	1,523	60	101	100	40	101	17	83
Cool Creek	4,200	496	75	95	95	20	70	28	60
Cool Creek	4,200	606	75	95	95	20	70	28	60
Cool Creek	4,200	1,240	45	95	95	50	133	28	79
Cool Creek	4,400	364	90	89	90	0	38	40	0
Cool Creek	4,400	795	60	89	89	29	101	40	60
Cool Creek	4,400	666	75	89	89	14	70	40	43
Cool Creek	4,400	583	75	89	89	14	70	40	43
Cool Creek	4,400	820	60	89	89	29	101	40	60
Cool Creek	4,600	1,057	60	83	83	23	101	53	48
Cool Creek	4,600	754	60	83	83	23	101	53	48

Stream Name	Elevat-ion[1]	Segment Length	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Cool Creek	4,600	598	90	83	90	0	38	53	0
Cool Creek	4,600	1,378	45	83	83	38	133	53	60
Cool Creek	4,800	802	75	77	77	2	70	65	7
Cool Creek	4,800	947	75	77	77	2	70	65	7
Cool Creek	4,800	655	75	77	77	2	70	65	7
Cool Creek	4,800	544	75	77	77	2	70	65	7
Cool Creek	4,800	1,478	45	77	77	32	133	65	51
Cool Creek	4,800	1,211	90	77	90	0	38	65	0
Cool Creek	4,800	560	60	77	77	17	101	65	36
Cool Creek	5,000	377	75	71	75	0	70	78	0
Cool Creek	5,000	710	60	71	71	11	101	78	23
Cool Creek	5,000	955	75	71	75	0	70	78	0
Cool Creek	5,000	658	60	71	71	11	101	78	23
Cool Creek	5,000	561	75	71	75	0	70	78	0
Cool Creek	5,000	1,086	60	71	71	11	101	78	23
Cool Creek	5,000	294	60	71	71	11	101	78	23
Cool Creek	5,000	332	75	71	75	0	70	78	0
Cool Creek	5,200	630	60	64	64	4	101	93	8
Cool Creek	5,200	514	75	64	75	0	70	93	0

Stream Name	Elevat-ion[1]	Segment Length	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Cool Creek	5,200	646	60	64	64	4	101	93	8
Cool Creek	5,200	625	75	64	75	0	70	93	0
Cool Creek	5,200	1,446	60	64	64	4	101	93	8
Cool Creek	5,200	936	45	64	64	19	133	93	30
Cool Creek	5,200	905	60	64	64	4	101	93	8
Cool Creek	5,200	382	75	64	75	0	70	93	0
Cool Creek	5,400	471	75	58	75	0	70	105	0
Cool Creek	5,400	396	75	58	75	0	70	105	0
Cool Creek	5,400	556	75	58	75	0	70	105	0
Cool Creek	5,400	586	60	58	60	0	101	105	0
Cool Creek	5,600	777	75	52	75	0	70	118	0

[1]More than one segment of a named water body may occur in the same 200-foot elevation zone. Generally this is because unnamed perennial tributaries are included in the analysis, a reach is split at the confluence of two tributaries (see map), or a reach is split because of a radical percent canopy closure change. The only way to know which data apply to which reach on the ground is to use the ArcView data set included with this report.

[2]Current Canopy Closure (%) is estimated from recent 1:15,840 stereo aerial photographs.

[3]CWE Modeled Canopy Closure (%) is the percent canopy closure predicted by the CWE temperature model as needed to protect stream temperatures for salmonid spawning and/or bull trout.

Appendix 7. Grizzly Creek and Cougar Creek Temperature TMDLs

An ArcView shapefile of
these data is on the diskette
located in the back of this document

Appendix 7. Grizzly Creek and Cougar Creek Temperature TMDLs

This appendix, along with ArcView shapefile data included on the enclosed diskette, constitutes the temperature TMDLs for Grizzly Creek and Cougar Creek. Figure 7-1 shows the distribution of stream segements needing increased percent canopy closure to meet the TMDLs targets. Tables 7-1 and 7-2 present the loading calculations data on a stream reach by stream reach basis. The location of each stream reach can be ascertained using the ArcView shapefile. The ArcView shapefile contains all the data used to create the percent canopy closure increase targets in Figure 7-1 and the data presented in Tables 7-1 and 7-2.

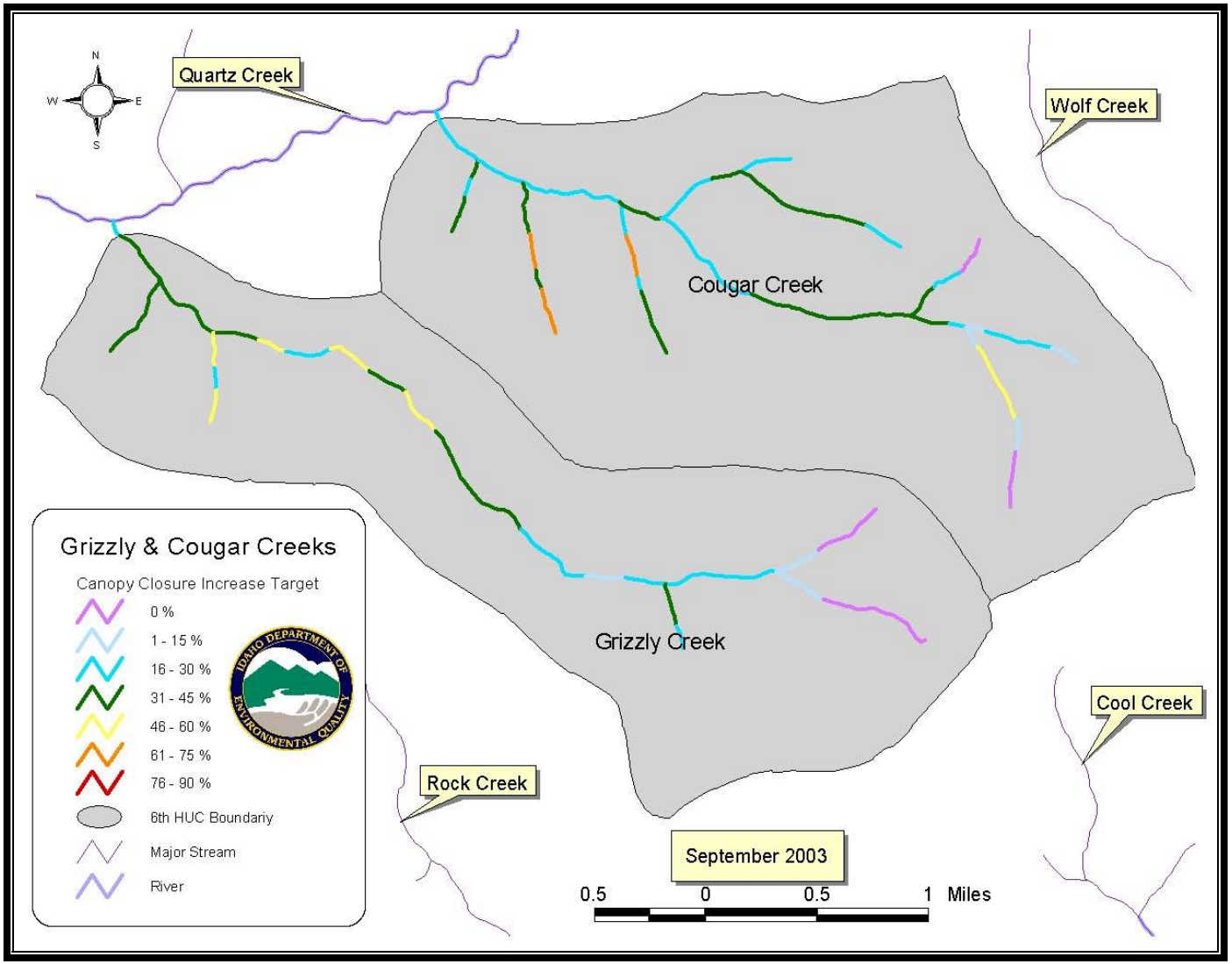


Figure 7-1. Targeted Percent Canopy Closure Increases for Grizzly Creek and Cougar Creek

Table 7-1. Grizzly Creek temperature TMDL, stream reach by stream reach.

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Grizzly Creek	385	2,200	75	157	100	25	76	18	76
Grizzly Creek	1,435	2,200	60	157	100	40	111	18	84
Grizzly Creek	565	2,400	60	151	100	40	111	18	84
Grizzly Creek	1,271	2,400	60	151	100	40	111	18	84
Grizzly Creek	609	2,600	60	145	100	40	111	18	84
Grizzly Creek	441	2,600	60	145	100	40	111	18	84
Grizzly Creek	1,089	2,800	60	139	100	40	111	18	84
Grizzly Creek	239	2,800	45	139	100	55	146	18	88
Grizzly Creek	432	2,800	60	139	100	40	111	18	84
Grizzly Creek	716	3,000	45	132	100	55	146	18	88
Grizzly Creek	253	3,000	45	132	100	55	146	18	88
Grizzly Creek	387	3,000	60	132	100	40	111	18	84
Grizzly Creek	1,104	3,200	75	126	100	25	76	18	76
Grizzly Creek	344	3,200	45	126	100	55	146	18	88
Grizzly Creek	303	3,200	60	126	100	40	111	18	84
Grizzly Creek	1,099	3,400	45	120	100	55	146	18	88
Grizzly Creek	524	3,400	75	120	100	25	76	18	76
Grizzly Creek	1,024	3,600	60	114	100	40	111	18	84
Grizzly Creek	404	3,600	45	114	100	55	146	18	88

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Grizzly Creek	1,179	3,800	45	108	100	55	146	18	88
Grizzly Creek	374	3,800	45	108	100	55	146	18	88
Grizzly Creek	1,535	4,000	60	101	100	40	111	18	84
Grizzly Creek	1,688	4,200	60	95	95	35	111	29	74
Grizzly Creek	2,027	4,400	60	89	89	29	111	43	61
Grizzly Creek	966	4,600	75	83	83	8	76	57	25
Grizzly Creek	974	4,600	60	83	83	23	111	57	49
Grizzly Creek	1,709	4,800	60	77	77	17	111	71	36
Grizzly Creek	1,004	4,800	60	77	77	17	111	71	36
Grizzly Creek	1,024	4,800	45	77	77	32	146	71	51
Grizzly Creek	569	4,800	60	77	77	17	111	71	36
Grizzly Creek	1,141	5,000	60	71	71	11	111	85	23
Grizzly Creek	1,320	5,000	60	71	71	11	111	85	23
Grizzly Creek	1,709	5,200	90	64	90	0	41	101	0
Grizzly Creek	1,646	5,200	90	64	90	0	41	101	0
Grizzly Creek	1,118	5,400	90	58	90	0	41	115	0

[1]More than one segment of a named water body may occur in the same 200-foot elevation zone. Generally this is because unnamed perennial tributaries are included in the analysis, a reach is split at the confluence of two tributaries (see map), or a reach is split because of a radical percent canopy closure change. The only way to know which data apply to which reach on the ground is to use the ArcView data set included with this report.

[2]Current Canopy Closure (%) is estimated from recent 1:15,840 stereo aerial photographs.

[3]CWE Modeled Canopy Closure (%) is the percent canopy closure predicted by the CWE temperature model as needed to protect stream temperatures for salmonid spawning and/or bull trout.

Table 7-2. Cougar Creek temperature TMDL, stream reach by stream reach.

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Cougar Creek	221	2,400	75	151	100	25	82	18	78
Cougar Creek	1,351	2,400	75	151	100	25	82	18	78
Cougar Creek	498	2,600	60	145	100	40	120	18	85
Cougar Creek	1,200	2,600	75	145	100	25	82	18	78
Cougar Creek	1,007	2,600	75	145	100	25	82	18	78
Cougar Creek	458	2,600	60	145	100	40	120	18	85
Cougar Creek	435	2,800	75	139	100	25	82	18	78
Cougar Creek	1,411	2,800	75	139	100	25	82	18	78
Cougar Creek	421	2,800	60	139	100	40	120	18	85
Cougar Creek	496	3,000	60	132	100	40	120	18	85
Cougar Creek	780	3,000	75	132	100	25	82	18	78
Cougar Creek	377	3,000	60	132	100	40	120	18	85
Cougar Creek	1,088	3,000	60	132	100	40	120	18	85
Cougar Creek	546	3,000	75	132	100	25	82	18	78
Cougar Creek	384	3,200	60	126	100	40	120	18	85
Cougar Creek	387	3,200	30	126	100	70	197	18	91
Cougar Creek	470	3,200	30	126	100	70	197	18	91

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Cougar Creek	1,192	3,200	75	126	100	25	82	18	78
Cougar Creek	770	3,200	75	126	100	25	82	18	78
Cougar Creek	478	3,400	30	120	100	70	197	18	91
Cougar Creek	556	3,400	30	120	100	70	197	18	91
Cougar Creek	1,161	3,400	75	120	100	25	82	18	78
Cougar Creek	757	3,400	75	120	100	25	82	18	78
Cougar Creek	465	3,600	60	114	100	40	120	18	85
Cougar Creek	337	3,600	75	114	100	25	82	18	78
Cougar Creek	1,062	3,600	60	114	100	40	120	18	85
Cougar Creek	341	3,600	75	114	100	25	82	18	78
Cougar Creek	706	3,600	60	114	100	40	120	18	85
Cougar Creek	408	3,600	60	114	100	40	120	18	85
Cougar Creek	624	3,800	30	108	100	70	197	18	91
Cougar Creek	922	3,800	60	108	100	40	120	18	85
Cougar Creek	927	3,800	75	108	100	25	82	18	78
Cougar Creek	1,364	3,800	60	108	100	40	120	18	85
Cougar Creek	1,346	3,800	60	108	100	40	120	18	85
Cougar Creek	474	4,000	30	101	100	70	197	18	91

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Cougar Creek	654	4,000	60	101	100	40	120	18	85
Cougar Creek	759	4,000	60	101	100	40	120	18	85
Cougar Creek	1,494	4,000	60	101	100	40	120	18	85
Cougar Creek	890	4,200	60	95	95	35	120	31	74
Cougar Creek	760	4,200	60	95	95	35	120	31	74
Cougar Creek	938	4,200	60	95	95	35	120	31	74
Cougar Creek	980	4,400	60	89	89	29	120	46	62
Cougar Creek	390	4,400	60	89	89	29	120	46	62
Cougar Creek	485	4,400	75	89	89	14	82	46	44
Cougar Creek	522	4,400	75	89	89	14	82	46	44
Cougar Creek	749	4,400	60	89	89	29	120	46	62
Cougar Creek	945	4,600	60	83	83	23	120	62	48
Cougar Creek	957	4,600	30	83	83	53	197	62	69
Cougar Creek	611	4,600	90	83	90	0	44	62	0
Cougar Creek	308	4,600	90	83	90	0	44	62	0
Cougar Creek	986	4,800	30	77	77	47	197	77	61
Cougar Creek	697	4,800	60	77	77	17	120	77	36
Cougar Creek	796	5,000	60	71	71	11	120	92	23

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Cougar Creek	725	5,000	60	71	71	11	120	92	23
Cougar Creek	913	5,200	75	64	75	0	82	110	0
Cougar Creek	413	5,400	75	58	75	0	82	126	0

[1]More than one segment of a named water body may occur in the same 200-foot elevation zone. Generally this is because unnamed perennial tributaries are included in the analysis, a reach is split at the confluence of two tributaries (see map), or a reach is split because of a radical percent canopy closure change. The only way to know which data apply to which reach on the ground is to use the ArcView data set included with this report.

[2]Current Canopy Closure (%) is estimated from recent 1:15,840 stereo aerial photographs.

[3]CWE Modeled Canopy Closure (%) is the percent canopy closure predicted by the CWE temperature model as needed to protect stream temperatures for salmonid spawning and/or bull trout.

Appendix 8. Gravey Creek and Marten Creek Temperature TMDLs

An ArcView shapefile of
these data is on the diskette
located in the back of this document

Appendix 8. Gravey Creek and Marten Creek Temperature TMDLs

This appendix, along with ArcView shapefile data included on the enclosed diskette, constitutes the temperature TMDLs for Gravey Creek and Marten Creek. Figure 8-1 shows the distribution of stream segements needing increased percent canopy closure to meet the TMDLs targets. Tables 8-1 and 8-2 present the loading calculations data on a stream reach by stream reach basis. The location of each stream reach can be ascertained using the ArcView shapefile. The ArcView shapefile contains all the data used to create the percent canopy closure increase targets in Figure 8-1 and the data presented in Tables 8-1 and 8-2.

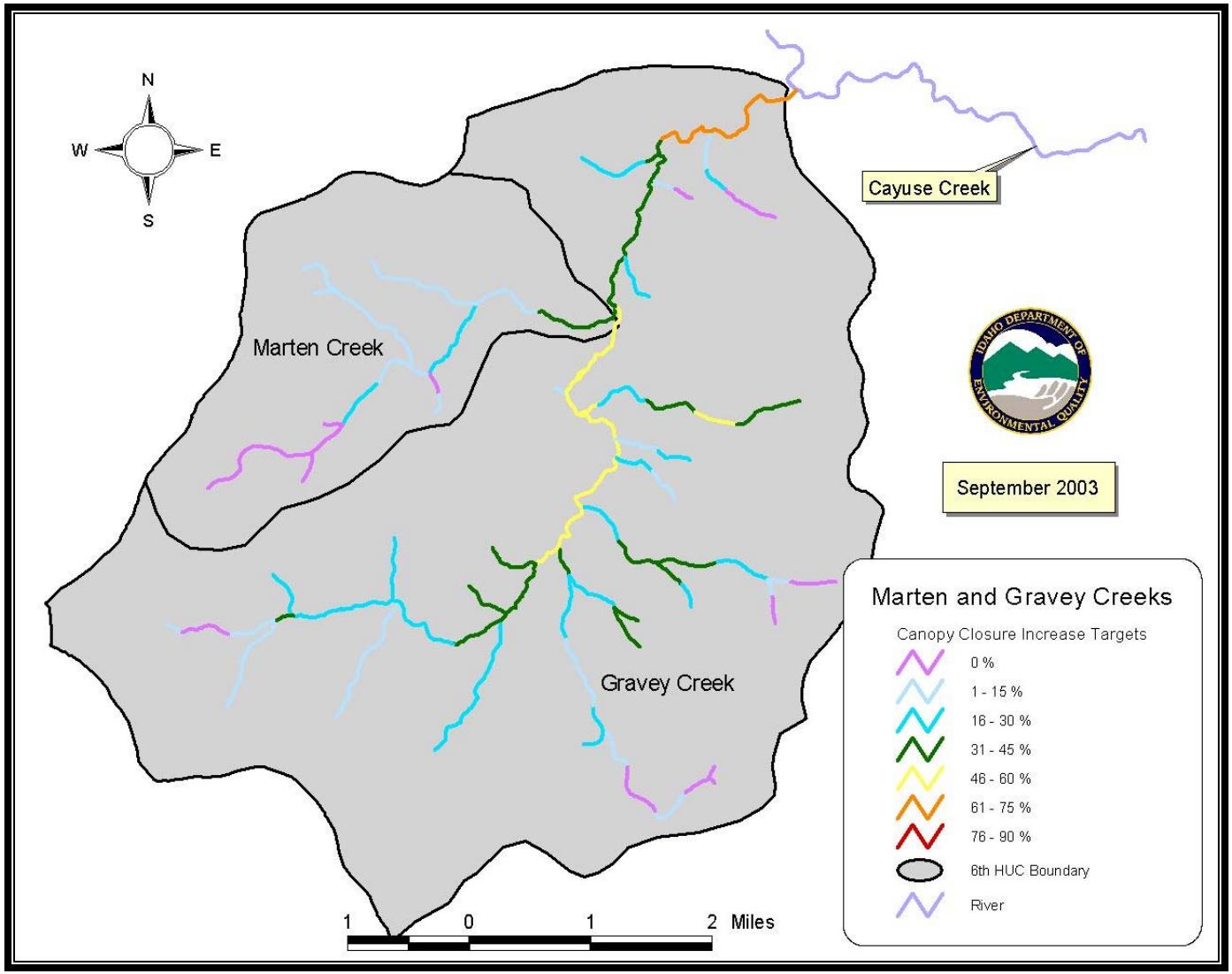


Figure 8-1. Targeted Percent Canopy Closure Increases for Gravey Creek and Marten Creek

Table 8-1. Gravey Creek temperature TMDL, stream reach by stream reach.

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Alder Creek	1,067	4,000	90	101	100	10	41	18	56
Alder Creek	858	4,200	100	95	100	0	18	29	0
Blowup Creek	963	4,200	45	95	95	50	159	31	81
Blowup Creek	2,684	4,400	60	89	89	29	120	46	62
Blowup Creek	2,403	4,600	45	83	83	38	159	62	61
Blowup Creek	1,901	4,800	30	77	77	47	197	77	61
Blowup Creek	1,202	5,000	30	71	71	41	197	92	53
Blowup Creek	1,816	5,200	30	64	64	34	197	110	44
Grass Creek	1,677	4,000	90	101	100	10	41	18	56
Grass Creek	1,211	4,200	75	95	95	20	76	29	62
Grass Creek	1,312	4,400	90	89	90	0	41	43	0
Grass Creek	1,196	4,600	90	83	90	0	41	57	0
Gravey Creek	2,936	4,000	30	101	100	70	181	18	90
Gravey Creek	5,321	4,000	30	101	100	70	181	18	90
Gravey Creek	559	4,000	60	101	100	40	111	18	84
Gravey Creek	1,576	4,000	60	101	100	40	111	18	84
Gravey Creek	3,957	4,000	60	101	100	40	111	18	84

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Gravey Creek	564	4,200	90	95	95	5	41	29	29
Gravey Creek	1,125	4,200	45	95	95	50	146	29	80
Gravey Creek	5,561	4,200	45	95	95	50	146	29	80
Gravey Creek	2,258	4,200	45	95	95	50	146	29	80
Gravey Creek	2,493	4,200	60	95	95	35	111	29	74
Gravey Creek	690	4,200	60	95	95	35	111	29	74
Gravey Creek	2,178	4,200	75	95	95	20	76	29	62
Gravey Creek	2,399	4,400	30	89	89	59	181	43	76
Gravey Creek	2,658	4,400	30	89	89	59	181	43	76
Gravey Creek	1,217	4,400	60	89	89	29	111	43	61
Gravey Creek	854	4,400	30	89	89	59	181	43	76
Gravey Creek	581	4,400	30	89	89	59	181	43	76
Gravey Creek	1,818	4,400	60	89	89	29	111	43	61
Gravey Creek	1,986	4,400	75	89	89	14	76	43	43
Gravey Creek	1,325	4,400	30	89	89	59	181	43	76
Gravey Creek	2,548	4,600	60	83	83	23	111	57	49
Gravey Creek	5,403	4,600	60	83	83	23	111	57	49
Gravey Creek	1,120	4,600	60	83	83	23	111	57	49
Gravey Creek	1,671	4,600	75	83	83	8	76	57	25

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Gravey Creek	1,571	4,600	60	83	83	23	111	57	49
Gravey Creek	3,106	4,600	45	83	83	38	146	57	61
Gravey Creek	2,155	4,600	45	83	83	38	146	57	61
Gravey Creek	2,398	4,600	45	83	83	38	146	57	61
Gravey Creek	1,180	4,800	45	77	77	32	146	71	51
Gravey Creek	2,134	4,800	60	77	77	17	111	71	36
Gravey Creek	2,491	4,800	75	77	77	2	76	71	7
Gravey Creek	1,391	4,800	60	77	77	17	111	71	36
Gravey Creek	2,322	4,800	75	77	77	2	76	71	7
Gravey Creek	832	4,800	60	77	77	17	111	71	36
Gravey Creek	1,419	4,800	45	77	77	32	146	71	51
Gravey Creek	2,039	4,800	45	77	77	32	146	71	51
Gravey Creek	2,764	4,800	60	77	77	17	111	71	36
Gravey Creek	1,233	4,800	60	77	77	17	111	71	36
Gravey Creek	2,224	5,000	60	71	71	11	111	85	23
Gravey Creek	1,084	5,000	45	71	71	26	146	85	42
Gravey Creek	3,460	5,000	60	71	71	11	111	85	23
Gravey Creek	789	5,200	60	64	64	4	111	101	9
Gravey Creek	1,147	5,400	75	58	75	0	76	115	0

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Gravey Creek	389	5,400	75	58	75	0	76	115	0
Horseshoe Creek	2,413	4,400	60	89	89	29	120	46	62
Horseshoe Creek	2,218	4,600	45	83	83	38	159	62	61
Horseshoe Creek	2,602	4,600	45	83	83	38	159	62	61
Horseshoe Creek	2,504	5,000	45	71	71	26	159	92	42
Horseshoe Creek	1,014	5,200	60	64	64	4	120	110	8
Horseshoe Creek	1,972	5,400	75	58	75	0	82	126	0
Mire Creek	3,289	4,600	60	83	83	23	120	62	48
Mire Creek	2,396	4,600	45	83	83	38	159	62	61
Mire Creek	3,734	4,600	60	83	83	23	120	62	48
Mire Creek	2,245	4,800	75	77	77	2	82	77	6
Mire Creek	1,385	4,800	60	77	77	17	120	77	36
Mire Creek	791	4,800	45	77	77	32	159	77	52
Mire Creek	2,205	5,000	75	71	75	0	82	92	0
Mire Creek	769	5,200	60	64	64	4	120	110	8
Serpent Creek	1,356	4,400	45	89	89	44	133	40	70
Serpent Creek	1,098	4,400	60	89	89	29	101	40	60
Serpent Creek	1,793	4,600	60	83	83	23	101	53	48
Serpent Creek	3,256	4,600	75	83	83	8	70	53	24

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Serpent Creek	1,183	4,800	60	77	77	17	101	65	36
Serpent Creek	2,116	4,800	75	77	77	2	70	65	7
Serpent Creek	2,553	5,000	75	71	75	0	70	78	0
Serpent Creek	1,977	5,200	60	64	64	4	101	93	8
Serpent Creek	550	5,400	75	58	75	0	70	105	0
Serpent Creek	1,199	5,400	75	58	75	0	70	105	0

[1]More than one segment of a named water body may occur in the same 200-foot elevation zone. Generally this is because unnamed perennial tributaries are included in the analysis, a reach is split at the confluence of two tributaries (see map), or a reach is split because of a radical percent canopy closure change. The only way to know which data apply to which reach on the ground is to use the ArcView data set included with this report.

[2]Current Canopy Closure (%) is estimated from recent 1:15,840 stereo aerial photographs.

[3]CWE Modeled Canopy Closure (%) is the percent canopy closure predicted by the CWE temperature model as needed to protect stream temperatures for salmonid spawning and/or bull trout.

Table 8-2. Marten Creek temperature TMDL, stream reach by stream reach.

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
False Creek	788	4,400	75	89	89	14	76	43	43
False Creek	2,116	4,600	75	83	83	8	76	57	25
False Creek	2,387	5,000	60	71	71	11	111	85	23
Marten Creek	1,660	4,200	60	95	95	35	111	29	74
Marten Creek	2,457	4,200	60	95	95	35	111	29	74
Marten Creek	3,346	4,400	75	89	89	14	76	43	43
Marten Creek	1,767	4,400	60	89	89	29	111	43	61
Marten Creek	933	4,600	75	83	83	8	76	57	25
Marten Creek	1,946	4,600	60	83	83	23	111	57	49
Marten Creek	1,001	4,600	90	83	90	0	41	57	0
Marten Creek	2,138	4,600	75	83	83	8	76	57	25
Marten Creek	824	4,800	75	77	77	2	76	71	7
Marten Creek	2,272	4,800	60	77	77	17	111	71	36
Marten Creek	1,350	5,000	75	71	75	0	76	85	0
Marten Creek	824	5,000	75	71	75	0	76	85	0
Marten Creek	1,829	5,000	75	71	75	0	76	85	0

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Marten Creek	822	5,000	75	71	75	0	76	85	0
Marten Creek	3,544	5,200	75	64	75	0	76	101	0
Marten Creek	1,263	5,400	60	58	60	0	111	115	0
Shin Tangle Creek	729	4,600	75	83	83	8	76	57	25
Shin Tangle Creek	2,601	4,800	75	77	77	2	76	71	7
Shin Tangle Creek	967	5,000	60	71	71	11	111	85	23
Shin Tangle Creek	1,640	5,000	60	71	71	11	111	85	23
Shin Tangle Creek	2,031	5,000	60	71	71	11	111	85	23

[1]More than one segment of a named water body may occur in the same 200-foot elevation zone. Generally this is because unnamed perennial tributaries are included in the analysis, a reach is split at the confluence of two tributaries (see map), or a reach is split because of a radical percent canopy closure change. The only way to know which data apply to which reach on the ground is to use the ArcView data set included with this report.

[2]Current Canopy Closure (%) is estimated from recent 1:15,840 stereo aerial photographs.

[3]CWE Modeled Canopy Closure (%) is the percent canopy closure predicted by the CWE temperature model as needed to protect stream temperatures for salmonid spawning and/or bull trout.

Appendix 9. Middle Creek Temperature TMDL

An ArcView shapefile of
these data is on the diskette
located in the back of this document

Appendix 9. Middle Creek Temperature TMDL

This appendix, along with ArcView shapefile data included on the enclosed diskette, constitutes the temperature TMDL for Middle Creek. Figure 9-1 shows the distribution of stream segements needing increased percent canopy closure to meet the TMDL targets. Table 9-1 presents the loading calculations data on a stream reach by stream reach basis. The location of each stream reach can be ascertained using the ArcView shapefile. The ArcView shapefile contains all the data used to create the percent canopy closure increase targets in Figure 9-1 and the data presented in Table 9-1.

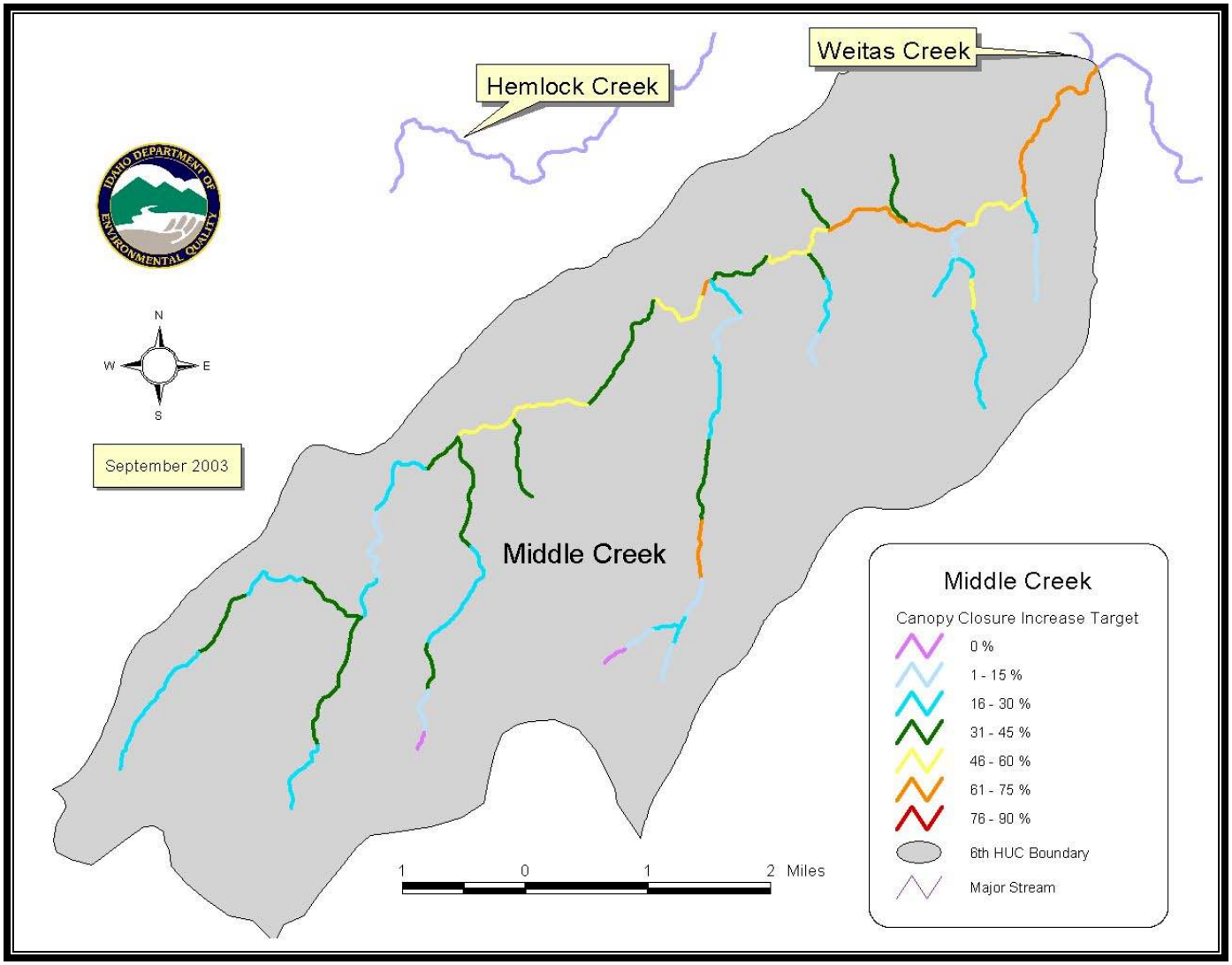


Figure 9-1. Targeted Percent Canopy Closure Increases for Middle Creek

Table 9-1. Middle Creek temperature TMDL, stream reach by stream reach.

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Beaver Dam Creek	6,280	4,600	45	83	83	38	133	53	60
Beaver Dam Creek	3,351	4,800	60	77	77	17	101	65	36
Felix Creek	1,801	4,000	60	101	100	40	101	17	83
Felix Creek	3,420	4,200	60	95	95	35	101	28	72
Felix Creek	2,444	4,400	60	89	89	29	101	40	60
Felix Creek	2,849	4,600	60	83	83	23	101	53	48
Felix Creek	2,100	4,800	45	77	77	32	133	65	51
Felix Creek	2,018	5,000	60	71	71	11	101	78	23
Felix Creek	805	5,200	75	64	75	0	70	93	0
Flame Creek	2,091	3,200	90	126	100	10	38	17	55
Flame Creek	1,282	3,400	75	120	100	25	70	17	76
Flame Creek	1,118	3,400	75	120	100	25	76	18	76
Flame Creek	1,360	3,600	45	114	100	55	133	17	87
Flame Creek	710	3,600	75	114	100	25	76	18	76
Flame Creek	1,235	3,800	75	108	100	25	70	17	76
Flame Creek	1,888	4,000	75	101	100	25	70	17	76
Flame Creek	1,434	4,200	75	95	95	20	70	28	60

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Middle Creek	1,272	2,800	30	139	100	70	181	18	90
Middle Creek	4,856	2,800	30	139	100	70	181	18	90
Middle Creek	793	3,000	75	132	100	25	76	18	76
Middle Creek	1,658	3,000	30	132	100	70	181	18	90
Middle Creek	3,279	3,000	45	132	100	55	146	18	88
Middle Creek	988	3,200	30	126	100	70	181	18	90
Middle Creek	908	3,200	75	126	100	25	76	18	76
Middle Creek	1,969	3,200	30	126	100	70	181	18	90
Middle Creek	3,989	3,200	30	126	100	70	181	18	90
Middle Creek	1,658	3,200	60	126	100	40	111	18	84
Middle Creek	750	3,400	45	120	100	55	146	18	88
Middle Creek	696	3,400	60	120	100	40	111	18	84
Middle Creek	1,150	3,400	90	120	100	10	41	18	56
Middle Creek	715	3,400	60	120	100	40	111	18	84
Middle Creek	823	3,400	60	120	100	40	111	18	84
Middle Creek	877	3,400	45	120	100	55	146	18	88
Middle Creek	2,180	3,400	45	120	100	55	146	18	88
Middle Creek	714	3,600	60	114	100	40	111	18	84
Middle Creek	854	3,600	30	114	100	70	181	18	90

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Middle Creek	1,761	3,600	90	114	100	10	41	18	56
Middle Creek	489	3,600	60	114	100	40	111	18	84
Middle Creek	699	3,600	60	114	100	40	111	18	84
Middle Creek	3,079	3,600	60	114	100	40	111	18	84
Middle Creek	3,055	3,600	45	114	100	55	146	18	88
Middle Creek	1,240	3,600	60	114	100	40	111	18	84
Middle Creek	858	3,800	75	108	100	25	76	18	76
Middle Creek	945	3,800	60	108	100	40	111	18	84
Middle Creek	4,478	3,800	60	108	100	40	111	18	84
Middle Creek	4,436	3,800	45	108	100	55	146	18	88
Middle Creek	1,849	4,000	45	101	100	55	146	18	88
Middle Creek	2,032	4,000	60	101	100	40	111	18	84
Middle Creek	1,786	4,000	75	101	100	25	76	18	76
Middle Creek	2,175	4,000	60	101	100	40	111	18	84
Middle Creek	3,696	4,200	75	95	95	20	76	29	62
Middle Creek	1,535	4,200	90	95	95	5	41	29	29
Middle Creek	1,661	4,200	60	95	95	35	111	29	74
Middle Creek	3,692	4,400	75	89	89	14	76	43	43
Middle Creek	2,039	4,400	60	89	89	29	111	43	61

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Middle Creek	3,264	4,600	45	83	83	38	146	57	61
Middle Creek	3,251	4,800	60	77	77	17	111	71	36
Middle Creek	3,301	5,000	30	71	71	41	181	85	53
Middle Creek	2,159	5,000	45	71	71	26	146	85	42
Middle Creek	4,192	5,200	45	64	64	19	146	101	31
Rocky Ridge Creek	2,085	3,600	75	114	100	25	70	17	76
Rocky Ridge Creek	2,439	3,600	90	114	100	10	38	17	55
Rocky Ridge Creek	3,973	3,800	75	108	100	25	70	17	76
Rocky Ridge Creek	3,570	4,000	60	101	100	40	101	17	83
Rocky Ridge Creek	2,556	4,200	30	95	95	65	164	28	83
Rocky Ridge Creek	1,886	4,400	75	89	89	14	70	40	43
Rocky Ridge Creek	500	4,600	60	83	83	23	101	53	48
Rocky Ridge Creek	766	4,600	60	83	83	23	111	57	49
Rocky Ridge Creek	1,233	4,800	60	77	77	17	111	71	36
Rocky Ridge Creek	1,710	4,800	75	77	77	2	76	71	7
Rocky Ridge Creek	836	5,000	60	71	71	11	111	85	23
Rocky Ridge Creek	632	5,200	60	64	64	4	111	101	9
Rocky Ridge Creek	1,135	5,400	75	58	75	0	76	115	0

[1]More than one segment of a named water body may occur in the same 200-foot elevation zone. Generally this is because unnamed perennial tributaries are included in the analysis, a reach is split at the confluence of two tributaries (see map), or a reach is split because of a radical percent canopy closure change. The only way to know which data apply to which reach on the ground is to use the ArcView data set included with this report.

[2]Current Canopy Closure (%) is estimated from recent 1:15,840 stereo aerial photographs.

[3]CWE Modeled Canopy Closure (%) is the percent canopy closure predicted by the CWE temperature model as needed to protect stream temperatures for salmonid spawning and/or bull trout.

Appendix 10. Sneak Creek Temperature TMDL

An ArcView shapefile of
these data is on the diskette
located in the back of this document

Appendix 10. Sneak Creek Temperature TMDL

This appendix, along with ArcView shapefile data included on the enclosed diskette, constitutes the temperature TMDL for Sneak Creek. Figure 10-1 shows the distribution of stream segements needing increased percent canopy closure to meet the TMDL targets. Table 10-1 presents the loading calculations data on a stream reach by stream reach basis. The location of each stream reach can be ascertained using the ArcView shapefile. The ArcView shapefile contains all the data used to create the percent canopy closure increase targets in Figure 10-1 and the data presented in Table 10-1.

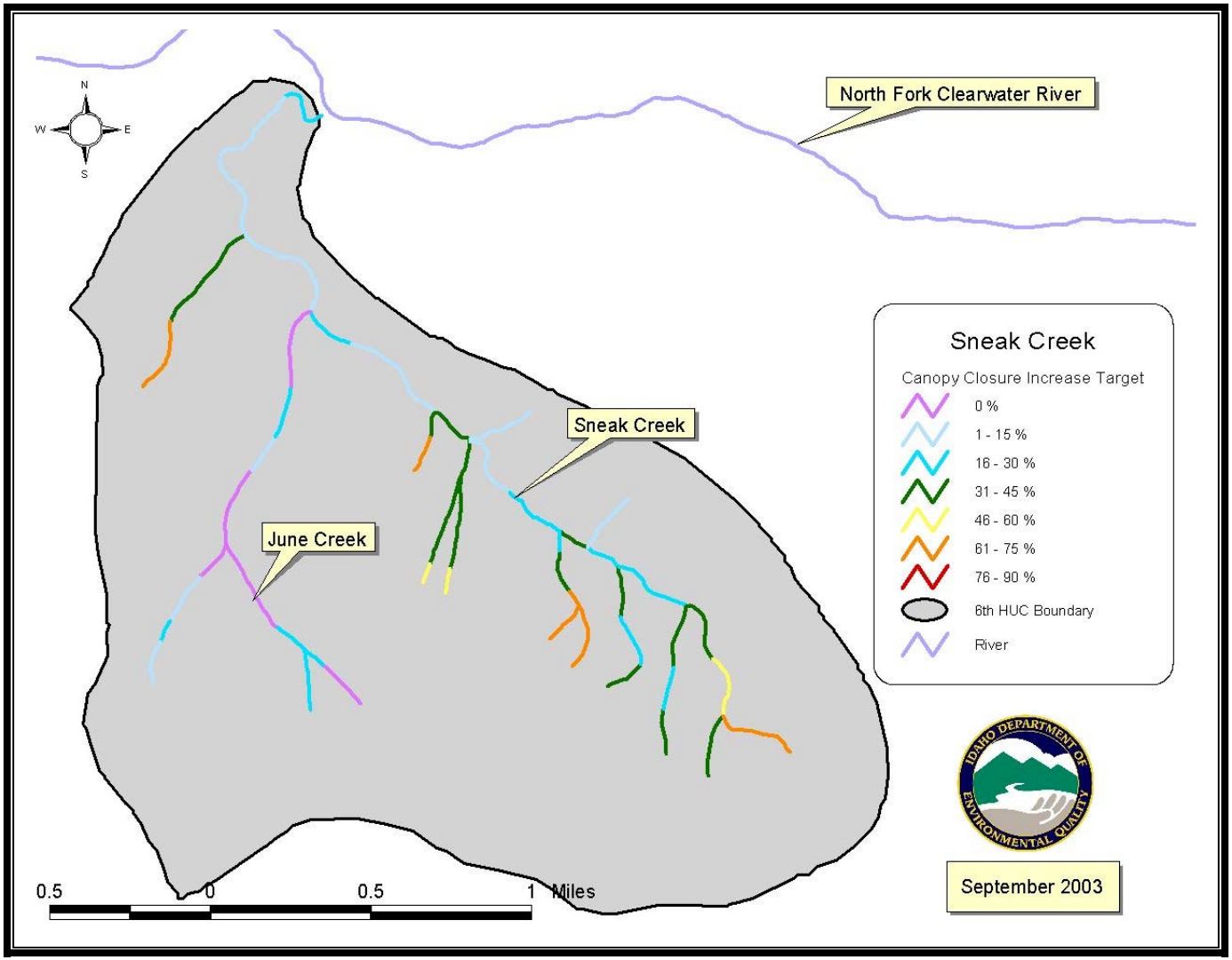


Figure 10-1. Targeted Percent Canopy Closure Increases for Sneak Creek

Table 10-1. Sneak Creek temperature TMDL, stream reach by stream reach.

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
June Creek	793	2,400	100	151	100	0	17	17	0
June Creek	616	2,600	100	145	100	0	17	17	0
June Creek	835	2,800	75	139	100	25	70	17	76
June Creek	681	3,000	90	132	100	10	38	17	55
June Creek	737	3,200	100	126	100	0	17	17	0
June Creek	577	3,400	100	120	100	0	17	17	0
June Creek	720	3,600	100	114	100	0	17	17	0
June Creek	473	3,800	90	108	100	10	38	17	55
June Creek	396	4,000	90	101	100	10	38	17	55
June Creek	380	4,200	75	95	95	20	70	28	60
June Creek	714	4,400	75	89	89	14	70	40	43
Sneak Creek	974	1,800	75	169	100	25	76	18	76
Sneak Creek	1,872	1,800	90	169	100	10	41	18	56
Sneak Creek	1,088	2,000	90	163	100	10	41	18	56
Sneak Creek	447	2,200	60	157	100	40	111	18	84
Sneak Creek	1,978	2,200	90	157	100	10	41	18	56
Sneak Creek	883	2,400	75	151	100	25	76	18	76

Stream Name	Stream Segment Length	Elevat-ion[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Sneak Creek	598	2,400	60	151	100	40	111	18	84
Sneak Creek	434	2,600	60	145	100	40	111	18	84
Sneak Creek	1,411	2,600	90	145	100	10	41	18	56
Sneak Creek	440	2,800	90	139	100	10	41	18	56
Sneak Creek	742	2,800	60	139	100	40	111	18	84
Sneak Creek	440	2,800	60	139	100	40	111	18	84
Sneak Creek	433	2,800	60	139	100	40	111	18	84
Sneak Creek	320	3,000	30	132	100	70	181	18	90
Sneak Creek	618	3,000	30	132	100	70	181	18	90
Sneak Creek	642	3,000	60	132	100	40	111	18	84
Sneak Creek	382	3,000	90	132	100	10	41	18	56
Sneak Creek	1,214	3,000	90	132	100	10	41	18	56
Sneak Creek	520	3,200	60	126	100	40	111	18	84
Sneak Creek	452	3,200	30	126	100	70	181	18	90
Sneak Creek	708	3,200	60	126	100	40	111	18	84
Sneak Creek	733	3,200	60	126	100	40	111	18	84
Sneak Creek	742	3,200	90	126	100	10	41	18	56
Sneak Creek	1,084	3,200	75	126	100	25	76	18	76
Sneak Creek	356	3,200	75	126	100	25	76	18	76

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Sneak Creek	472	3,400	30	120	100	70	181	18	90
Sneak Creek	374	3,400	60	120	100	40	111	18	84
Sneak Creek	359	3,400	60	120	100	40	111	18	84
Sneak Creek	627	3,400	75	120	100	25	76	18	76
Sneak Creek	679	3,400	60	120	100	40	111	18	84
Sneak Creek	481	3,400	90	120	100	10	41	18	56
Sneak Creek	843	3,400	60	120	100	40	111	18	84
Sneak Creek	1,001	3,400	75	120	100	25	76	18	76
Sneak Creek	719	3,600	100	114	100	0	18	18	0
Sneak Creek	421	3,600	60	114	100	40	111	18	84
Sneak Creek	431	3,600	60	114	100	40	111	18	84
Sneak Creek	281	3,600	30	114	100	70	181	18	90
Sneak Creek	576	3,600	90	114	100	10	41	18	56
Sneak Creek	401	3,600	30	114	100	70	181	18	90
Sneak Creek	613	3,600	30	114	100	70	181	18	90
Sneak Creek	871	3,600	75	114	100	25	76	18	76
Sneak Creek	334	3,600	75	114	100	25	76	18	76
Sneak Creek	1,088	3,600	60	114	100	40	111	18	84
Sneak Creek	345	3,800	100	108	100	0	18	18	0

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Sneak Creek	269	3,800	100	108	100	0	18	18	0
Sneak Creek	332	3,800	45	108	100	55	146	18	88
Sneak Creek	421	3,800	45	108	100	55	146	18	88
Sneak Creek	336	3,800	30	108	100	70	181	18	90
Sneak Creek	492	3,800	30	108	100	70	181	18	90
Sneak Creek	659	3,800	60	108	100	40	111	18	84
Sneak Creek	1,037	3,800	60	108	100	40	111	18	84
Sneak Creek	1,045	3,800	45	108	100	55	146	18	88
Sneak Creek	392	3,800	60	108	100	40	111	18	84
Sneak Creek	603	3,800	30	108	100	70	181	18	90
Sneak Creek	709	3,800	75	108	100	25	76	18	76
Sneak Creek	287	4,000	100	101	100	0	18	18	0
Sneak Creek	415	4,000	75	101	100	25	76	18	76
Sneak Creek	755	4,000	60	101	100	40	111	18	84
Sneak Creek	667	4,000	60	101	100	40	111	18	84
Sneak Creek	760	4,000	30	101	100	70	181	18	90
Sneak Creek	172	4,200	75	95	95	20	76	29	62
Sneak Creek	311	4,200	75	95	95	20	76	29	62
Sneak Creek	421	4,200	75	95	95	20	76	29	62

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Sneak Creek	858	4,400	90	89	90	0	41	43	0
Sneak Creek	689	4,400	60	89	89	29	111	43	61

[1]More than one segment of a named water body may occur in the same 200-foot elevation zone. Generally this is because unnamed perennial tributaries are included in the analysis, a reach is split at the confluence of two tributaries (see map), or a reach is split because of a radical percent canopy closure change. The only way to know which data apply to which reach on the ground is to use the ArcView data set included with this report.

[2]Current Canopy Closure (%) is estimated from recent 1:15,840 stereo aerial photographs.

[3]CWE Modeled Canopy Closure (%) is the percent canopy closure predicted by the CWE temperature model as needed to protect stream temperatures for salmonid spawning and/or bull trout.

Appendix 11. Deception Gulch Temperature TMDL

An ArcView shapefile of
these data is on the diskette
located in the back of this document

Appendix 11. Deception Gulch Temperature TMDL

This appendix, along with ArcView shapefile data included on the enclosed diskette, constitutes the temperature TMDL for Deception Gulch. Figure 11-1 shows the distribution of stream segements needing increased percent canopy closure to meet the TMDL targets. Table 11-1 presents the loading calculations data on a stream reach by stream reach basis. The location of each stream reach can be ascertained using the ArcView shapefile. The ArcView shapefile contains all the data used to create the percent canopy closure increase targets in Figure 11-1 and the data presented in Table 11-1.

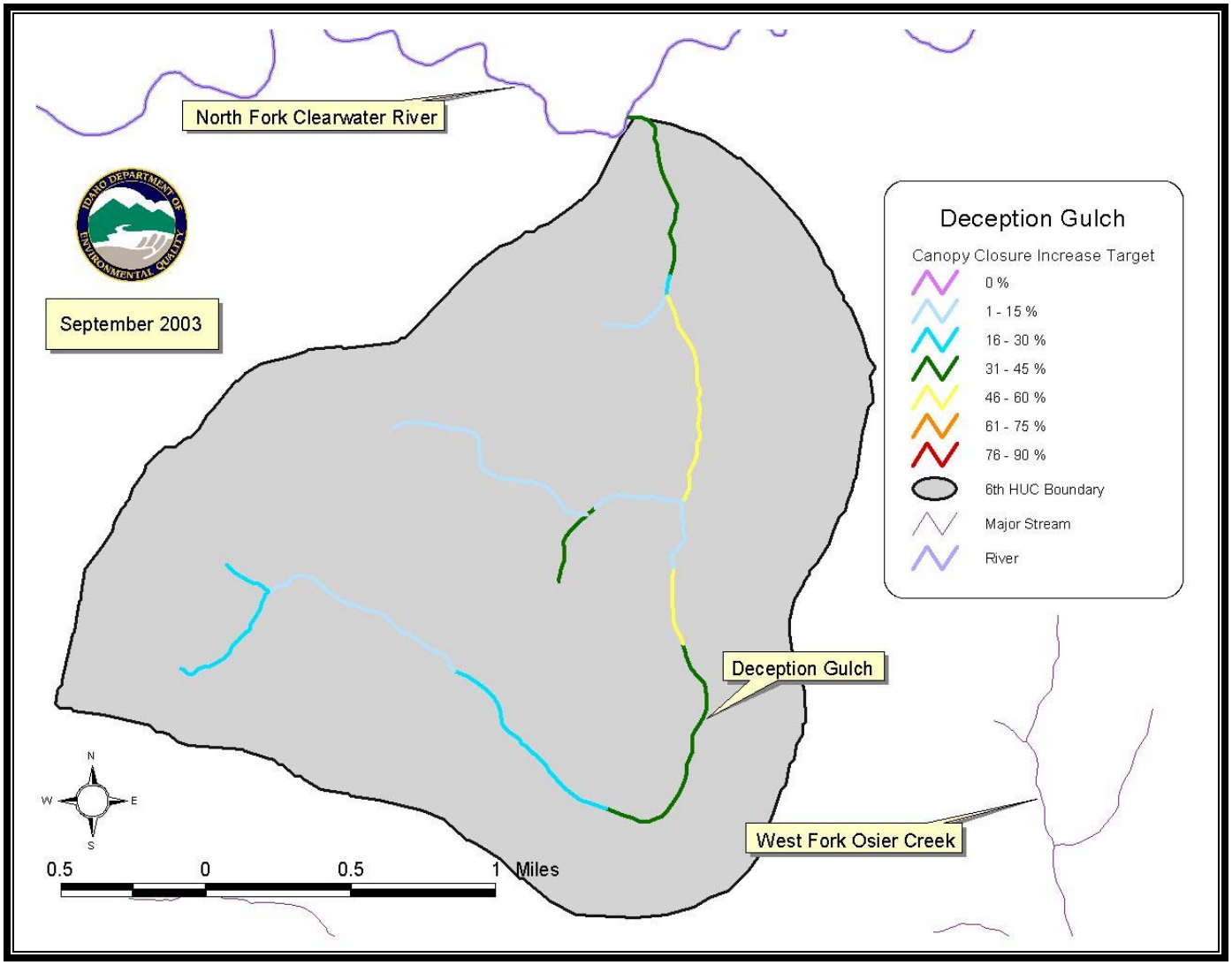


Figure 11-1. Targeted Percent Canopy Closure Increases for Deception Gulch

Table 11-1. Deception Gulch temperature TMDL, stream reach by stream reach.

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Deception Gulch	3,356	3,400	60	120	100	40	101	17	83
Deception Gulch	1,376	3,600	90	114	100	10	38	17	55
Deception Gulch	356	3,600	75	114	100	25	70	17	76
Deception Gulch	3,940	3,600	45	114	100	55	133	17	87
Deception Gulch	184	3,800	60	108	100	40	101	17	83
Deception Gulch	1,670	3,800	90	108	100	10	38	17	55
Deception Gulch	1,397	3,800	60	108	100	40	101	17	83
Deception Gulch	653	3,800	90	108	100	10	38	17	55
Deception Gulch	1,366	3,800	90	108	100	10	38	17	55
Deception Gulch	1,366	3,800	45	108	100	55	133	17	87
Deception Gulch	2,210	4,000	90	101	100	10	38	17	55
Deception Gulch	4,510	4,000	60	101	100	40	101	17	83
Deception Gulch	1,541	4,200	90	95	95	5	38	28	26
Deception Gulch	3,867	4,200	75	95	95	20	70	28	60
Deception Gulch	2,542	4,400	75	89	89	14	70	40	43
Deception Gulch	1,508	4,600	75	83	83	8	70	53	24
Deception Gulch	2,398	4,800	60	77	77	17	101	65	36

Stream Name	Stream Segment Length	Elevation[1]	Current Canopy Closure[2]	CWE Modeled Canopy Closure[3]	Target Canopy Closure	Target Canopy Closure Increase	Current Insolation Heat Load	Target Insolation Heat Load	Target Insolation Heat Load Reduction
	(feet)	(feet)	(%)	(%)	(%)	(%)	(watts/m^2)	(watts/m^2)	(%)
Deception Gulch	915	4,800	60	77	77	17	101	65	36

[1]More than one segment of a named water body may occur in the same 200-foot elevation zone. Generally this is because unnamed perennial tributaries are included in the analysis, a reach is split at the confluence of two tributaries (see map), or a reach is split because of a radical percent canopy closure change. The only way to know which data apply to which reach on the ground is to use the ArcView data set included with this report.

[2]Current Canopy Closure (%) is estimated from recent 1:15,840 stereo aerial photographs.

[3]CWE Modeled Canopy Closure (%) is the percent canopy closure predicted by the CWE temperature model as needed to protect stream temperatures for salmonid spawning and/or bull trout.

Appendix 12. CWE Road Sediment Delivery Assessment Data

The data shown in this appendix are
in an AcrView shapefile
on the diskette
in the back of this document.

Appendix 12. CWE Road Sediment Delivery Assessment Data

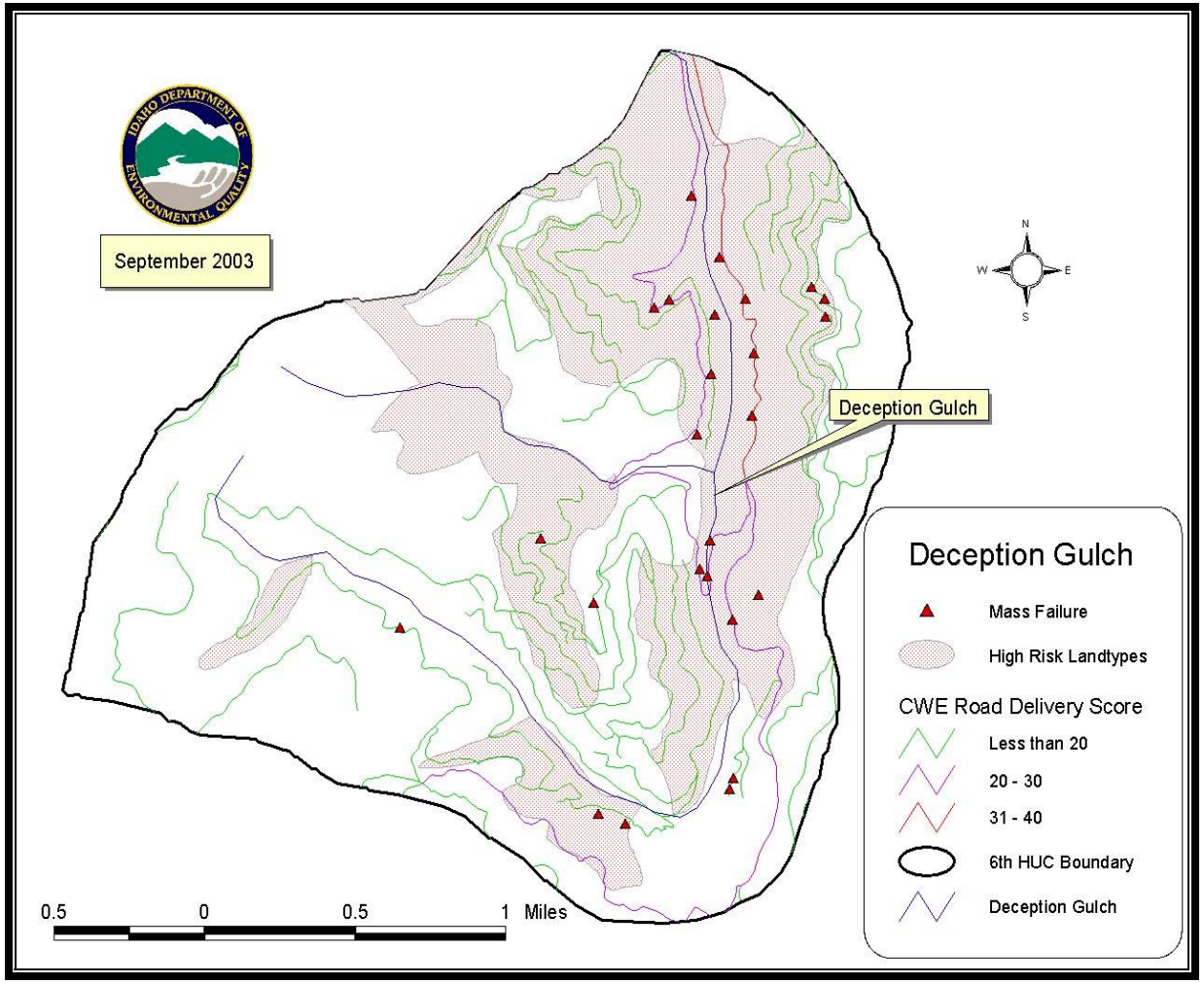


Figure 12-1. Roads Assessed Using the CWE Sediment Delivery Protocol

Table 12-1. CWE road sediment delivery data[1], road segment by road segment.

Road Segment Length (Feet)	Road Segment Length (Miles)	Cut Slope Erosion Rating	Fill Slope Erosion Rating	Road Surface Erosion Rating	Inside Ditch Erosion Rating	Delivery Multiplier	Total Road Sediment Delivery Score	Assumed Road Sediment Delivery Score
7,719	1.46	2	1	2	2	2	36	0
4,320	0.82	1	1	2	2	2	30	0
1,414	0.27	1	1	2	2	2	30	0
2,341	0.44	1	1	2	2	2	30	0
601	0.11	1	1	1	1	2	20	0
5,480	1.04	1	1	1	1	2	20	0
5,862	1.11	1	1	1	1	2	20	0
4,226	0.80	1	1	1	1	2	20	0
3,877	0.73	1	1	1	1	2	20	0
2,183	0.41	1	1	1	1	2	20	0
615	0.12	1	1	1	1	2	20	0
605	0.12	1	1	1	1	2	20	0
1,371	0.26	1	1	2	2	1	15	0
800	0.15	1	1	2	2	1	15	0
2,397	0.45	1	1	2	2	1	15	0
1,102	0.21	1	1	1	1	1	10	0
1,788	0.34	1	1	1	1	1	10	0
1,731	0.33	0	0	0	0	0	0	15

Road Segment Length (Feet)	Road Segment Length (Miles)	Cut Slope Erosion Rating	Fill Slope Erosion Rating	Road Surface Erosion Rating	Inside Ditch Erosion Rating	Delivery Multiplier	Total Road Sediment Delivery Score	Assumed Road Sediment Delivery Score
502	0.10	0	0	0	0	0	0	15
1,506	0.29	0	0	0	0	0	0	15
535	0.10	0	0	0	0	0	0	15
160	0.03	0	0	0	0	0	0	15
472	0.09	0	0	0	0	0	0	15
248	0.05	0	0	0	0	0	0	15
2,495	0.47	0	0	0	0	0	0	15
715	0.14	0	0	0	0	0	0	15
3,673	0.70	0	0	0	0	0	0	15
2,250	0.43	0	0	0	0	0	0	15
3,331	0.63	0	0	0	0	0	0	15
738	0.14	0	0	0	0	0	0	15
1,363	0.26	0	0	0	0	0	0	15
268	0.05	0	0	0	0	0	0	15
89	0.02	0	0	0	0	0	0	15
4,896	0.93	0	0	0	0	0	0	15
2,169	0.41	0	0	0	0	0	0	15
941	0.18	0	0	0	0	0	0	15
3,633	0.69	0	0	0	0	0	0	15

Road Segment Length (Feet)	Road Segment Length (Miles)	Cut Slope Erosion Rating	Fill Slope Erosion Rating	Road Surface Erosion Rating	Inside Ditch Erosion Rating	Delivery Multiplier	Total Road Sediment Delivery Score	Assumed Road Sediment Delivery Score
4,906	0.93	0	0	0	0	0	0	15
4,899	0.93	0	0	0	0	0	0	15
1,494	0.28	0	0	0	0	0	0	15
1,875	0.36	0	0	0	0	0	0	15
1,734	0.33	0	0	0	0	0	0	15
3,270	0.62	0	0	0	0	0	0	15
449	0.09	0	0	0	0	0	0	15
739	0.14	0	0	0	0	0	0	15
4,144	0.79	0	0	0	0	0	0	15
432	0.08	0	0	0	0	0	0	15
789	0.15	0	0	0	0	0	0	15
1,649	0.31	0	0	0	0	0	0	15
278	0.05	0	0	0	0	0	0	15
219	0.04	0	0	0	0	0	0	15
4,049	0.77	0	0	0	0	0	0	15
68	0.01	0	0	0	0	0	0	15
1,151	0.22	0	0	0	0	0	0	15
96	0.02	0	0	0	0	0	0	15
3,814	0.72	0	0	0	0	0	0	15

Road Segment Length (Feet)	Road Segment Length (Miles)	Cut Slope Erosion Rating	Fill Slope Erosion Rating	Road Surface Erosion Rating	Inside Ditch Erosion Rating	Delivery Multiplier	Total Road Sediment Delivery Score	Assumed Road Sediment Delivery Score
1,276	0.24	0	0	0	0	0	0	15
383	0.07	0	0	0	0	0	0	15
3,948	0.75	0	0	0	0	0	0	15
3,979	0.75	0	0	0	0	0	0	15
70	0.01	0	0	0	0	0	0	15
3,665	0.69	0	0	0	0	0	0	15
3,282	0.62	0	0	0	0	0	0	15
1,086	0.21	0	0	0	0	0	0	15
983	0.19	0	0	0	0	0	0	15
1,105	0.21	0	0	0	0	0	0	15
217	0.04	0	0	0	0	0	0	15
2,653	0.50	0	0	0	0	0	0	15
522	0.10	0	0	0	0	0	0	15
1,416	0.27	0	0	0	0	0	0	15
1,112	0.21	0	0	0	0	0	0	15
2,042	0.39	0	0	0	0	0	0	15
3,467	0.66	0	0	0	0	0	0	15
371	0.07	0	0	0	0	0	0	15
278	0.05	0	0	0	0	0	0	15

Road Segment Length (Feet)	Road Segment Length (Miles)	Cut Slope Erosion Rating	Fill Slope Erosion Rating	Road Surface Erosion Rating	Inside Ditch Erosion Rating	Delivery Multiplier	Total Road Sediment Delivery Score	Assumed Road Sediment Delivery Score
39	0.01	0	0	0	0	0	0	15
643	0.12	0	0	0	0	0	0	15
597	0.11	0	0	0	0	0	0	15
7	0.00	0	0	0	0	0	0	15
991	0.19	0	0	0	0	0	0	15
1,811	0.34	0	0	0	0	0	0	15
1,800	0.34	0	0	0	0	0	0	15
1,048	0.20	0	0	0	0	0	0	15
973	0.18	0	0	0	0	0	0	15
1,024	0.19	0	0	0	0	0	0	15
788	0.15	0	0	0	0	0	0	15
2,702	0.51	0	0	0	0	0	0	15
1,904	0.36	0	0	0	0	0	0	15
217	0.04	0	0	0	0	0	0	15
357	0.07	0	0	0	0	0	0	15
1,847	0.35	0	0	0	0	0	0	15
1,130	0.21	0	0	0	0	0	0	15
180	0.03	0	0	0	0	0	0	15
62	0.01	0	0	0	0	0	0	15

Road Segment Length (Feet)	Road Segment Length (Miles)	Cut Slope Erosion Rating	Fill Slope Erosion Rating	Road Surface Erosion Rating	Inside Ditch Erosion Rating	Delivery Multiplier	Total Road Sediment Delivery Score	Assumed Road Sediment Delivery Score
1,701	0.32	0	0	0	0	0	0	15
770	0.15	0	0	0	0	0	0	15
1,636	0.31	0	0	0	0	0	0	15
63	0.01	0	0	0	0	0	0	15
5,356	1.02	0	0	0	0	0	0	15
1243	0.24	0	0	0	0	0	0	15
6,003	1.14	0	0	0	0	0	0	15
2,049	0.39	0	0	0	0	0	0	15
2,530	0.48	0	0	0	0	0	0	15
61	0.01	0	0	0	0	0	0	15
1,345	0.26	0	0	0	0	0	0	15
152	0.03	0	0	0	0	0	0	15
317	0.06	0	0	0	0	0	0	15
3,675	0.70	0	0	0	0	0	0	15
1,746	0.33	0	0	0	0	0	0	15
1,777	0.34	0	0	0	0	0	0	15
742	0.14	0	0	0	0	0	0	15
151	0.03	0	0	0	0	0	0	15
1,186	0.23	0	0	0	0	0	0	15

Road Segment Length (Feet)	Road Segment Length (Miles)	Cut Slope Erosion Rating	Fill Slope Erosion Rating	Road Surface Erosion Rating	Inside Ditch Erosion Rating	Delivery Multiplier	Total Road Sediment Delivery Score	Assumed Road Sediment Delivery Score
1,179	0.22	0	0	0	0	0	0	15
278	0.05	0	0	0	0	0	0	15
97	0.02	0	0	0	0	0	0	15
512	0.10	0	0	0	0	0	0	15
6,128	1.16	0	0	0	0	0	0	15
1,124	0.21	0	0	0	0	0	0	15
1,506	0.29	0	0	0	0	0	0	15
1,387	0.26	0	0	0	0	0	0	15
864	0.16	0	0	0	0	0	0	15
447	0.09	0	0	0	0	0	0	15
4,420	0.84	0	0	0	0	0	0	15
5,912	1.12	0	0	0	0	0	0	15
53	0.01	0	0	0	0	0	0	15
2,257	0.43	0	0	0	0	0	0	15

[1] The data in this table were generated following the CWE road protocol (IDL 2000).

Appendix 13. Comparison Between Stream Temperature Prediction Models: SSTemp, *Heat Source*, and Idaho Cumulative Watershed Effects

Comparison Between Stream Temperature Prediction Models: SSTemp, *Heat Source*, and Idaho Cumulative Watershed Effects

by

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Lewiston, Idaho

for

Idaho Department of Environmental Quality
January, 2001

Introduction

Idaho Department of Environmental Quality (IDEQ) contracted Western Watershed Analysts (WWA) to conduct a comparison between three stream temperature prediction models: SSTemp (developed by U.S. Fish and Wildlife Service), *Heat Source* (developed by Oregon Department of Environmental Quality), and the Idaho Cumulative Watershed Effects (CWE) procedure. The first two models are process-based, and require numerous stream morphology and meteorologic input parameters. The Idaho CWE temperature prediction relationships are empirically-based on extensive water temperature measurements made throughout northern Idaho, and require only two inputs - vegetative shade level and elevation.

The Cold Springs/Cool Creek drainage in the Upper North Fork Clearwater basin was used to make comparisons between the three models. Predicted daily maximum and daily average water temperatures from each of the three models were compared to water temperatures measured in the Cold Springs/Cool Creek drainage during 1998, 1999, and 2000. The purpose of the comparison was to ascertain whether the Idaho CWE temperature relationships predicted actual temperatures as accurately as the other two process-based models. If so, the CWE relationships could be used within the context of a Total Maximum Daily Load (TMDL) allocation to determine shade levels required to maintain water quality temperature standards.

Background

The federal Clean Water Act (CWA) requires states to protect the quality of their rivers, streams, and lakes. The IDEQ has the responsibility for developing standards that protect

beneficial uses of Idaho's water resources. Section 303(d) of the Clean Water Act requires the state to develop a list of waterbodies that do not meet standards. Listed streams are water quality limited for physical and biological factors, such as temperature, pH, bacteria, and dissolved oxygen. The IDEQ has proposed a TMDL program to address water quality problems, including temperature. A temperature TMDL addresses stream heating problems by linking them to watershed characteristics and management practices, establishing objectives for water quality improvement, and identifying and implementing new or altered management measures designed to achieve those objectives.

In developing a temperature TMDL, regulators must be able to identify locations within the listed waterbody where temperatures exceed water quality standards, and determine the factors (both natural and anthropogenic) that contribute to high water temperatures at those locations. Only then can the agency determine the management actions necessary to maintain the water temperature standards. To identify these factors, typically a combination of temperature monitoring at selected locations along with stream temperature modeling is utilized.

Two general types of stream temperature prediction models are available. Reach-based models predict water temperatures on a site by site basis and generally require extensive inputs to calculate the various heat fluxes associated with stream heating and cooling. Basin models are capable of predicting water temperatures over a wider area and typically require fewer input parameters, which makes them generally easier and less expensive to use in applications to entire watersheds.

Temperature Model Descriptions

Heat Source

The *Heat Source* model was developed at Oregon State University as a tool for analyzing stream temperature data (Boyd 1996). The model is used to predict effects on stream temperatures resulting from changes in various stream parameters, and allows evaluation of variations due to different management scenarios. The *Heat Source* model has been described in detail by ODEQ (1999). The code is written in Visual Basic, with an Excel spreadsheet input/output interface. *Heat Source* uses the same fundamental physical and thermodynamic concepts as many other process-based models. The fundamental premise of the model is that the water temperature at any given time and location in the stream is the result of the physical heat transfer processes between the stream and its surrounding environment. As a reach-based model, *Heat Source* predicts water temperatures at a downstream location based on some known water temperatures at an upstream location; it cannot predict stream temperatures at a given location in the stream system unless it is given water temperature inputs from an upstream location.

The model itself requires four basic types of input:

1. stream characteristics - location, aspect, wetted width, flow, etc.
2. riparian characteristics - buffer height, width, overhang, etc.

3. atmospheric conditions - air temperature, humidity, wind speed
4. hourly water temperatures at the upstream end of the reach through the course of a day

Based on these inputs, the model predicts the hourly water temperatures at the downstream end of the reach, and displays the results in tabular and graphic formats.

SSTemp

The SSTemp model was developed by the U.S. Fish and Wildlife Service Technical Services Branch (Theurer et al 1984; Bartholow 1989). SSTemp runs in a fashion similar to *Heat Source*, and many of the inputs required for SSTemp are the same or similar to those for *Heat Source*. However, SSTemp is oriented toward average daily conditions. For example, rather than inputting minimum and maximum daily air temperatures and humidities, as in *Heat Source*, SSTemp uses only daily average values of air temperature and humidity. As a result, SSTemp is designed to predict only the daily average water temperature for the reach. The SSTemp model results do report an estimated maximum daily temperature, but it is only an estimate based on empirical relations, not on heat transfer process calculations. In addition, SSTemp is implemented as an executable application, and therefore the code is not visible to, nor changeable by, the user.

Idaho Cumulative Watershed Effects (CWE)

The Idaho CWE temperature model is an empirical model based on extensive water temperature monitoring conducted throughout northern Idaho by Plum Creek Timber Company (PCTC), Potlatch Corporation, and Idaho Department of Lands (IDL). The data collection and analysis methods are described in detail in Sugden et al (1998). The results of the analysis indicated that maximum weekly maximum water temperature (MWMT), which is the average of the daily maximum water temperatures for the warmest seven-day period in the summer, can be predicted with only two parameters - elevation and canopy cover - with a correlation coefficient of $r^2 = 0.49$ (MWMT was used because most temperature standards for fish species are written in terms of the MWMT). Slightly better predictions ($r^2 = 0.58$) could be obtained by adding a third parameter - the average July-August drought index.

The Idaho CWE process (IDL 2000) uses the MWMT relationships developed in the PCTC analysis, solving the equation for canopy cover in order to predict the shade level required to maintain the various temperature standards, depending on fish species. The result is a table that estimates required canopy cover, given elevation and the appropriate temperature standard.

For our analysis, we used canopy cover and elevation as inputs to the CWE relationships to predict the MWMT for the stream reach. Additional relationships developed by Sugden et al (1998) were then used to predict instantaneous maximum and daily average water temperatures in order to make comparisons to the results of the other two process-based models.

Study Area

The Cold Springs/Cool Creek drainage was chosen for temperature modeling comparisons because of the relative abundance of available data. Stream morphology characteristics were available from stream surveys done by Clearwater BioStudies (1996), streamflow records were available for water years 1983-92, and water temperature data had been recorded in 1998, 1999, and 2000. The drainage is located in the Upper North Fork Clearwater basin, and flows into the North Fork Clearwater just downstream of Kelly Forks. The drainage ranges in elevation from 2,700 feet to over 5,800 feet, and encompasses approximately 11 square miles. The stream system was divided into 43 reaches (see Figure 1), with reach breaks taken at major tributary junctions or significant changes in stream characteristics, such as aspect, gradient, or riparian shade. A total of approximately 16 miles of stream was modeled.

Model Inputs

Heat Source

The complete set of input parameters used for the *Heat Source* model are shown in Tables 1 and 2. Table 1 shows the input values used to calibrate the model from data derived for July 27, 1998, which was the date that the warmest water temperatures were recorded in the study drainage in 1998. Table 2 shows the input values used to predict water temperatures on August 6, 1999, which was the date of warmest water temperatures recorded in that year. Stream gauge data was recorded in Cold Springs Creek near the downstream end of Reach # 41. Unfortunately, water temperature data and stream flow data were not available for any overlapping time period. Therefore, discharge of the North Fork Clearwater at the Canyon Ranger Station was correlated to discharge in Cold Springs Creek for the months of July and August from 1985 to 1992 (Figure 2). This correlation was then used to predict the flow at Reach #41 for July 27, 1998, and August 6, 1999, from flows recorded for the North Fork Clearwater. Flows for all other reach locations on those two dates were then estimated by multiplying the flow at Reach # 41 by the ratio of the drainage areas, as measured from GIS. Reach lengths were also obtained from GIS.

Latitude, longitude, stream aspect, stream elevations, and topographic shade angles were estimated for each reach from topographic maps. Average wetted width of each reach was estimated from stream survey data obtained by Clearwater BioStudies (1997). Rosgen stream types recorded by Clearwater BioStudies (1997) were used to estimate bankfull values of Manning's n, as suggested by Rosgen (1996), with adjustments made to account for low flow conditions based on recommendations by Jarrett (1984). Average stream depth and velocity for each reach were then estimated using Manning relationships.

Height and density of riparian vegetation along each reach was estimated from recent stereo aerial photography. The width of the riparian buffer was taken as one-half the height, in order to enable compatibility between input parameters between *Heat Source* and SSTemp (i.e., *Heat Source* requires buffer width as an input, whereas SSTemp requires tree crown diameter as the equivalent input).

Minimum and maximum air temperatures for each day were obtained from weather station data at Pierce, Idaho (3,150 feet elevation), and adjusted for variations in elevation using a typical lapse rate of 1.8ºC per 1,000 feet. Values of humidity and average wind speed used in the modeling were those reported for Missoula, Montana, because that was the nearest weather station location for which humidity and wind speed data could be obtained. Groundwater temperature was assumed to be equal to the average annual air temperature as reported for Pierce, Idaho, and again adjusted for elevation.

Initial runs of the model resulted in predicted water temperatures well below those actually measured on July 27, 1998. Several input parameters were therefore adjusted to calibrate the model (see Table 1). Since the air column immediately above the stream may be moister than that recorded in the open (i.e., at a weather station), average humidity was raised from 55% to 65%. Similarly, because the air temperature immediately above the water surface may be partially regulated due to its proximity to the water, the daily variation in air temperature was reduced to one-sixth of the actual measured variation, keeping the daily average air temperature the same (i.e., measured minimum and maximum temperatures on July 27, 1998, of 11ºC and 36ºC, respectively, at Pierce were adjusted to 22ºC and 26ºC, respectively, in the modeling). Because groundwater temperature is in fact not a well known quantity, the value for groundwater temperature was also raised by 8ºC, yielding the following relationship:

$$T_{gw} = 14 + 0.0018\ (3{,}150 - E)$$

where T_{gw} = groundwater temperature (ºC)
E = average stream reach elevation (feet)

To predict temperatures on August 6, 1999, the only input parameters that needed to be changed were stream flow and air temperature. Flow on that day was slightly higher than for July 27, 1998 (see Table 2). Measured air temperatures at Pierce for that date were 12ºC minimum and 32ºC maximum. Therefore, consistent with the adjustments made for the calibration on July 27, 1998, air temperatures input to the model for August 6, 1999 were 20.5ºC minimum and 23.5ºC maximum (at 3,150 feet elevation).

SSTemp

The complete set of input parameters used for the SSTemp model are shown in Tables 3 and 4. Table 3 shows the input values used to calibrate the model from data derived for July 27, 1998, and Table 4 shows the input values used to predict water temperatures on August 6, 1999.

All of the input parameters for the SSTemp model could be taken directly from or were easily derived from the inputs used for the *Heat Source* model. Initial runs of SSTemp also indicated that predicted average water temperatures were below those actually measured on July 27, 1998, although the difference was less than that encountered in the initial runs of *Heat Source*. Therefore, calibration of the SSTemp model consisted of increasing the

average humidity to 65% (the same as for *Heat Source*) and raising groundwater temperature by only 2ºC (i.e., 6ºC cooler than that used for the calibration of *Heat Source*). As was true for the *Heat Source* calibration, the average daily air temperature was left unchanged (see Table 3). To predict temperatures on August 6, 1999, the stream flow and average air temperature were changed to the same values as those used in the *Heat Source* model for that date (see Table 4).

Idaho CWE

The Idaho CWE temperature model uses only two input parameters - canopy cover and elevation. These parameters are shown in Table 5, and are the same values as those used for *Heat Source* and SSTemp. The CWE prediction equation for northern Idaho is:

$$MWMT = 29.1 - 0.00262\ E - 0.0849\ C$$

where MWMT = maximum weekly maximum temperature (ºC)
E = stream reach elevation (feet)
C = riparian canopy cover (%)

In addition, the daily average temperature is predicted by:

$$T_{ave} = 0.95 + 0.83\ MWMT$$

and the daily maximum temperature is predicted by:

$$T_{max} = 0.15 + 1.04\ MWMT$$

Results

The predicted average and maximum water temperatures for each model/date combination are shown in Tables 1-5 (last two rows of each table); these values are also plotted in Figures 3-7, along with the actual measured temperatures for comparison.

Calibration of *Heat Source* for the best achievable agreement at Reach # 27 on July 27, 1998, resulted in under-prediction of temperatures at Reach #41 for that date (see Figure 3). However, *Heat Source* temperature predictions for August 6, 1999, were very close to measured values at reach #41, and somewhat high for Reach # 27 (Figure 4). Calibration of SSTemp for the best possible agreement with the average measured temperature at Reach # 27 on July 27, 1998, also resulted in under-prediction of the average temperature at Reach #41 for that date (Figure 5), but SSTemp over-predicted maximum temperatures at both locations. SSTemp predictions of average temperatures for August 6, 1999, were fairly close to the measured values, but SSTemp again over-predicted maximum temperatures (Figure 6).

In order to provide an estimate of the "goodness of fit" of the model calibrations, the root-mean-square (RMS) of the deviations between simulated and measured temperatures for July 27, 1998, were calculated for each model (see Table 6). The RMS values were calculated for

all measurements, and also for maximum temperatures only, because maximum temperatures are the primary quantity of interest in a water quality context. Table 6 indicates that with our model calibration, the average error in temperature predictions that might be expected from *Heat Source* would be a little more than 1ºC, and the average error in maximum predicted temperatures might be about 1.5ºC. Similarly, given our model calibration, the average error in temperature predictions that might be expected with SSTemp would be around 1ºC, or possibly a little less for average water temperatures.

RMS errors for *Heat Source* temperature predictions on August 6, 1999, are approximately 1.3ºC to 1.6ºC (Table 7), which are consistent with the calibration RMS deviations for the *Heat Source* model. RMS errors for SSTemp temperature predictions on August 6, 1999, are approximately 1.3ºC to 1.7ºC (Table 7), which are considerably higher than the calibration RMS deviations for SSTemp.

The results of the CWE prediction equations are shown in Figure 7. Because its inputs are not dependent upon the specific date, the CWE model predicts water temperatures that would be found during the warmest period of a typical summer in northern Idaho. Therefore, for comparison purposes, Figure 7 shows measured temperatures for the warmest days in 1998, 1999, and 2000; the averages of these measurements are shown in Table 7. Comparing the CWE predictions to these average measured values shows RMS errors of 1.0ºC to 1.2ºC for the CWE model (Table 7).

Discussion

The best calibrations of the *Heat Source* and SSTemp models that we were able to achieve through adjustment of humidity, air temperature, and groundwater temperature inputs were on the order of 1ºC to 1.5ºC (Table 6). RMS errors for *Heat Source* temperature predictions of 1.3ºC to 1.6ºC (Table 7) were entirely consistent with the calibration RMS deviations for the *Heat Source* model. In other words, given our ability to calibrate the *Heat Source* model for this drainage, we would not expect to be able to predict temperatures much better than this on average.

RMS errors for SSTemp temperature predictions of 1.3ºC to 1.7ºC (Table 7) were considerably higher than the calibration RMS deviations for SSTemp. Possible explanations for this poorer prediction performance are either we adjusted the wrong input parameters to calibrate the model, or the SSTemp model does not perform well under varying atmospheric and stream flow conditions. The fact that we were able to obtain consistent results with a similar calibration of the *Heat Source* model suggests that the former is unlikely. Furthermore, even when calibrated to predict average temperatures with reasonable accuracy, SSTemp consistently over-predicted maximum temperatures in all conditions tested for this drainage, indicating a systematic bias in the model's prediction of maximum temperatures.

RMS errors for the CWE temperature predictions of 1.0ºC to 1.2ºC (Table 7) were slightly better than those for either of the other two models, suggesting that the CWE model performs at least as well as the other models in a drainage such as Cold Springs Creek. In addition, the

CWE model requires no calibration, and also involves substantially less time and effort in obtaining the necessary model inputs and executing the model calculations.

Conclusions

Water temperatures were modeled during summer low flow conditions in approximately 16 miles of stream in Cold Springs Creek, a small (11 sq. mi.) headwater drainage in the Upper North Fork Clearwater basin, using three different temperature models, and compared to temperatures measured in 1998, 1999, and 2000. The *Heat Source* and SSTemp models require extensive inputs regarding stream and riparian characteristics and atmospheric conditions. The CWE model requires only elevation and canopy cover as model inputs.

After calibration, *Heat Source* predicted average and maximum water temperatures to within about 1.5ºC or less. Accuracy of predictions from the SSTemp model was similar to that for *Heat Source*. However, SSTemp appears to consistently over-predict maximum temperatures. CWE predictions of average and maximum water temperatures were as good as or slightly better than predictions from the other two models. CWE exhibits additional advantages in its simplicity of inputs and rapid execution.

References

Bartholow, J. M. 1989. Stream temperature investigations: field and analytic methods. Instream Flow Information Paper No. 13. U.S. Fish and Wildlife Service Biological Report 89 (17). 139 p.

Boyd, M. S. 1996. *Heat Source*: stream temperature prediction. Master's thesis, Departments of Civil and Bioresource Engineering, Oregon State University, Corvallis, Oregon.

Clearwater BioStudies. 1997. Habitat conditions and salmonid abundance in selected streams within the Cold Springs drainage, North Fork Ranger District, summer 1996. Canby, Oregon. 38 p. plus appendices.

Idaho Department of Lands. 2000. Forest practices cumulative watershed effects process for Idaho. Boise, Idaho.

Jarrett, R. D. 1984. Hydraulics of high-gradient streams. Journal of Hydraulic Engineering 110 (11): 1519-1539.

ODEQ. 1999. *Heat Source* methodology review: reach analysis of stream and river temperature dynamics. Oregon Department of Environmental Quality, Portland, Oregon. 83 p.

Rosgen, D. L. 1996. Applied river morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Sugden, B. D., T. W. Hillman, J. E. Caldwell, and R. J. Ryel. 1998. Stream temperature considerations in the development of Plum Creek's Native Fish Habitat Conservation Plan. Native Fish Habitat Conservation Plan Report #12. Plum Creek Timber Company, Columbia Falls, Montana. 57 p. plus tables and figures.

Theurer, F. D., K. A. Voos, and W. J. Miller. 1984. Instream water temperature model. Instream Flow Information Paper No. 16. U.S. Fish and Wildlife Service, Fort Collins, Colorado. 200 p.

Figure 1. Stream Reaches Defined for Cold Springs/Cool Creek Drainage

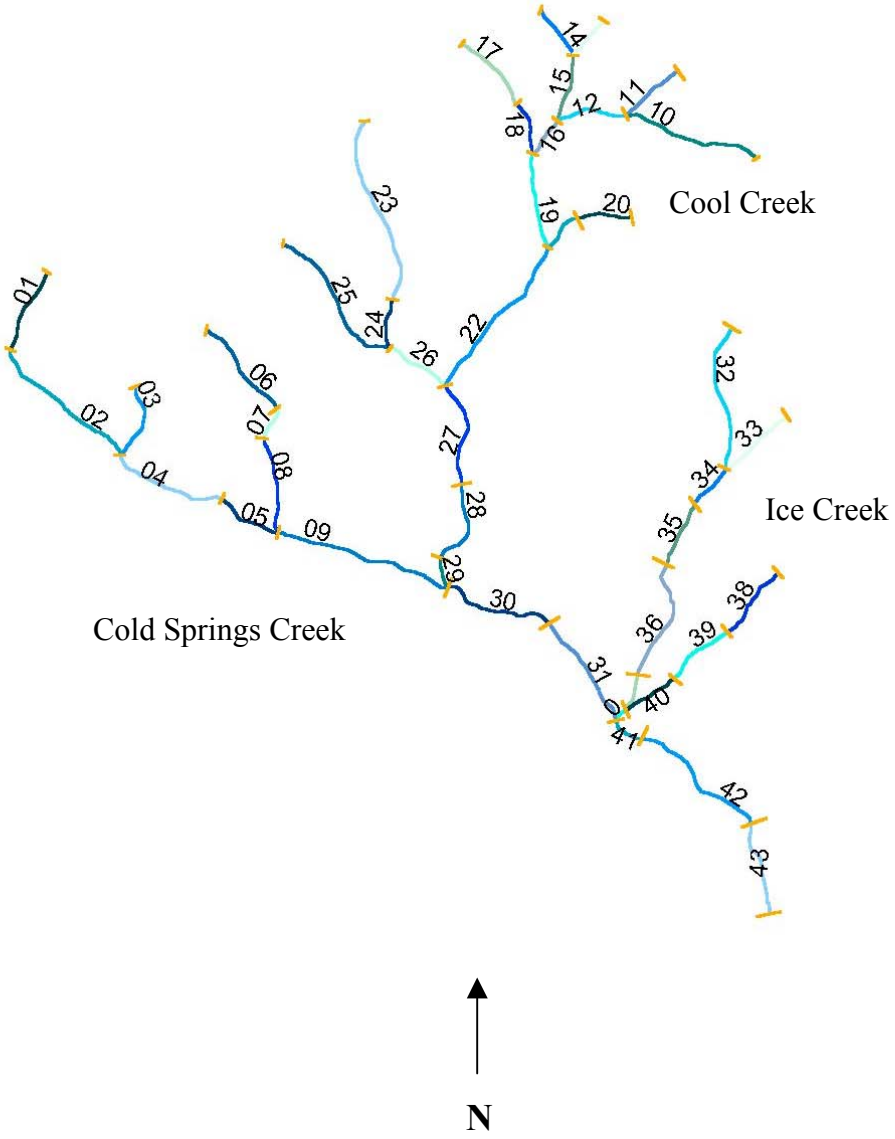


Figure 2. Stream Gauge Correlation

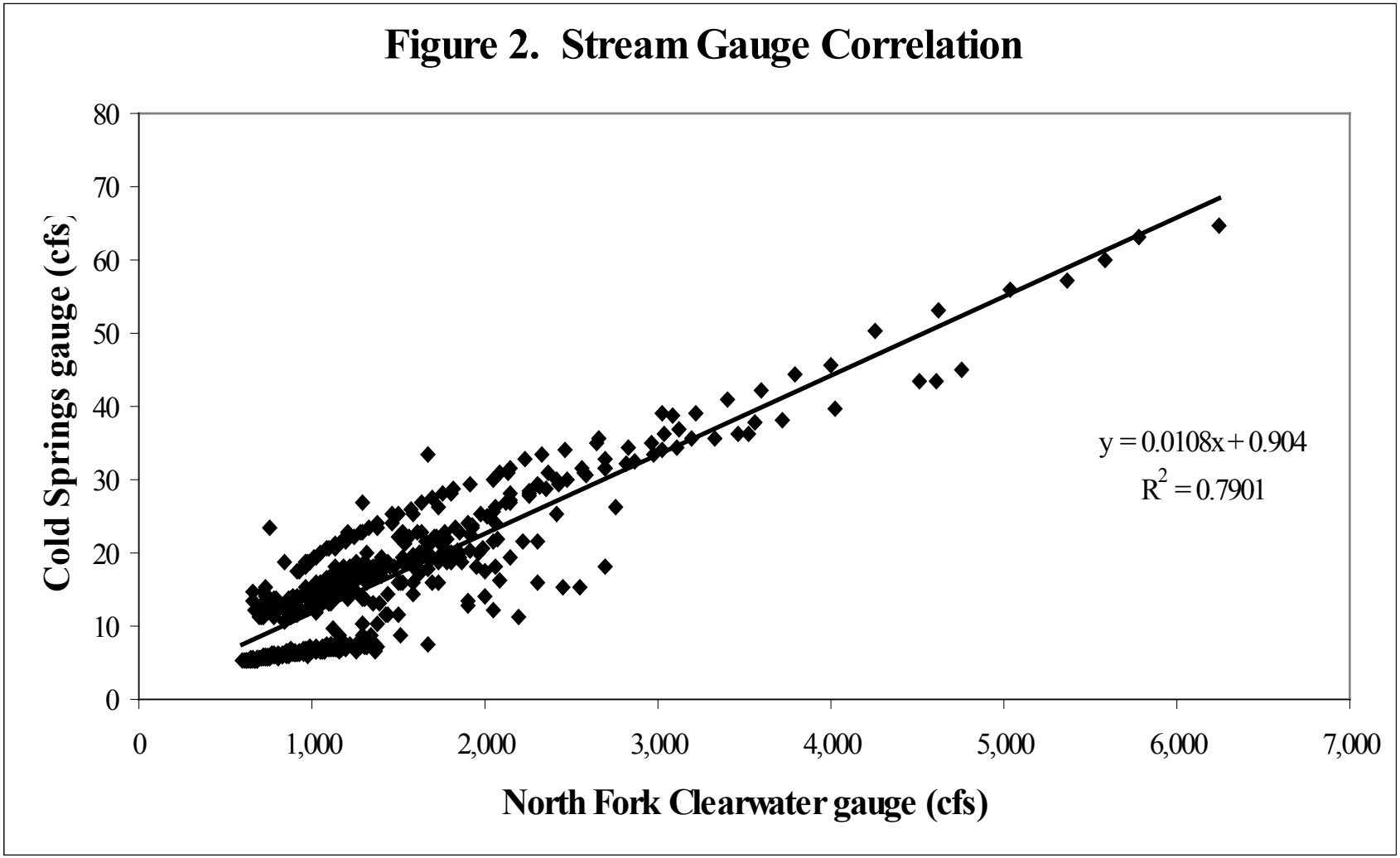


Figure 3. He*at Source* Calibration – 7/27/98

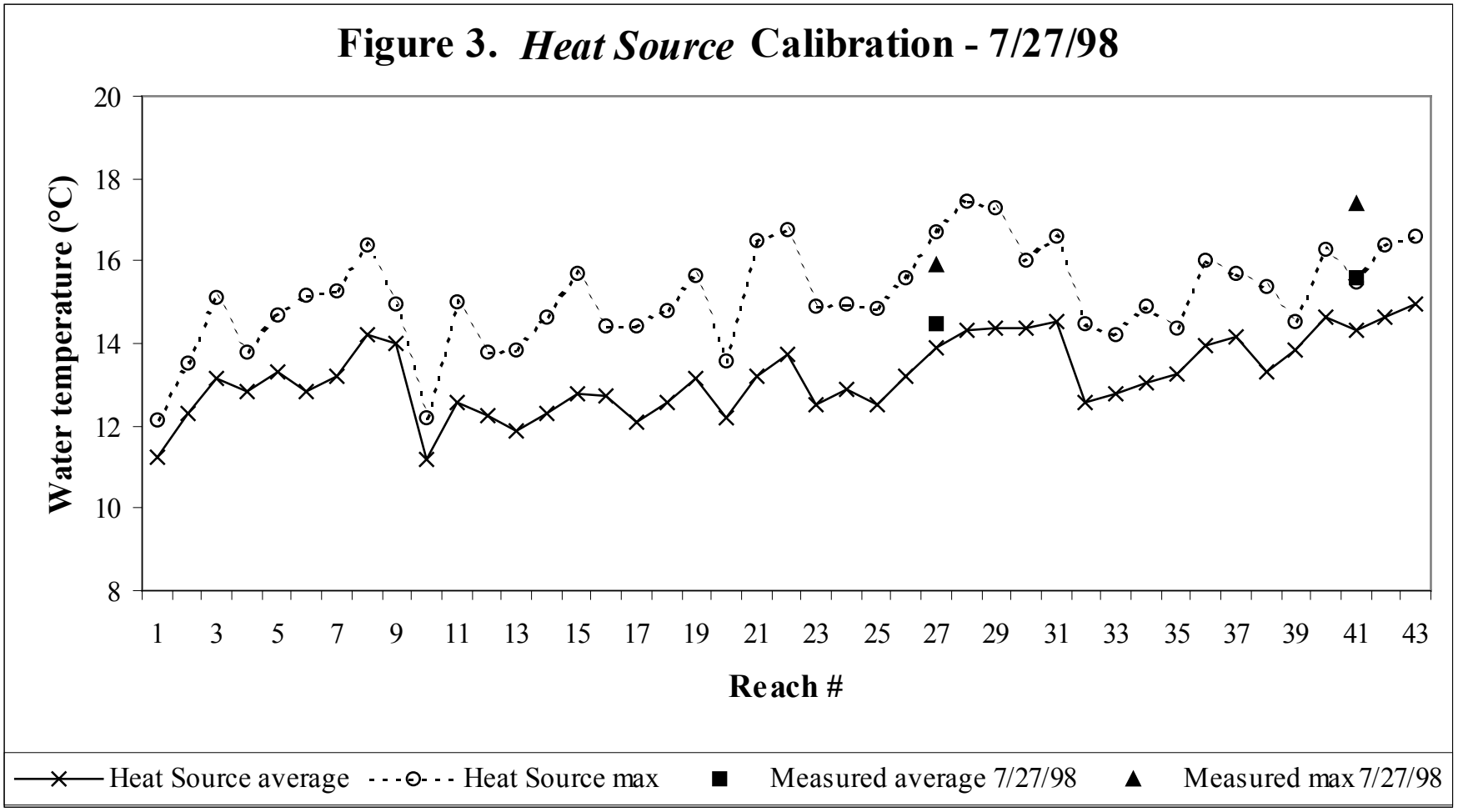


Figure 4. *Heat Source* Prediction – 8/6/99

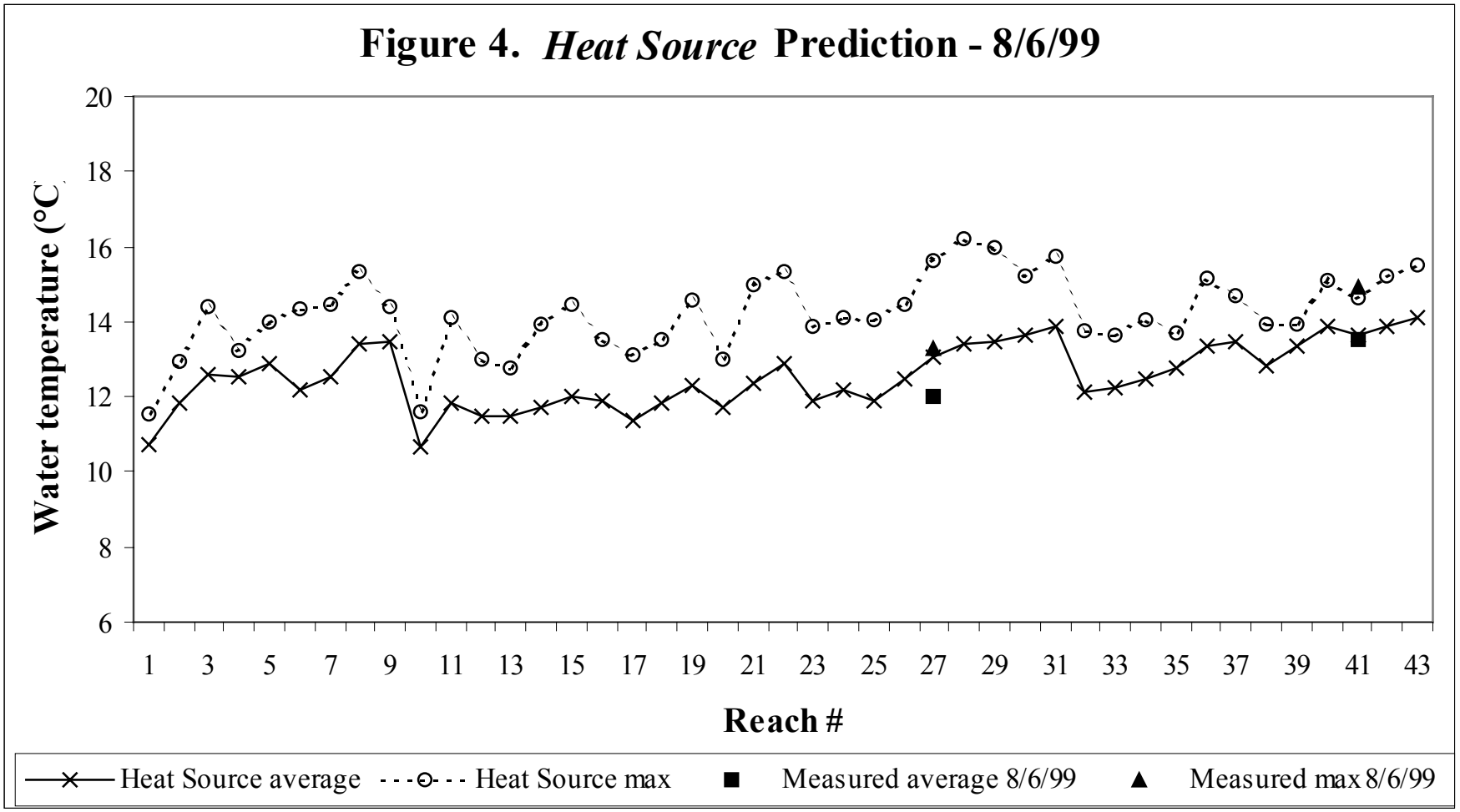


Figure 5. SSTEMP Calibration – 7/27/98

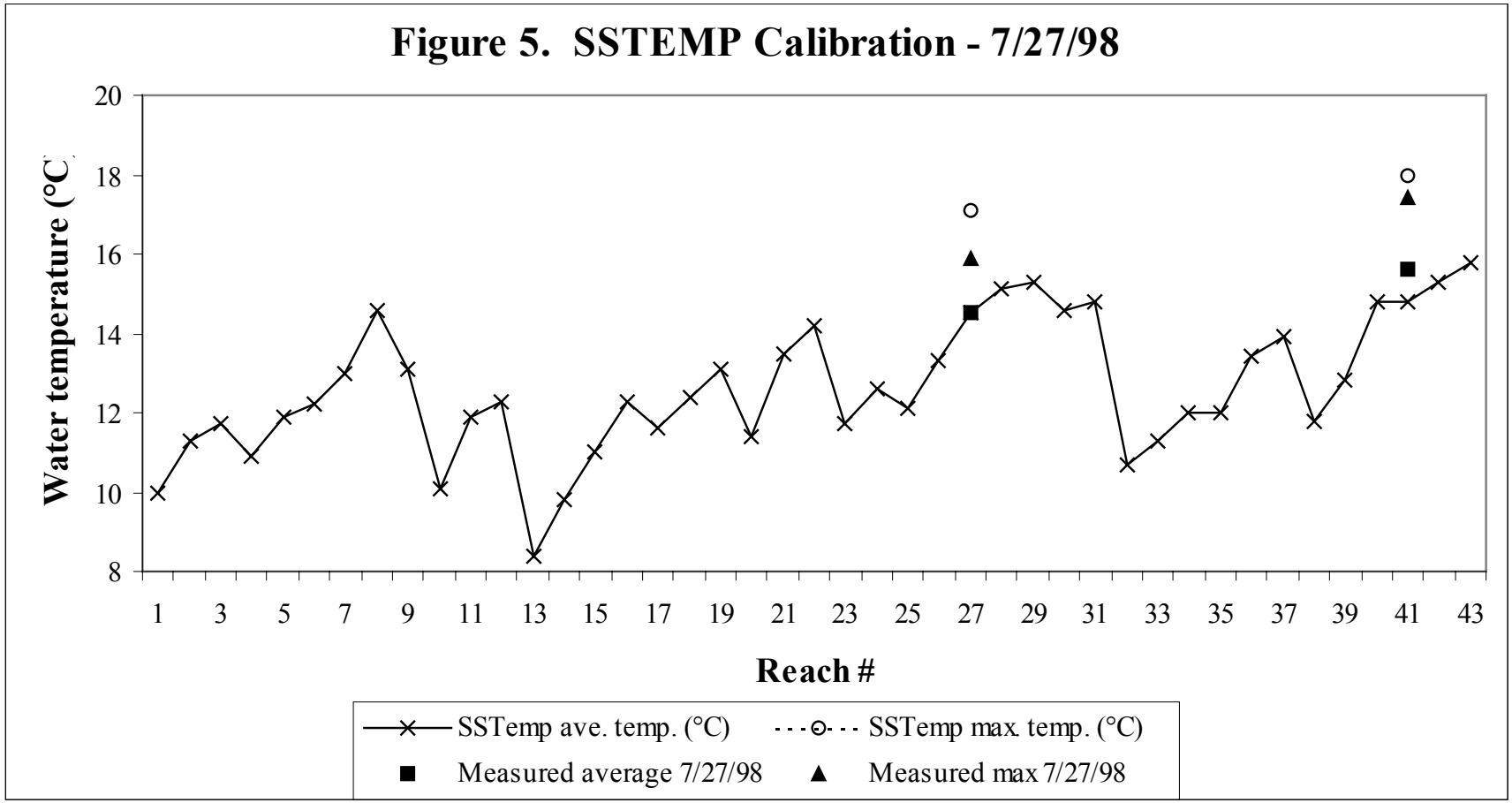


Figure 6. SSTEMP Prediction – 8/6/99

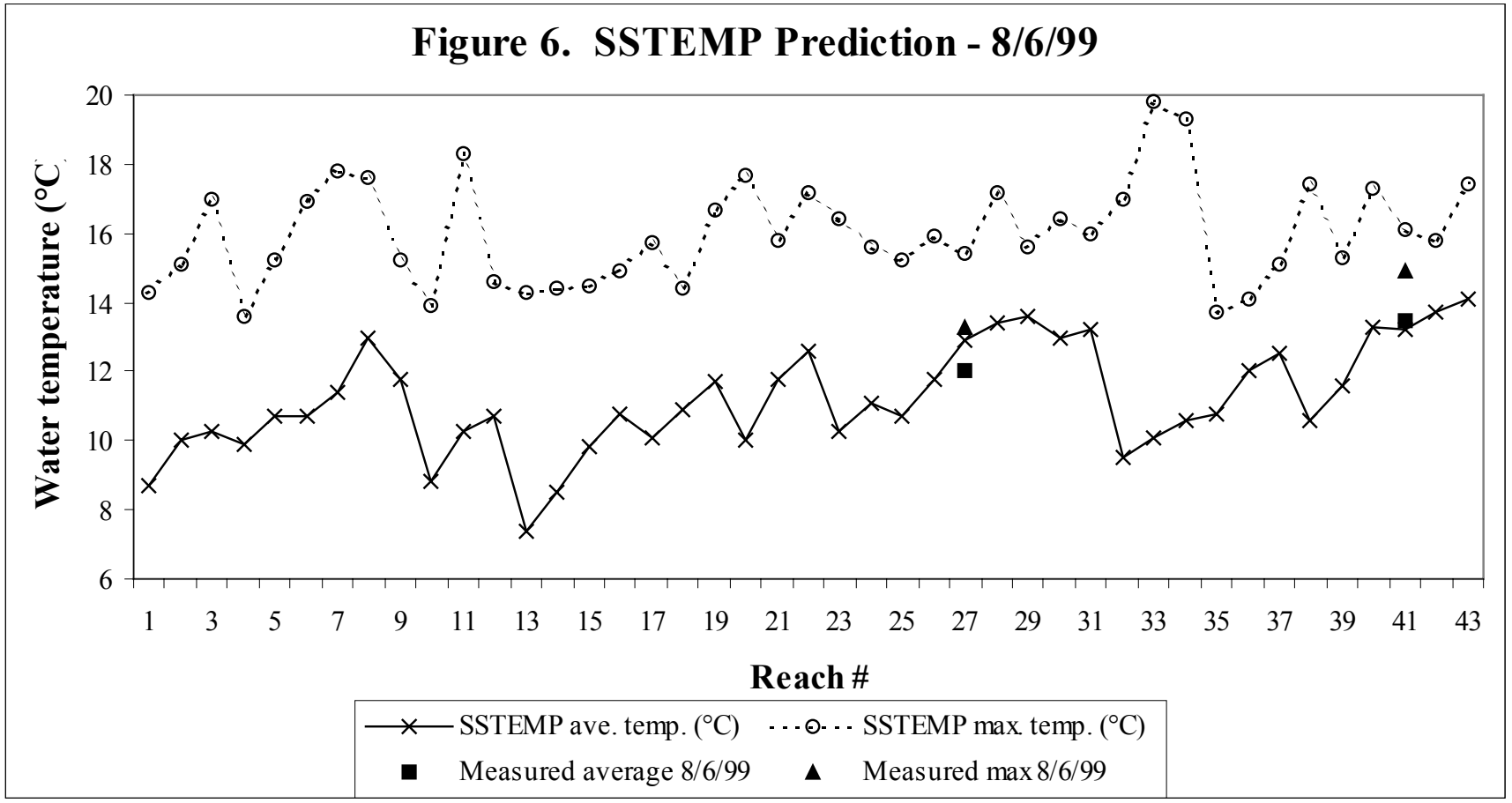


Figure 7. CWE Prediction

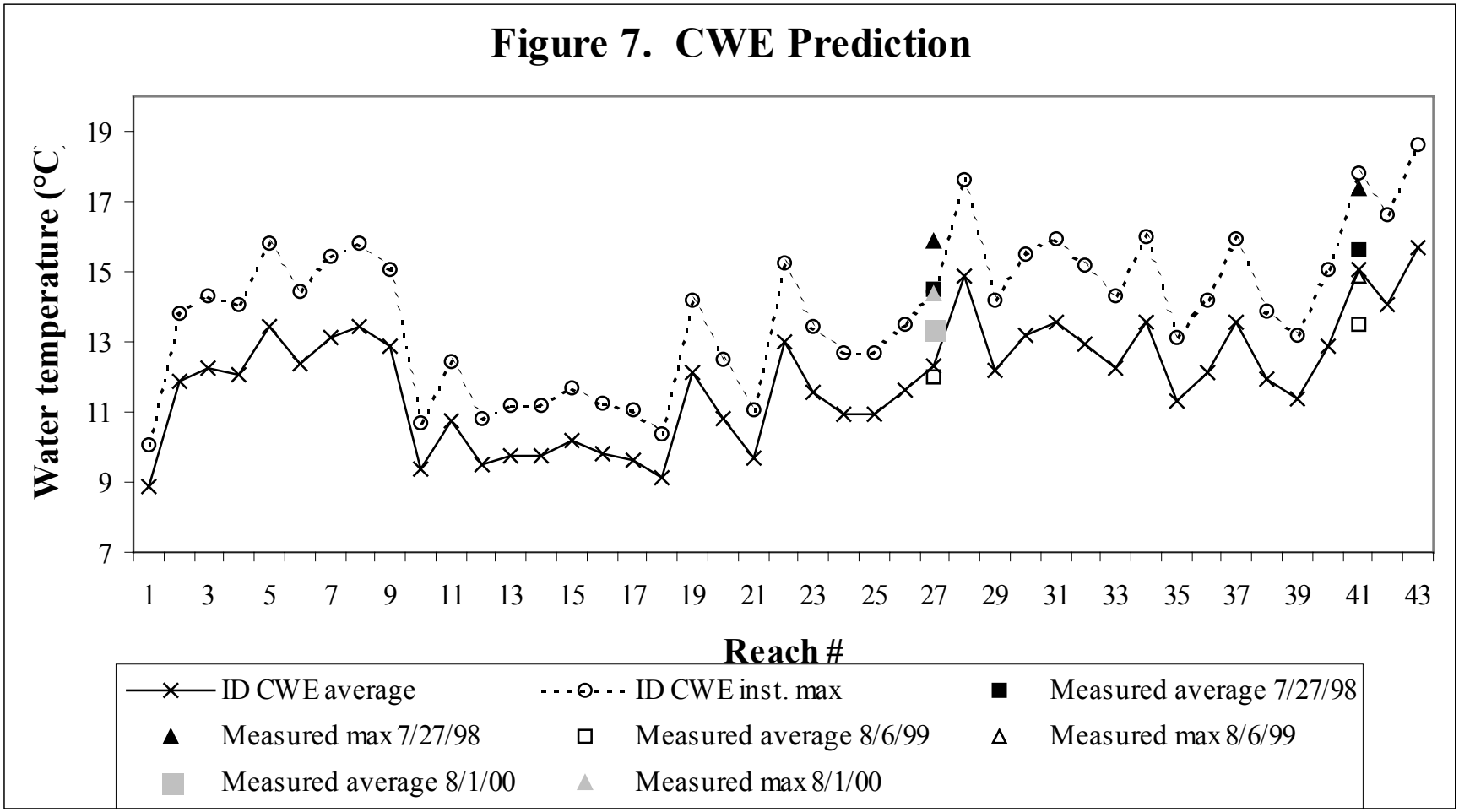


Table 1. *Heat Source* Calibration for 7/27/98 (page 1 of 5)

Cold Springs Creek - ***Heat Source* Inputs for 7/27/98 Calibration**									
Input parameters									
Reach #	1	2	3	4	5	6	7	8	9
Stream	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Latitude (°)	47	47	47	47	47	47	47	47	47
Longitude (°)	115	115	115	115	115	115	115	115	115
Stream aspect (°)	210	130	215	115	120	135	215	170	105
% bedrock	25%	25%	25%	25%	25%	25%	25%	25%	25%
Reach length (m)	586	1,074	534	798	462	736	238	660	1,231
Stream width (m)	1.5	2.0	1.5	2.3	2.7	2.0	2.0	2.0	3.5
Flow volume (cms)	0.0020	0.0085	0.0060	0.0387	0.0728	0.0062	0.0138	0.0165	0.1011
Velocity (m/s)	0.18	0.24	0.18	0.28	0.26	0.19	0.19	0.20	0.38
G/W inflow (cms)	0.0065	0.0202	0.0040	0.0341	0.0069	0.0076	0.0027	0.0049	0.0394
G/W temperature (°C)	9.8	11.1	11.5	12.3	12.8	11.0	11.9	12.5	13.3
Stream depth (m)	0.032	0.060	0.036	0.112	0.115	0.035	0.043	0.053	0.106
Buffer height (m)	18	18	18	18	18	18	18	18	18
Buffer width (m)	10	10	10	10	10	10	10	10	10
Canopy density	70%	55%	50%	65%	50%	45%	40%	50%	70%
Distance to stream (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Incision (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tree overhang (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Topographic west (°)	17	39	35	35	39	45	40	39	35
Topographic east (°)	17	39	35	35	39	45	40	39	35
Min. air temp. (°C)	17.8	19.1	19.5	20.3	20.8	19.0	19.9	20.5	21.3
Max. air temp. (°C)	21.8	23.1	23.5	24.3	24.8	23.0	23.9	24.5	25.3

Cold Springs Creek - *Heat Source* Inputs for 7/27/98 Calibration									
Input parameters									
Reach #	1	2	3	4	5	6	7	8	9
Stream	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr
Min. humidity	45%	45%	45%	45%	45%	45%	45%	45%	45%
Max. humidity	85%	85%	85%	85%	85%	85%	85%	85%	85%
Elevation (m)	1,676	1,448	1,387	1,250	1,167	1,463	1,311	1,210	1,082
Wind speed (m/s)	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Ave. outflow temp (°C)	11.2	12.3	13.2	12.8	13.3	12.8	13.2	14.2	14.0
Max. outflow temp (°C)	12.2	13.5	15.1	13.8	14.7	15.2	15.3	16.4	15.0

Table 1. *Heat Source* Calibration for 7/27/98 (page 2 of 5)

Cold Springs Creek -									
Input parameters									
Reach #	10	11	12	13	14	15	16	17	18
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Latitude (°)	47	47	47	47	47	47	47	47	47
Longitude (°)	115	115	115	115	115	115	115	115	115
Stream aspect (°)	290	230	265	225	140	195	215	135	155
% bedrock	25%	25%	25%	25%	25%	25%	25%	25%	25%
Reach length (m)	955	464	491	307	377	460	288	560	369
Stream width (m)	2.0	2.0	3.0	2.0	2.0	2.7	3.2	2.0	2.2

Cold Springs Creek - Input parameters									
Reach #	10	11	12	13	14	15	16	17	18
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool
Flow volume (cms)	0.0022	0.0049	0.0263	0.0080	0.0067	0.0214	0.0554	0.0031	0.0085
Velocity (m/s)	0.17	0.14	0.15	0.16	0.13	0.15	0.33	0.14	0.13
G/W inflow (cms)	0.0156	0.0036	0.0038	0.0040	0.0027	0.0038	0.0016	0.0054	0.0033
G/W temperature (°C)	9.8	10.0	10.6	10.2	10.2	10.6	11.0	10.1	10.9
Stream depth (m)	0.053	0.031	0.065	0.039	0.036	0.063	0.055	0.030	0.040
Buffer height (m)	18	18	18	18	18	18	18	18	18
Buffer width (m)	10	10	10	10	10	10	10	10	10
Canopy density	65%	45%	70%	60%	60%	60%	70%	65%	80%
Distance to stream (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Incision (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tree overhang (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Topographic west (°)	29	27	39	29	39	29	35	31	29
Topographic east (°)	29	27	39	29	39	29	35	31	29
Min. air temp. (°C)	17.8	18.0	18.6	18.2	18.2	18.6	19.0	18.1	18.9
Max. air temp. (°C)	21.8	22.0	22.6	22.2	22.2	22.6	23.0	22.1	22.9
Min. humidity	45%	45%	45%	45%	45%	45%	45%	45%	45%
Max. humidity	85%	85%	85%	85%	85%	85%	85%	85%	85%
Elevation (m)	1,670	1,637	1,533	1,603	1,603	1,530	1,475	1,615	1,487
Wind speed (m/s)	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Ave. outflow temp (°C)	11.2	12.6	12.2	11.9	12.3	12.8	12.7	12.1	12.6
Max. outflow temp (°C)	12.2	15.0	13.8	13.8	14.6	15.7	14.4	14.4	14.8

Table 1. *Heat Source* Calibration for 7/27/98 (page 3 of 5)

Cold Springs Creek - Input parameters									
Reach #	19	20	21	22	23	24	25	26	27
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	W. Cool	W. Cool	W. Cool	W. Cool	Lower Cool
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Latitude (°)	47	47	47	47	47	47	47	47	47
Longitude (°)	115	115	115	115	115	115	115	115	115
Stream aspect (°)	170	265	220	220	160	190	140	120	170
% bedrock	25%	25%	25%	25%	25%	25%	25%	25%	25%
Reach length (m)	663	377	293	1,191	1,309	346	1,087	459	728
Stream width (m)	3.6	2.0	2.2	4.0	2.5	2.7	2.0	3.1	5.2
Flow volume (cms)	0.0688	0.0031	0.0080	0.0886	0.0098	0.0314	0.0040	0.0507	0.1672
Velocity (m/s)	0.32	0.15	0.14	0.37	0.29	0.35	0.28	0.34	0.29
G/W inflow (cms)	0.0107	0.0049	0.0011	0.0231	0.0216	0.0036	0.0116	0.0049	0.0136
G/W temperature (°C)	11.3	10.6	11.3	12.1	10.7	11.7	11.0	12.3	12.9
Stream depth (m)	0.069	0.027	0.030	0.075	0.043	0.038	0.027	0.052	0.121
Buffer height (m)	18	18	18	18	18	18	18	18	18
Buffer width (m)	10	10	10	10	10	10	10	10	10
Canopy density	45%	55%	80%	50%	50%	70%	70%	70%	70%
Distance to stream (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Incision (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tree overhang (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Topographic west (°)	35	17	22	39	31	39	45	45	45
Topographic east (°)	35	17	22	39	31	39	45	45	45
Min. air temp. (°C)	19.3	18.6	19.3	20.1	18.7	19.7	19.0	20.3	20.9
Max. air temp. (°C)	23.3	22.6	23.3	24.1	22.7	23.7	23.0	24.3	24.9
Min. humidity	45%	45%	45%	45%	45%	45%	45%	45%	45%

Cold Springs Creek - Input parameters									
Reach #	19	20	21	22	23	24	25	26	27
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	W. Cool	W. Cool	W. Cool	W. Cool	Lower Cool
Max. humidity	85%	85%	85%	85%	85%	85%	85%	85%	85%
Elevation (m)	1,411	1,536	1,417	1,286	1,524	1,347	1,469	1,247	1,149
Wind speed (m/s)	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Ave. outflow temp (°C)	13.1	12.2	13.2	13.7	12.5	12.9	12.5	13.2	13.9
Max. outflow temp (°C)	15.7	13.6	16.5	16.7	14.9	15.0	14.8	15.6	16.7

Table 1. *Heat Source* Calibration for 7/27/98 (page 4 of 5)

Cold Springs Creek - Input parameters									
Reach #	28	29	30	31	32	33	34	35	36
Stream	Lower Cool	Lower Cool	Lo Cld Spr	Lo Cld Spr	N. Ice	N. Ice	N. Ice	N. Ice	N. Ice
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Latitude (°)	47	47	47	47	47	47	47	47	47
Longitude (°)	115	115	115	115	115	115	115	115	115
Stream aspect (°)	170	165	105	145	185	230	230	210	210
% bedrock	25%	25%	25%	25%	25%	25%	25%	25%	25%
Reach length (m)	605	212	787	810	1,006	549	325	452	847
Stream width (m)	4.5	4.5	4.5	4.5	2.0	2.0	2.5	2.5	2.9
Flow volume (cms)	0.1809	0.1883	0.3298	0.3566	0.0116	0.0084	0.0450	0.0505	0.0643
Velocity (m/s)	0.39	0.33	0.77	0.78	0.44	0.39	0.40	0.43	0.25
G/W inflow (cms)	0.0074	0.0009	0.0269	0.0229	0.0182	0.0069	0.0054	0.0138	0.0091

Cold Springs Creek - Input parameters									
Reach #	28	29	30	31	32	33	34	35	36
Stream	Lower Cool	Lower Cool	Lo Cld Spr	Lo Cld Spr	N. Ice	N. Ice	N. Ice	N. Ice	N. Ice
G/W temperature (°C)	13.4	13.6	13.8	14.1	11.2	11.3	12.2	12.8	13.6
Stream depth (m)	0.107	0.127	0.103	0.108	0.034	0.019	0.051	0.059	0.099
Buffer height (m)	18	18	18	18	12	12	3	18	18
Buffer width (m)	10	10	10	10	7	7	3	10	10
Canopy density	40%	80%	70%	70%	40%	50%	40%	85%	85%
Distance to stream (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Incision (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tree overhang (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Topographic west (°)	45	45	45	45	39	29	39	46	46
Topographic east (°)	45	45	45	45	39	29	39	46	46
Min. air temp. (°C)	21.4	21.6	21.8	22.1	19.2	19.3	20.2	20.8	21.6
Max. air temp. (°C)	25.4	25.6	25.8	26.1	23.2	23.3	24.2	24.8	25.6
Min. humidity	45%	45%	45%	45%	45%	45%	45%	45%	45%
Max. humidity	85%	85%	85%	85%	85%	85%	85%	85%	85%
Elevation (m)	1,067	1,030	1,000	951	1,426	1,417	1,265	1,158	1,036
Wind speed (m/s)	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Ave. outflow temp (°C)	14.3	14.4	14.3	14.5	12.6	12.8	13.0	13.2	13.9
Max. outflow temp (°C)	17.5	17.3	16.0	16.6	14.5	14.2	14.9	14.4	16.0

Table 1. *Heat Source* Calibration for 7/27/98 (page 5 of 5)

Cold Springs Creek - Input parameters							
Reach #	37	38	39	40	41	42	43
Stream	N. Ice	S. Ice	S. Ice	S. Ice	Lo Cld Spr	Lo Cld Spr	Lo Cld Spr
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Latitude (°)	47	47	47	47	47	47	47
Longitude (°)	115	115	115	115	115	115	115
Stream aspect (°)	210	225	230	240	120	130	170
% bedrock	25%	25%	25%	25%	25%	25%	25%
Reach length (m)	254	549	491	391	229	995	646
Stream width (m)	2.9	2.0	2.0	2.5	5.5	5.5	5.5
Flow volume (cms)	0.0734	0.0076	0.0147	0.0214	0.4761	0.4814	0.4959
Velocity (m/s)	0.28	0.37	0.39	0.29	0.43	0.46	0.43
G/W inflow (cms)	0.0007	0.0071	0.0067	0.0011	0.0053	0.0145	0.0056
G/W temperature (°C)	14.1	12.3	13.2	13.9	14.2	14.5	14.7
Stream depth (m)	0.092	0.020	0.027	0.031	0.201	0.197	0.214
Buffer height (m)	18	18	18	18	18	18	12
Buffer width (m)	10	10	10	10	10	10	7
Canopy density	70%	70%	90%	80%	50%	70%	50%
Distance to stream (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Incision (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tree overhang (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Topographic west (°)	54	29	17	42	45	45	11
Topographic east (°)	54	29	17	42	45	45	11
Min. air temp. (°C)	22.1	20.3	21.2	21.9	22.2	22.5	22.7
Max. air temp. (°C)	26.1	24.3	25.2	25.9	26.2	26.5	26.7
Min. humidity	45%	45%	45%	45%	45%	45%	45%
Max. humidity	85%	85%	85%	85%	85%	85%	85%

Cold Springs Creek - Input parameters							
Reach #	37	38	39	40	41	42	43
Stream	N. Ice	S. Ice	S. Ice	S. Ice	Lo Cld Spr	Lo Cld Spr	Lo Cld Spr
Elevation (m)	951	1,250	1,097	981	920	884	838
Wind speed (m/s)	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Ave. outflow temp (°C)	14.2	13.3	13.9	14.6	14.3	14.6	14.9
Max. outflow temp (°C)	15.7	15.4	14.5	16.3	15.5	16.4	16.6

Table 2. *Heat Source* Calibration for 8/6/99 (page 1 of 5)

Cold Springs Creek - ***Heat Source* Inputs for 8/6/99 Prediction** Input parameters									
Reach #	1	2	3	4	5	6	7	8	9
Stream	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Latitude (°)	47	47	47	47	47	47	47	47	47
Longitude (°)	115	115	115	115	115	115	115	115	115
Stream aspect (°)	210	130	215	115	120	135	215	170	105
% bedrock	25%	25%	25%	25%	25%	25%	25%	25%	25%
Reach length (m)	586	1,074	534	798	462	736	238	660	1,231
Stream width (m)	1.5	2.0	1.5	2.3	2.7	2.0	2.0	2.0	3.5
Flow volume (cms)	0.0020	0.0085	0.0060	0.0387	0.0728	0.0062	0.0138	0.0165	0.1011
Velocity (m/s)	0.18	0.24	0.18	0.28	0.26	0.19	0.19	0.20	0.38
G/W inflow (cms)	0.0065	0.0202	0.0040	0.0341	0.0069	0.0076	0.0027	0.0049	0.0394
G/W temperature (°C)	9.8	11.1	11.5	12.3	12.8	11.0	11.9	12.5	13.3
Stream depth (m)	0.032	0.060	0.036	0.112	0.115	0.035	0.043	0.053	0.106

Cold Springs Creek - ***Heat Source*** **Inputs for 8/6/99 Prediction**

Input parameters

Reach #	1	2	3	4	5	6	7	8	9
Stream	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr
Buffer height (m)	18	18	18	18	18	18	18	18	18
Buffer width (m)	10	10	10	10	10	10	10	10	10
Canopy density	70%	55%	50%	65%	50%	45%	40%	50%	70%
Distance to stream (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Incision (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tree overhang (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Topographic west (°)	17	39	35	35	39	45	40	39	35
Topographic east (°)	17	39	35	35	39	45	40	39	35
Min. air temp. (°C)	17.8	19.1	19.5	20.3	20.8	19.0	19.9	20.5	21.3
Max. air temp. (°C)	21.8	23.1	23.5	24.3	24.8	23.0	23.9	24.5	25.3
Min. humidity	45%	45%	45%	45%	45%	45%	45%	45%	45%
Max. humidity	85%	85%	85%	85%	85%	85%	85%	85%	85%
Elevation (m)	1,676	1,448	1,387	1,250	1,167	1,463	1,311	1,210	1,082
Wind speed (m/s)	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Ave. outflow temp (°C)	11.2	12.3	13.2	12.8	13.3	12.8	13.2	14.2	14.0
Max. outflow temp (°C)	12.2	13.5	15.1	13.8	14.7	15.2	15.3	16.4	15.0

Table 2. *Heat Source* Calibration for 8/6/99 (page 2 of 5)

Cold Springs Creek - Input parameters									
Reach #	10	11	12	13	14	15	16	17	18
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Latitude (°)	47	47	47	47	47	47	47	47	47
Longitude (°)	115	115	115	115	115	115	115	115	115
Stream aspect (°)	290	230	265	225	140	195	215	135	155
% bedrock	25%	25%	25%	25%	25%	25%	25%	25%	25%
Reach length (m)	955	464	491	307	377	460	288	560	369
Stream width (m)	2.0	2.0	3.0	2.0	2.0	2.7	3.2	2.0	2.2
Flow volume (cms)	0.0022	0.0049	0.0263	0.0080	0.0067	0.0214	0.0554	0.0031	0.0085
Velocity (m/s)	0.17	0.14	0.15	0.16	0.13	0.15	0.33	0.14	0.13
G/W inflow (cms)	0.0156	0.0036	0.0038	0.0040	0.0027	0.0038	0.0016	0.0054	0.0033
G/W temperature (°C)	9.8	10.0	10.6	10.2	10.2	10.6	11.0	10.1	10.9
Stream depth (m)	0.053	0.031	0.065	0.039	0.036	0.063	0.055	0.030	0.040
Buffer height (m)	18	18	18	18	18	18	18	18	18
Buffer width (m)	10	10	10	10	10	10	10	10	10
Canopy density	65%	45%	70%	60%	60%	60%	70%	65%	80%
Distance to stream (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Incision (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tree overhang (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Topographic west (°)	29	27	39	29	39	29	35	31	29
Topographic east (°)	29	27	39	29	39	29	35	31	29
Min. air temp. (°C)	17.8	18.0	18.6	18.2	18.2	18.6	19.0	18.1	18.9
Max. air temp. (°C)	21.8	22.0	22.6	22.2	22.2	22.6	23.0	22.1	22.9
Min. humidity	45%	45%	45%	45%	45%	45%	45%	45%	45%

Cold Springs Creek - Input parameters									
Reach #	10	11	12	13	14	15	16	17	18
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool
Max. humidity	85%	85%	85%	85%	85%	85%	85%	85%	85%
Elevation (m)	1,670	1,637	1,533	1,603	1,603	1,530	1,475	1,615	1,487
Wind speed (m/s)	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Ave. outflow temp (°C)	11.2	12.6	12.2	11.9	12.3	12.8	12.7	12.1	12.6
Max. outflow temp (°C)	12.2	15.0	13.8	13.8	14.6	15.7	14.4	14.4	14.8

Table 2. *Heat Source* Calibration for 8/6/99 (page 3 of 5)

Cold Springs Creek - Input parameters									
Reach #	19	20	21	22	23	24	25	26	27
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	W. Cool	W. Cool	W. Cool	W. Cool	Lower Cool
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Latitude (°)	47	47	47	47	47	47	47	47	47
Longitude (°)	115	115	115	115	115	115	115	115	115
Stream aspect (°)	170	265	220	220	160	190	140	120	170
% bedrock	25%	25%	25%	25%	25%	25%	25%	25%	25%
Reach length (m)	663	377	293	1,191	1,309	346	1,087	459	728
Stream width (m)	3.6	2.0	2.2	4.0	2.5	2.7	2.0	3.1	5.2
Flow volume (cms)	0.0688	0.0031	0.0080	0.0886	0.0098	0.0314	0.0040	0.0507	0.1672
Velocity (m/s)	0.32	0.15	0.14	0.37	0.29	0.35	0.28	0.34	0.29
G/W inflow (cms)	0.0107	0.0049	0.0011	0.0231	0.0216	0.0036	0.0116	0.0049	0.0136

Cold Springs Creek - Input parameters									
Reach #	19	20	21	22	23	24	25	26	27
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	W. Cool	W. Cool	W. Cool	W. Cool	Lower Cool
G/W temperature (°C)	11.3	10.6	11.3	12.1	10.7	11.7	11.0	12.3	12.9
Stream depth (m)	0.069	0.027	0.030	0.075	0.043	0.038	0.027	0.052	0.121
Buffer height (m)	18	18	18	18	18	18	18	18	18
Buffer width (m)	10	10	10	10	10	10	10	10	10
Canopy density	45%	55%	80%	50%	50%	70%	70%	70%	70%
Distance to stream (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Incision (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tree overhang (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Topographic west (°)	35	17	22	39	31	39	45	45	45
Topographic east (°)	35	17	22	39	31	39	45	45	45
Min. air temp. (°C)	19.3	18.6	19.3	20.1	18.7	19.7	19.0	20.3	20.9
Max. air temp. (°C)	23.3	22.6	23.3	24.1	22.7	23.7	23.0	24.3	24.9
Min. humidity	45%	45%	45%	45%	45%	45%	45%	45%	45%
Max. humidity	85%	85%	85%	85%	85%	85%	85%	85%	85%
Elevation (m)	1,411	1,536	1,417	1,286	1,524	1,347	1,469	1,247	1,149
Wind speed (m/s)	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Ave. outflow temp (°C)	13.1	12.2	13.2	13.7	12.5	12.9	12.5	13.2	13.9
Max. outflow temp (°C)	15.7	13.6	16.5	16.7	14.9	15.0	14.8	15.6	16.7

Table 2. *Heat Source* Calibration for 8/6/99 (page 4 of 5)

Cold Springs Creek - Input parameters									
Reach #	28	29	30	31	32	33	34	35	36
Stream	Lower Cool	Lower Cool	Lo Cld Spr	Lo Cld Spr	N. Ice	N. Ice	N. Ice	N. Ice	N. Ice
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Latitude (°)	47	47	47	47	47	47	47	47	47
Longitude (°)	115	115	115	115	115	115	115	115	115
Stream aspect (°)	170	165	105	145	185	230	230	210	210
% bedrock	25%	25%	25%	25%	25%	25%	25%	25%	25%
Reach length (m)	605	212	787	810	1,006	549	325	452	847
Stream width (m)	4.5	4.5	4.5	4.5	2.0	2.0	2.5	2.5	2.9
Flow volume (cms)	0.1809	0.1883	0.3298	0.3566	0.0116	0.0084	0.0450	0.0505	0.0643
Velocity (m/s)	0.39	0.33	0.77	0.78	0.44	0.39	0.40	0.43	0.25
G/W inflow (cms)	0.0074	0.0009	0.0269	0.0229	0.0182	0.0069	0.0054	0.0138	0.0091
G/W temperature (°C)	13.4	13.6	13.8	14.1	11.2	11.3	12.2	12.8	13.6
Stream depth (m)	0.107	0.127	0.103	0.108	0.034	0.019	0.051	0.059	0.099
Buffer height (m)	18	18	18	18	12	12	3	18	18
Buffer width (m)	10	10	10	10	7	7	3	10	10
Canopy density	40%	80%	70%	70%	40%	50%	40%	85%	85%
Distance to stream (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Incision (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tree overhang (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Topographic west (°)	45	45	45	45	39	29	39	46	46
Topographic east (°)	45	45	45	45	39	29	39	46	46
Min. air temp. (°C)	21.4	21.6	21.8	22.1	19.2	19.3	20.2	20.8	21.6
Max. air temp. (°C)	25.4	25.6	25.8	26.1	23.2	23.3	24.2	24.8	25.6
Min. humidity	45%	45%	45%	45%	45%	45%	45%	45%	45%

Cold Springs Creek - Input parameters									
Reach #	28	29	30	31	32	33	34	35	36
Stream	Lower Cool	Lower Cool	Lo Cld Spr	Lo Cld Spr	N. Ice	N. Ice	N. Ice	N. Ice	N. Ice
Max. humidity	85%	85%	85%	85%	85%	85%	85%	85%	85%
Elevation (m)	1,067	1,030	1,000	951	1,426	1,417	1,265	1,158	1,036
Wind speed (m/s)	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Ave. outflow temp (°C)	14.3	14.4	14.3	14.5	12.6	12.8	13.0	13.2	13.9
Max. outflow temp (°C)	17.5	17.3	16.0	16.6	14.5	14.2	14.9	14.4	16.0

Table 2. *Heat Source* Calibration for 8/6/99 (page 5 of 5)

Cold Springs Creek - Input parameters							
Reach #	37	38	39	40	41	42	43
Stream	N. Ice	S. Ice	S. Ice	S. Ice	Lo Cld Spr	Lo Cld Spr	Lo Cld Spr
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Latitude (°)	47	47	47	47	47	47	47
Longitude (°)	115	115	115	115	115	115	115
Stream aspect (°)	210	225	230	240	120	130	170
% bedrock	25%	25%	25%	25%	25%	25%	25%
Reach length (m)	254	549	491	391	229	995	646
Stream width (m)	2.9	2.0	2.0	2.5	5.5	5.5	5.5
Flow volume (cms)	0.0734	0.0076	0.0147	0.0214	0.4761	0.4814	0.4959
Velocity (m/s)	0.28	0.37	0.39	0.29	0.43	0.46	0.43
G/W inflow (cms)	0.0007	0.0071	0.0067	0.0011	0.0053	0.0145	0.0056
G/W temperature (°C)	14.1	12.3	13.2	13.9	14.2	14.5	14.7

Cold Springs Creek - Input parameters							
Reach #	37	38	39	40	41	42	43
Stream	N. Ice	S. Ice	S. Ice	S. Ice	Lo Cld Spr	Lo Cld Spr	Lo Cld Spr
Stream depth (m)	0.092	0.020	0.027	0.031	0.201	0.197	0.214
Buffer height (m)	18	18	18	18	18	18	12
Buffer width (m)	10	10	10	10	10	10	7
Canopy density	70%	70%	90%	80%	50%	70%	50%
Distance to stream (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Incision (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tree overhang (m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Topographic west (°)	54	29	17	42	45	45	11
Topographic east (°)	54	29	17	42	45	45	11
Min. air temp. (°C)	22.1	20.3	21.2	21.9	22.2	22.5	22.7
Max. air temp. (°C)	26.1	24.3	25.2	25.9	26.2	26.5	26.7
Min. humidity	45%	45%	45%	45%	45%	45%	45%
Max. humidity	85%	85%	85%	85%	85%	85%	85%
Elevation (m)	951	1,250	1,097	981	920	884	838
Wind speed (m/s)	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Ave. outflow temp (°C)	14.2	13.3	13.9	14.6	14.3	14.6	14.9
Max. outflow temp (°C)	15.7	15.4	14.5	16.3	15.5	16.4	16.6

Table 3. SSTemp Calibration for 7/27/98 (page 1 of 5)

Cold Springs Creek - SSTemp Inputs for 7/27/98									
Reach #	1	2	3	4	5	6	7	8	9
Stream	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Inflow volume (cfs)	0.07	0.30	0.21	1.37	2.57	0.22	0.49	0.58	3.57
Inflow temp. (°C)	3.8	10.0	5.5	11.4	10.9	5.0	12.2	13.0	12.5
Outflow volume (cfs)	0.30	1.01	0.35	2.57	2.82	0.49	0.58	0.76	4.96
G/W temperature (°C)	3.8	5.1	5.5	6.3	6.8	5.0	5.9	6.5	7.3
Latitude (°)	47	47	47	47	47	47	47	47	47
Reach length (mi)	0.364	0.667	0.332	0.496	0.287	0.457	0.148	0.410	0.765
Upstream elev. (ft)	5,800	5,200	4,800	4,300	3,920	5,200	4,400	4,200	3,740
Downstream elev. (ft)	5,200	4,300	4,300	3,900	3,740	4,400	4,200	3,740	3,360
Width A term (s/ft^2)	6.89	7.13	6.34	6.59	7.26	8.08	7.43	7.11	8.59
B term (W = A Q^B)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Manning's n (wetted)	0.320	0.320	0.320	0.320	0.320	0.320	0.320	0.320	0.183
Azimuth (° from south)	30	-50	35	-65	-60	-45	35	-10	-75
Topographic west (°)	17	39	35	35	39	45	40	39	35
Topographic east (°)	17	39	35	35	39	45	40	39	35
Buffer height west (ft)	60	60	60	60	60	60	60	60	60
Buffer height east (ft)	60	60	60	60	60	60	60	60	60
Buffer crown west (ft)	30	30	30	30	30	30	30	30	30
Buffer crown east (ft)	30	30	30	30	30	30	30	30	30
Buffer offset west (ft)	15	15	15	15	15	15	15	15	15
Buffer offset east (ft)	15	15	15	15	15	15	15	15	15
Canopy density west	70%	55%	50%	65%	50%	45%	40%	50%	70%

Cold Springs Creek - SSTemp Inputs for 7/27/98									
Reach #	1	2	3	4	5	6	7	8	9
Stream	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr
Canopy density east	70%	55%	50%	65%	50%	45%	40%	50%	70%
Average air temp. (°C)	19.3	20.6	21.0	21.8	22.3	20.5	21.4	22.0	22.8
Average humidity	65%	65%	65%	65%	65%	65%	65%	65%	65%
Wind speed (mph)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ground temp. (°C)	3.8	5.1	5.5	6.3	6.8	5.0	5.9	6.5	7.3
Ave. wetted width (ft)	4.9	6.6	4.9	7.5	8.9	6.6	6.6	6.6	11.5
Calculated depth (ft)	0.11	0.20	0.12	0.37	0.38	0.12	0.14	0.17	0.35
SSTemp ave. temp. (°C)	10.0	11.3	11.7	10.9	11.9	12.2	13.0	14.6	13.1
SSTemp max. temp. (°C)									

Table 3. SSTemp Calibration for 7/27/98 (page 2 of 5)

Cold Springs Creek -									
Reach #	10	11	12	13	14	15	16	17	18
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Inflow volume (cfs)	0.08	0.17	0.93	0.28	0.24	0.76	1.96	0.11	0.30
Inflow temp. (°C)	3.8	4.0	10.7	4.2	4.2	9.0	11.7	4.1	11.6
Outflow volume (cfs)	0.63	0.30	1.06	0.42	0.33	0.89	2.01	0.30	0.42
G/W temperature (°C)	3.8	4.0	4.6	4.2	4.2	4.6	5.0	4.1	4.9
Latitude (°)	47	47	47	47	47	47	47	47	47
Reach length (mi)	0.593	0.288	0.305	0.191	0.234	0.286	0.179	0.348	0.229

Cold Springs Creek -									
Reach #	10	11	12	13	14	15	16	17	18
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool
Upstream elev. (ft)	5,800	5,600	5,140	5,400	5,400	5,120	4,920	5,600	5,000
Downstream elev. (ft)	5,140	5,140	4,920	5,120	5,120	4,920	4,760	5,000	4,760
Width A term (s/ft^2)	8.08	8.75	9.85	8.08	8.43	9.21	9.15	9.00	8.86
B term (W = A Q^B)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Manning's n (wetted)	0.389	0.389	0.389	0.389	0.389	0.389	0.183	0.389	0.389
Azimuth (° from south)	-70	50	85	45	-40	15	35	-45	-25
Topographic west (°)	29	27	39	29	39	29	35	31	29
Topographic east (°)	29	27	39	29	39	29	35	31	29
Buffer height west (ft)	60	60	60	60	60	60	60	60	60
Buffer height east (ft)	60	60	60	60	60	60	60	60	60
Buffer crown west (ft)	30	30	30	30	30	30	30	30	30
Buffer crown east (ft)	30	30	30	30	30	30	30	30	30
Buffer offset west (ft)	15	15	15	15	15	15	15	15	15
Buffer offset east (ft)	15	15	15	15	15	15	15	15	15
Canopy density west	65%	45%	70%	60%	60%	60%	70%	65%	80%
Canopy density east	65%	45%	70%	60%	60%	60%	70%	65%	80%
Average air temp. (°C)	19.3	19.5	20.1	19.7	19.7	20.1	20.5	19.6	20.4
Average humidity	65%	65%	65%	65%	65%	65%	65%	65%	65%
Wind speed (mph)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ground temp. (°C)	3.8	4.0	4.6	4.2	4.2	4.6	5.0	4.1	4.9
Ave. wetted width (ft)	6.6	6.6	9.8	6.6	6.6	8.9	10.5	6.6	7.2
Calculated depth (ft)	0.17	0.10	0.21	0.13	0.12	0.21	0.18	0.10	0.13
SSTemp ave. temp. (°C)	10.1	11.9	12.3	8.4	9.8	11.0	12.3	11.6	12.4
SSTemp max. temp. (°C)									

Table 3. SSTemp Calibration for 7/27/98 (page 3 of 5)

Cold Springs Creek -									
Reach #	19	20	21	22	23	24	25	26	27
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	W. Cool	W. Cool	W. Cool	W. Cool	Lower Cool
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Inflow volume (cfs)	2.43	0.11	0.28	3.13	0.35	1.11	0.14	1.79	5.91
Inflow temp. (°C)	12.3	4.6	11.4	13.1	4.7	11.7	5.0	12.4	13.9
Outflow volume (cfs)	2.81	0.28	0.32	3.94	1.11	1.24	0.55	1.96	6.39
G/W temperature (°C)	5.3	4.6	5.3	6.1	4.7	5.7	5.0	6.3	6.9
Latitude (°)	47	47	47	47	47	47	47	47	47
Reach length (mi)	0.412	0.234	0.182	0.740	0.813	0.215	0.675	0.285	0.452
Upstream elev. (ft)	4,760	5,280	4,800	4,500	5,400	4,600	5,400	4,240	3,940
Downstream elev. (ft)	4,500	4,800	4,500	3,940	4,600	4,240	4,240	3,940	3,600
Width A term (s/ft^2)	9.74	9.09	9.17	10.19	8.74	8.58	8.11	8.97	11.86
B term (W = A Q^B)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Manning's n (wetted)	0.183	0.389	0.389	0.183	0.183	0.183	0.183	0.183	0.320
Azimuth (° from south)	-10	85	40	40	-20	10	-40	-60	-10
Topographic west (°)	35	17	22	39	31	39	45	45	45
Topographic east (°)	35	17	22	39	31	39	45	45	45
Buffer height west (ft)	60	60	60	60	60	60	60	60	60
Buffer height east (ft)	60	60	60	60	60	60	60	60	60
Buffer crown west (ft)	30	30	30	30	30	30	30	30	30
Buffer crown east (ft)	30	30	30	30	30	30	30	30	30
Buffer offset west (ft)	15	15	15	15	15	15	15	15	15
Buffer offset east (ft)	15	15	15	15	15	15	15	15	15
Canopy density west	45%	55%	80%	50%	50%	70%	70%	70%	70%
Canopy density east	45%	55%	80%	50%	50%	70%	70%	70%	70%
Average air temp. (°C)	20.8	20.1	20.8	21.6	20.2	21.2	20.5	21.8	22.4

Cold Springs Creek -									
Reach #	19	20	21	22	23	24	25	26	27
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	W. Cool	W. Cool	W. Cool	W. Cool	Lower Cool
Average humidity	65%	65%	65%	65%	65%	65%	65%	65%	65%
Wind speed (mph)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ground temp. (°C)	5.3	4.6	5.3	6.1	4.7	5.7	5.0	6.3	6.9
Ave. wetted width (ft)	11.8	6.6	7.2	13.1	8.2	8.9	6.6	10.2	17.1
Calculated depth (ft)	0.23	0.09	0.10	0.25	0.14	0.12	0.09	0.17	0.40
SSTemp ave. temp. (°C)	13.1	11.4	13.5	14.2	11.7	12.6	12.1	13.3	14.5
SSTemp max. temp. (°C)									17.1

Table 3. SSTemp Calibration for 7/27/98 (page 4 of 5)

Cold Springs Creek -									
Reach #	28	29	30	31	32	33	34	35	36
Stream	Lower Cool	Lower Cool	Lo Cld Spr	Lo Cld Spr	N. Ice	N. Ice	N. Ice	N. Ice	N. Ice
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Inflow volume (cfs)	6.39	6.65	11.65	12.59	0.41	0.29	1.59	1.78	2.27
Inflow temp. (°C)	14.5	15.1	14.4	14.6	5.2	5.3	10.9	12.0	12.0
Outflow volume (cfs)	6.65	6.68	12.59	13.40	1.05	0.54	1.78	2.27	2.59
G/W temperature (°C)	7.4	7.6	7.8	8.1	5.2	5.3	6.2	6.8	7.6
Latitude (°)	47	47	47	47	47	47	47	47	47
Reach length (mi)	0.376	0.132	0.489	0.503	0.625	0.341	0.202	0.281	0.526
Upstream elev. (ft)	3,600	3,400	3,360	3,200	5,060	5,000	4,300	4,000	3,600
Downstream elev. (ft)	3,400	3,360	3,200	3,040	4,300	4,300	4,000	3,600	3,200
Width A term (s/ft^2)	10.15	10.10	8.96	8.84	6.98	7.81	7.39	7.12	7.96
B term (W = A Q^B)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Manning's n (wetted)	0.183	0.183	0.071	0.071	0.114	0.114	0.183	0.183	0.320

Cold Springs Creek -									
Reach #	28	29	30	31	32	33	34	35	36
Stream	Lower Cool	Lower Cool	Lo Cld Spr	Lo Cld Spr	N. Ice	N. Ice	N. Ice	N. Ice	N. Ice
Azimuth (° from south)	-10	-15	-75	-35	5	50	50	30	30
Topographic west (°)	45	45	45	45	39	29	39	46	46
Topographic east (°)	45	45	45	45	39	29	39	46	46
Buffer height west (ft)	60	60	60	60	40	40	10	60	60
Buffer height east (ft)	60	60	60	60	40	40	10	60	60
Buffer crown west (ft)	30	30	30	30	20	20	5	30	30
Buffer crown east (ft)	30	30	30	30	20	20	5	30	30
Buffer offset west (ft)	15	15	15	15	10	10	3	15	15
Buffer offset east (ft)	15	15	15	15	10	10	3	15	15
Canopy density west	40%	80%	70%	70%	40%	50%	40%	85%	85%
Canopy density east	40%	80%	70%	70%	40%	50%	40%	85%	85%
Average air temp. (°C)	22.9	23.1	23.3	23.6	20.7	20.8	21.7	22.3	23.1
Average humidity	65%	65%	65%	65%	65%	65%	65%	65%	65%
Wind speed (mph)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ground temp. (°C)	7.4	7.6	7.8	8.1	5.2	5.3	6.2	6.8	7.6
Ave. wetted width (ft)	14.8	14.8	14.8	14.8	6.6	6.6	8.2	8.2	9.5
Calculated depth (ft)	0.35	0.42	0.34	0.35	0.11	0.06	0.17	0.19	0.33
SSTemp ave. temp. (°C)	15.1	15.3	14.6	14.8	10.7	11.3	12.0	12.0	13.4
SSTemp max. temp. (°C)									

Table 3. SSTemp Calibration for 7/27/98 (page 5 of 5)

Cold Springs Creek -							
Reach #	37	38	39	40	41	42	43
Stream	N. Ice	S. Ice	S. Ice	S. Ice	Lo Cld Spr	Lo Cld Spr	Lo Cld Spr
Date	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98	7/27/98
Inflow volume (cfs)	2.59	0.27	0.52	0.76	16.81	17.00	17.51
Inflow temp. (°C)	13.4	6.3	11.8	12.8	14.7	14.8	15.3
Outflow volume (cfs)	2.62	0.52	0.76	0.80	17.00	17.51	17.71
G/W temperature (°C)	8.1	6.3	7.2	7.9	8.2	8.5	8.7
Latitude (°)	47	47	47	47	47	47	47
Reach length (mi)	0.158	0.341	0.305	0.243	0.142	0.618	0.401
Upstream elev. (ft)	3,200	4,400	3,800	3,400	3,040	3,000	2,800
Downstream elev. (ft)	3,040	3,800	3,400	3,040	3,000	2,800	2,700
Width A term (s/ft^2)	7.86	7.90	7.18	8.63	10.25	10.21	10.16
B term (W = A Q^B)	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Manning's n (wetted)	0.320	0.114	0.114	0.183	0.183	0.183	0.183
Azimuth (° from south)	30	45	50	60	-60	-50	-10
Topographic west (°)	54	29	17	42	45	45	11
Topographic east (°)	54	29	17	42	45	45	11
Buffer height west (ft)	60	60	60	60	60	60	40
Buffer height east (ft)	60	60	60	60	60	60	40
Buffer crown west (ft)	30	30	30	30	30	30	20
Buffer crown east (ft)	30	30	30	30	30	30	20
Buffer offset west (ft)	15	15	15	15	15	15	10
Buffer offset east (ft)	15	15	15	15	15	15	10
Canopy density west	70%	70%	90%	80%	50%	70%	50%
Canopy density east	70%	70%	90%	80%	50%	70%	50%
Average air temp. (°C)	23.6	21.8	22.7	23.4	23.7	24.0	24.2
Average humidity	65%	65%	65%	65%	65%	65%	65%

Cold Springs Creek -							
Reach #	37	38	39	40	41	42	43
Stream	N. Ice	S. Ice	S. Ice	S. Ice	Lo Cld Spr	Lo Cld Spr	Lo Cld Spr
Wind speed (mph)	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ground temp. (°C)	8.1	6.3	7.2	7.9	8.2	8.5	8.7
Ave. wetted width (ft)	9.5	6.6	6.6	8.2	18.0	18.0	18.0
Calculated depth (ft)	0.30	0.07	0.09	0.10	0.66	0.65	0.70
SSTemp ave. temp. (°C)	13.9	11.8	12.8	14.8	14.8	15.3	15.8
SSTemp max. temp. (°C)					18.0		

Table 4. SSTemp Calibration for 8/6/99 (page 1 of 5)

Cold Springs Creek -	SSTemp Inputs for 8/6/99 Prediction								
Reach #	1	2	3	4	5	6	7	8	9
Stream	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr
Date	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99
Inflow volume (cfs)	0.08	0.35	0.25	1.61	3.03	0.26	0.57	0.69	4.20
Inflow temp. (°C)	3.8	8.7	5.5	10.1	9.9	5.0	10.7	11.4	11.2
Outflow volume (cfs)	0.35	1.19	0.41	3.03	3.31	0.57	0.69	0.89	5.84
G/W temperature (°C)	3.8	5.1	5.5	6.3	6.8	5.0	5.9	6.5	7.3
Latitude (°)	47	47	47	47	47	47	47	47	47
Reach length (mi)	0.364	0.667	0.332	0.496	0.287	0.457	0.148	0.410	0.765
Upstream elev. (ft)	5,800	5,200	4,800	4,300	3,920	5,200	4,400	4,200	3,740
Downstream elev. (ft)	5,200	4,300	4,300	3,900	3,740	4,400	4,200	3,740	3,360
Width A term (s/ft^2)	6.67	6.91	6.13	6.38	7.03	7.82	7.20	6.88	8.31
B term (W = A Q^B)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Manning's n (wetted)	0.317	0.317	0.317	0.317	0.317	0.317	0.317	0.317	0.181
Azimuth (° from south)	30	-50	35	-65	-60	-45	35	-10	-75

Cold Springs Creek -	SSTemp Inputs for 8/6/99 Prediction								
Reach #	1	2	3	4	5	6	7	8	9
Stream	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr
Topographic west (°)	17	39	35	35	39	45	40	39	35
Topographic east (°)	17	39	35	35	39	45	40	39	35
Buffer height west (ft)	60	60	60	60	60	60	60	60	60
Buffer height east (ft)	60	60	60	60	60	60	60	60	60
Buffer crown west (ft)	30	30	30	30	30	30	30	30	30
Buffer crown east (ft)	30	30	30	30	30	30	30	30	30
Buffer offset west (ft)	15	15	15	15	15	15	15	15	15
Buffer offset east (ft)	15	15	15	15	15	15	15	15	15
Canopy density west	70%	55%	50%	65%	50%	45%	40%	50%	70%
Canopy density east	70%	55%	50%	65%	50%	45%	40%	50%	70%
Average air temp. (°C)	17.8	19.1	19.5	20.3	20.8	19.0	19.9	20.5	21.3
Average humidity	65%	65%	65%	65%	65%	65%	65%	65%	65%
Wind speed (mph)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ground temp. (°C)	3.8	5.1	5.5	6.3	6.8	5.0	5.9	6.5	7.3
Ave. wetted width (ft)	4.9	6.6	4.9	7.5	8.9	6.6	6.6	6.6	11.5
Calculated depth (ft)	0.12	0.21	0.13	0.40	0.42	0.13	0.15	0.19	0.38
SSTEMP ave. temp. (°C)	8.7	10.0	10.3	9.9	10.7	10.7	11.4	13.0	11.8
SSTEMP max. temp. (°C)	14.3	15.1	17.0	13.6	15.2	16.9	17.8	17.6	15.2

Table 4. SSTemp Calibration for 8/6/99 (page 2 of 5)

Cold Springs Creek -									
Reach #	10	11	12	13	14	15	16	17	18
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool
Date	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99
Inflow volume (cfs)	0.09	0.20	1.09	0.33	0.28	0.89	2.30	0.13	0.35
Inflow temp. (°C)	3.8	4.0	9.3	4.2	4.2	7.9	10.3	4.1	10.1
Outflow volume (cfs)	0.74	0.35	1.25	0.50	0.39	1.05	2.37	0.35	0.49
G/W temperature (°C)	3.8	4.0	4.6	4.2	4.2	4.6	5.0	4.1	4.9
Latitude (°)	47	47	47	47	47	47	47	47	47
Reach length (mi)	0.593	0.288	0.305	0.191	0.234	0.286	0.179	0.348	0.229
Upstream elev. (ft)	5,800	5,600	5,140	5,400	5,400	5,120	4,920	5,600	5,000
Downstream elev. (ft)	5,140	5,140	4,920	5,120	5,120	4,920	4,760	5,000	4,760
Width A term (s/ft^2)	7.82	8.47	9.53	7.82	8.16	8.91	8.86	8.72	8.57
B term (W = A Q^B)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Manning's n (wetted)	0.385	0.385	0.385	0.385	0.385	0.385	0.181	0.385	0.385
Azimuth (° from south)	-70	50	85	45	-40	15	35	-45	-25
Topographic west (°)	29	27	39	29	39	29	35	31	29
Topographic east (°)	29	27	39	29	39	29	35	31	29
Buffer height west (ft)	60	60	60	60	60	60	60	60	60
Buffer height east (ft)	60	60	60	60	60	60	60	60	60
Buffer crown west (ft)	30	30	30	30	30	30	30	30	30
Buffer crown east (ft)	30	30	30	30	30	30	30	30	30
Buffer offset west (ft)	15	15	15	15	15	15	15	15	15
Buffer offset east (ft)	15	15	15	15	15	15	15	15	15
Canopy density west	65%	45%	70%	60%	60%	60%	70%	65%	80%
Canopy density east	65%	45%	70%	60%	60%	60%	70%	65%	80%
Average air temp. (°C)	17.8	18.0	18.6	18.2	18.2	18.6	19.0	18.1	18.9

Cold Springs Creek -									
Reach #	10	11	12	13	14	15	16	17	18
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool
Average humidity	65%	65%	65%	65%	65%	65%	65%	65%	65%
Wind speed (mph)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ground temp. (°C)	3.8	4.0	4.6	4.2	4.2	4.6	5.0	4.1	4.9
Ave. wetted width (ft)	6.6	6.6	9.8	6.6	6.6	8.9	10.5	6.6	7.2
Calculated depth (ft)	0.19	0.11	0.23	0.14	0.13	0.23	0.20	0.11	0.14
SSTEMP ave. temp. (°C)	8.8	10.3	10.7	7.4	8.5	9.8	10.8	10.1	10.9
SSTEMP max. temp. (°C)	13.9	18.3	14.6	14.3	14.4	14.5	14.9	15.7	14.4

Table 4. SSTemp Calibration for 8/6/99 (page 3 of 5)

Cold Springs Creek -									
Reach #	19	20	21	22	23	24	25	26	27
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	W. Cool	W. Cool	W. Cool	W. Cool	Lower Cool
Date	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99
Inflow volume (cfs)	2.86	0.13	0.33	3.68	0.41	1.31	0.17	2.10	6.95
Inflow temp. (°C)	10.8	4.6	10.0	11.7	4.7	10.3	5.0	11.0	12.3
Outflow volume (cfs)	3.30	0.33	0.38	4.64	1.31	1.46	0.65	2.31	7.51
G/W temperature (°C)	5.3	4.6	5.3	6.1	4.7	5.7	5.0	6.3	6.9
Latitude (°)	47	47	47	47	47	47	47	47	47
Reach length (mi)	0.412	0.234	0.182	0.740	0.813	0.215	0.675	0.285	0.452
Upstream elev. (ft)	4,760	5,280	4,800	4,500	5,400	4,600	5,400	4,240	3,940
Downstream elev. (ft)	4,500	4,800	4,500	3,940	4,600	4,240	4,240	3,940	3,600
Width A term (s/ft^2)	9.43	8.80	8.88	9.87	8.46	8.30	7.85	8.68	11.48
B term (W = A Q^B)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Manning's n (wetted)	0.181	0.385	0.385	0.181	0.181	0.181	0.181	0.181	0.317

Cold Springs Creek -									
Reach #	19	20	21	22	23	24	25	26	27
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	W. Cool	W. Cool	W. Cool	W. Cool	Lower Cool
Azimuth (° from south)	-10	85	40	40	-20	10	-40	-60	-10
Topographic west (°)	35	17	22	39	31	39	45	45	45
Topographic east (°)	35	17	22	39	31	39	45	45	45
Buffer height west (ft)	60	60	60	60	60	60	60	60	60
Buffer height east (ft)	60	60	60	60	60	60	60	60	60
Buffer crown west (ft)	30	30	30	30	30	30	30	30	30
Buffer crown east (ft)	30	30	30	30	30	30	30	30	30
Buffer offset west (ft)	15	15	15	15	15	15	15	15	15
Buffer offset east (ft)	15	15	15	15	15	15	15	15	15
Canopy density west	45%	55%	80%	50%	50%	70%	70%	70%	70%
Canopy density east	45%	55%	80%	50%	50%	70%	70%	70%	70%
Average air temp. (°C)	19.3	18.6	19.3	20.1	18.7	19.7	19.0	20.3	20.9
Average humidity	65%	65%	65%	65%	65%	65%	65%	65%	65%
Wind speed (mph)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ground temp. (°C)	5.3	4.6	5.3	6.1	4.7	5.7	5.0	6.3	6.9
Ave. wetted width (ft)	11.8	6.6	7.2	13.1	8.2	8.9	6.6	10.2	17.1
Calculated depth (ft)	0.25	0.10	0.11	0.27	0.16	0.13	0.10	0.19	0.43
SSTEMP ave. temp. (°C)	11.7	10.0	11.8	12.6	10.3	11.1	10.7	11.8	12.9
SSTEMP max. temp. (°C)	16.7	17.7	15.8	17.2	16.4	15.6	15.2	15.9	15.4

Table 4. SSTemp Calibration for 8/6/99 (page 4 of 5)

Cold Springs Creek -									
Reach #	28	29	30	31	32	33	34	35	36
Stream	Lower Cool	Lower Cool	Lo Cld Spr	Lo Cld Spr	N. Ice	N. Ice	N. Ice	N. Ice	N. Ice
Date	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99
Inflow volume (cfs)	7.51	7.82	13.70	14.82	0.48	0.35	1.87	2.10	2.67
Inflow temp. (°C)	12.9	13.4	12.8	13.0	5.2	5.3	9.7	10.6	10.8
Outflow volume (cfs)	7.82	7.86	14.82	15.77	1.24	0.63	2.10	2.67	3.05
G/W temperature (°C)	7.4	7.6	7.8	8.1	5.2	5.3	6.2	6.8	7.6
Latitude (°)	47	47	47	47	47	47	47	47	47
Reach length (mi)	0.376	0.132	0.489	0.503	0.625	0.341	0.202	0.281	0.526
Upstream elev. (ft)	3,600	3,400	3,360	3,200	5,060	5,000	4,300	4,000	3,600
Downstream elev. (ft)	3,400	3,360	3,200	3,040	4,300	4,300	4,000	3,600	3,200
Width A term (s/ft^2)	9.82	9.78	8.68	8.55	6.76	7.56	7.15	6.89	7.71
B term (W = A Q^B)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Manning's n (wetted)	0.181	0.181	0.070	0.070	0.113	0.113	0.181	0.181	0.317
Azimuth (° from south)	-10	-15	-75	-35	5	50	50	30	30
Topographic west (°)	45	45	45	45	39	29	39	46	46
Topographic east (°)	45	45	45	45	39	29	39	46	46
Buffer height west (ft)	60	60	60	60	40	40	10	60	60
Buffer height east (ft)	60	60	60	60	40	40	10	60	60
Buffer crown west (ft)	30	30	30	30	20	20	5	30	30
Buffer crown east (ft)	30	30	30	30	20	20	5	30	30
Buffer offset west (ft)	15	15	15	15	10	10	3	15	15
Buffer offset east (ft)	15	15	15	15	10	10	3	15	15
Canopy density west	40%	80%	70%	70%	40%	50%	40%	85%	85%
Canopy density east	40%	80%	70%	70%	40%	50%	40%	85%	85%
Average air temp. (°C)	21.4	21.6	21.8	22.1	19.2	19.3	20.2	20.8	21.6

Cold Springs Creek -									
Reach #	28	29	30	31	32	33	34	35	36
Stream	Lower Cool	Lower Cool	Lo Cld Spr	Lo Cld Spr	N. Ice	N. Ice	N. Ice	N. Ice	N. Ice
Average humidity	65%	65%	65%	65%	65%	65%	65%	65%	65%
Wind speed (mph)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ground temp. (°C)	7.4	7.6	7.8	8.1	5.2	5.3	6.2	6.8	7.6
Ave. wetted width (ft)	14.8	14.8	14.8	14.8	6.6	6.6	8.2	8.2	9.5
Calculated depth (ft)	0.38	0.46	0.37	0.39	0.12	0.07	0.18	0.21	0.36
SSTEMP ave. temp. (°C)	13.4	13.6	13.0	13.2	9.5	10.1	10.6	10.8	12.0
SSTEMP max. temp. (°C)	17.2	15.6	16.4	16.0	17.0	19.8	19.3	13.7	14.1

Table 4. SSTemp Calibration for 8/6/99 (page 5 of 5)

Cold Springs Creek -							
Reach #	37	38	39	40	41	42	43
Stream	N. Ice	S. Ice	S. Ice	S. Ice	Lo Cld Spr	Lo Cld Spr	Lo Cld Spr
Date	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99	8/6/99
Inflow volume (cfs)	3.05	0.32	0.61	0.89	19.78	20.00	20.60
Inflow temp. (°C)	12.0	6.3	10.6	11.6	13.1	13.2	13.7
Outflow volume (cfs)	3.08	0.61	0.89	0.94	20.00	20.60	20.84
G/W temperature (°C)	8.1	6.3	7.2	7.9	8.2	8.5	8.7
Latitude (°)	47	47	47	47	47	47	47
Reach length (mi)	0.158	0.341	0.305	0.243	0.142	0.618	0.401
Upstream elev. (ft)	3,200	4,400	3,800	3,400	3,040	3,000	2,800
Downstream elev. (ft)	3,040	3,800	3,400	3,040	3,000	2,800	2,700
Width A term (s/ft^2)	7.60	7.65	6.95	8.35	9.92	9.88	9.84
B term (W = A Q^B)	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Manning's n (wetted)	0.317	0.113	0.113	0.181	0.181	0.181	0.181
Azimuth (° from south)	30	45	50	60	-60	-50	-10

Cold Springs Creek -							
Reach #	37	38	39	40	41	42	43
Stream	N. Ice	S. Ice	S. Ice	S. Ice	Lo Cld Spr	Lo Cld Spr	Lo Cld Spr
Topographic west (°)	54	29	17	42	45	45	11
Topographic east (°)	54	29	17	42	45	45	11
Buffer height west (ft)	60	60	60	60	60	60	40
Buffer height east (ft)	60	60	60	60	60	60	40
Buffer crown west (ft)	30	30	30	30	30	30	20
Buffer crown east (ft)	30	30	30	30	30	30	20
Buffer offset west (ft)	15	15	15	15	15	15	10
Buffer offset east (ft)	15	15	15	15	15	15	10
Canopy density west	70%	70%	90%	80%	50%	70%	50%
Canopy density east	70%	70%	90%	80%	50%	70%	50%
Average air temp. (°C)	22.1	20.3	21.2	21.9	22.2	22.5	22.7
Average humidity	65%	65%	65%	65%	65%	65%	65%
Wind speed (mph)	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ground temp. (°C)	8.1	6.3	7.2	7.9	8.2	8.5	8.7
Ave. wetted width (ft)	9.5	6.6	6.6	8.2	18.0	18.0	18.0
Calculated depth (ft)	0.33	0.07	0.10	0.11	0.72	0.71	0.77
SSTEMP ave. temp. (°C)	12.5	10.6	11.6	13.3	13.2	13.7	14.1
SSTEMP max. temp. (°C)	15.1	17.4	15.3	17.3	16.1	15.8	17.4

Table 5. CWE Prediction

Cold Springs Creek - CWE Prediction									
Reach #	1	2	3	4	5	6	7	8	9
Stream	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr
Downstream elev. (ft)	5,200	4,300	4,300	3,900	3,740	4,400	4,200	3,740	3,360
Canopy density	70%	55%	50%	65%	50%	45%	40%	50%	70%
Ave. outflow temp. (°C)	8.9	11.9	12.2	12.0	13.4	12.4	13.2	13.4	12.9
Max. outflow temp. (°C)	10.1	13.8	14.3	14.0	15.8	14.5	15.4	15.8	15.1

Reach #	10	11	12	13	14	15	16	17	18
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool	Upper Cool
Downstream elev. (ft)	5,140	5,140	4,920	5,120	5,120	4,920	4,760	5,000	4,760
Canopy density	65%	45%	70%	60%	60%	60%	70%	65%	80%
Ave. outflow temp. (°C)	9.3	10.8	9.5	9.7	9.7	10.2	9.8	9.6	9.1
Max. outflow temp. (°C)	10.7	12.4	10.8	11.2	11.2	11.7	11.3	11.1	10.4

Reach #	19	20	21	22	23	24	25	26	27
Stream	Upper Cool	Upper Cool	Upper Cool	Upper Cool	W. Cool	W. Cool	W. Cool	W. Cool	Lower Cool
Downstream elev. (ft)	4,500	4,800	4,500	3,940	4,600	4,240	4,240	3,940	3,600
Canopy density	45%	55%	80%	50%	50%	70%	70%	70%	70%
Ave. outflow temp. (°C)	12.1	10.8	9.7	13.0	11.6	11.0	11.0	11.6	12.3
Max. outflow temp. (°C)	14.2	12.5	11.1	15.3	13.5	12.7	12.7	13.5	14.4

Reach #	28	29	30	31	32	33	34	35	36
Stream	Lower Cool	Lower Cool	Lo Cld Spr	Lo Cld Spr	N. Ice	N. Ice	N. Ice	N. Ice	N. Ice

Cold Springs Creek - CWE Prediction

Reach #	1	2	3	4	5	6	7	8	9
Stream	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr	Up Cld Spr
Downstream elev. (ft)	3,400	3,360	3,200	3,040	4,300	4,300	4,000	3,600	3,200
Canopy density	40%	80%	70%	70%	40%	50%	40%	85%	85%
Ave. outflow temp. (°C)	14.9	12.2	13.2	13.6	12.9	12.2	13.6	11.3	12.2
Max. outflow temp. (°C)	17.6	14.2	15.5	15.9	15.2	14.3	16.0	13.1	14.2

Reach #	37	38	39	40	41	42	43
Stream	N. Ice	S. Ice	S. Ice	S. Ice	Lo Cld Spr	Lo Cld Spr	Lo Cld Spr
Downstream elev. (ft)	3,040	3,800	3,400	3,040	3,000	2,800	2,700
Canopy density	70%	70%	90%	80%	50%	70%	50%
Ave. outflow temp. (°C)	13.6	11.9	11.4	12.9	15.1	14.1	15.7
Max. outflow temp. (°C)	15.9	13.9	13.2	15.1	17.8	16.6	18.6

Table 6. Temperature Modeling Comparisons for 7/27/98 Calibration

Parameter/location	Measured (°C)	Heat Source (°C)		SSTEMP (°C)	
		simulated	deviation	simulated	deviation
Reach 27 average temperature	14.5	13.9	-0.6	14.5	0.0
Reach 27 maximum temperature	15.9	16.7	0.8	17.1	1.2
Reach 41 average temperature	15.6	14.3	-1.3	14.8	-0.8
Reach 41 maximum temperature	17.4	15.5	-1.9	18.0	0.6
RMS deviation (all)			**1.25**		**0.78**
RMS deviation in maximums			**1.46**		**0.95**

Table 7. Temperature Modeling Comparisons for 8/6/99 Prediction

Parameter/location	Measured (°C)	Heat Source (°C)		SSTEMP (°C)		Measured - ave. '98-'00 (°C)	CWE (°C)	
		predicted	error	predicted	error		predicted	error
Reach 27 average temperature	12.0	13.1	1.1	12.9	0.9	13.3	12.3	-1.0
Reach 27 maximum temperature	13.3	15.6	2.3	15.4	2.1	14.5	14.4	-0.1
Reach 41 average temperature	13.5	13.6	0.1	13.2	-0.3	14.6	15.1	0.5
Reach 41 maximum temperature	14.9	14.6	-0.3	16.1	1.2	16.2	17.8	1.7
RMS error (all)			**1.28**		**1.30**			**1.01**
RMS error in maximums			**1.64**		**1.71**			**1.17**

Appendix 14. Response to Comments

Appendix 14. Response to Comments

February 28, 2001

The draft *Upper North Fork Clearwater Subbasin Assessment and Total Maximum Daily Loads* was made available for public comment on November 20, 2000. Two individuals and four organizations provided written comment (Table 14-1). This appendix presents the public comments and provides DEQ's responses to them. We appreciate the comments received in that they add substantial information and documentation to the subbasin assessment and TMDLs.

Note: Public comments received and addressed in this appendix refer to a draft of the subbasin assessment and TMDL that was developed in November 2000 and submitted to USEPA in February 2001. The USEPA did not approve that document and returned it to DEQ for revision in December 2001. This October 2003 revision of the document has been substantially reorganized following DEQ's new subbasin assessment and TMDL format such that sections referred to in these public comments are not the same as those that appear in the current document. The final revision requested by USEPA, and a discussion of DEQ's response, is presented in Appendix 15.

Table 14-1. Summary of public comments.

Commenter	Type of Comment	Date of Comment
Mark Solomon P.O. Box 4087 Moscow, ID 83843	Email	Dec. 5, 2000
Dave Sandersfeld Email: fnature@hotmail.com Concerned Citizen	Email	Dec. 11, 2000
Doug Gochnour, Acting Forest Supervisor Clearwater National Forest 12730 Highway 12 Orofino, ID 83544	Letter	Dec 15, 2000
Samuel N. Penney, Chairman Nez Perce Tribal Executive Committee P.O. Box 305 Lapwai, ID 83540	Letter	Jan. 2, 2001

Commenter	Type of Comment	Date of Comment
Curry Jones Environmental Protection Specialist USEPA Region 10 1200 Sixth Avenue Seattle, WA 98101	Letter	Dec. 21, 2000
Robert McKnight, Area Supervisor Clearwater Supervisory Area Idaho Department of Lands 10230 Highway 12 Orofino, ID 83544	Letter	Jan. 8, 2001

Mr. Mark Solomon

Mr. Mark Solomon**,** who is a member of the Clearwater Basin Advisory Group as the environmental group representative, commented by email.

"Please accept this as a comment on DEQ's decision to not write sediment TMDLs for listed streams in the Upper North Fork Clearwater River, especially those listed for bull trout recovery under either the "Idaho Plan" or EPA's designation of bull trout streams for purposes of temperature compliance.

I would refer you to the section on bull trout in the recently submitted BA for the Potlatch mill discharge for a discussion with cites on the effects of fine sediment on bull trout. Pages 53-55. One sample: "This long time (3 weeks as fry) spent within the substrate makes bull trout extremely vulnerable to fine sediment accumulation and water quality degradation. (Fraley and Shepard, 1989)"

Other literature cited includes: Megahan et al, 1980; Lisle, 1982; Beschta and Platts, 1986; Everest et al, 1987; Clifton, 1989; USFWS, 1998.

As was demonstrated by the complete absence of any bull trout in fishing samples referenced in the UNFCR Subbasin Assessment, these streams have been hammered. Recovering bull trout will require active steps to reduce sediment loading as well as reducing in-stream temperatures. DEQ must write TMDLs for control of fine sediments in these streams."

DEQ Response: *Mr. Solomon's analyses and conclusion may be correct, but what he is requesting as a solution, in terms of sediment TMDLs for bull trout restoration, is outside the scope of the federal Clean Water Act, the federally promulgated water quality standards for bull trout, and Idaho's water quality standards. Basically, bull trout restoration is required under the federal Endangered Species Act, not the Clean Water Act. The federally promulgated standards for bull trout under the Clean Water Act address only temperature, for which we have developed TMDLs in this document. Idaho's water quality standards for sediment in these streams require that beneficial uses be supported. The designated beneficial use for these streams is "salmonid spawning," but is not specific to the species of salmonids that must be present. All of the water bodies assessed in this document, except Deception Gulch, support salmonid spawning at levels that meet or exceed the state's water quality standards as determined through implementation of the* Water Body Assessment Guidance.

The absence of bull trout in these streams does not imply a sediment problem. There are several other possible reasons for the absence of bull trout in these streams. Most of these streams have healthy populations of westslope cutthroat trout, which are also sediment sensitive. Some research indicates that cutthroat are more sensitive to sediment than bull trout. In the final analysis, however, to develop a TMDL for sediment, it is necessary to first show that there is a sediment problem, and then to show that the sediment problem exceeds the applicable water quality standards.

Further, DEQ concludes that the Clearwater National Forest is taking active steps to reduce both heat and sediment inputs to all streams in their jurisdiction. They are implementing INFISH, which stipulates that no timber harvest shall occur within 300 feet of a perennial stream. This management practice will reduce stream temperatures as natural canopies recover, and it will provide a buffer to any sediment that might be produced further upslope. The Clearwater National Forest also has an active program of obliterating the most unstable and sediment-producing roads, with the goal of obliterating one-third of the roads on the forest. We conclude that the in-stream sediment condition has been improving for at least the last decade, will continue to do so under their current management plans, and already meets Idaho's water quality standards.

Mr. Dave Sandersfeld

Mr. Dave Sandersfeld provided the following comment by email:

> Affiliation = Concerned citizen
>
> Comments = My background is geotechnical and environmental engineering and I am familiar with the water quality problems in the Clearwater Drainages - largely caused by exposing the very fragile, Idaho batholith soils. It took thousands of years for Nature to stabilize these soils and man can reverse the process in hours!
>
> I am very grateful to the Idaho DEQ for taking the initiative for eventually healing these scars along the Clearwater River. These scars have been ignored for decades!
>
> Your proposed TMDLs will not only help protect the Clearwater drainage; but our floundering native salmonoid runs.
>
> Well done
> Dave Sandersfeld 208-461-1142

Mr. Doug Gochnour, Acting Forest Supervisor, USFS Clearwater National Forest

Mr. Doug Gochnour, Acting Forest Supervisor for the USFS Clearwater National Forest commented on eight different points of the report. We present the USFS comments and the DEQ responses, point by point.

Section 4.3.2 Heat Sources:

In the fourth paragraph, the report noted that removal of the watershed canopy (not the riparian canopy), in some cases, could decrease late season stream flow and therefore increase water temperature. We agree that some of the literature makes this point, however, we have no evidence that this situation exists in the North Fork Clearwater River Subbasin. In fact, there have been some observations that clearcutting in the North Fork Clearwater River watersheds has extended late season stream flows in the headwater streams. The data that exists within the UNFCRS on increasing or decreasing streamflow due to canopy changes and the resultant heat generated is inconclusive. This point should be clarified.

DEQ Response: *We agree with the USFS comment and appreciate their further input that their observations tend to support the idea that timber removal does not decrease late season flows in the UNFCRS. We did not allocate any heat load reduction as a function of this process because we did not have any evidence that it occurs in the UNFCRS. We made the general statement in section 4.3.2 to alert readers that we had considered the situation as a possibility. We have added the following statement to section 4.3.2, "The CNF notes that their data for the UNFCRS on increasing or decreasing stream flow due to canopy changes is inconclusive."*

Sections 6.2 Cold Spring Creek, 6.3 Cool Creek, and 6.13 Lower Orogrande Creek:

Within the individual stream write-ups, conclusive remarks were made that "water quality would be greatly improved if the CNF were to address these problems" within each of the above referenced drainages. We would like to submit that the Forest has already identified the erosional and sedimentation problems and has either started or is proposing appropriate watershed restoration projects. Within the Cold Springs Creek and Cool Creek drainages, approximately 22 and 20 miles of roads are being proposed for decommissioning (road obliteration) and long-term intermittent use (LTIU), respectively, under the Middle Black EIS analysis; implementation would be scheduled between 2001 and 2010. Within the lower Orogrande Creek drainage the Forest has completed 51.1 miles of road obliteration and 0.9 miles of LTIU between 1995 and 1999 within the Pine Creek, Fuzzy Creek and Clark Mountain tributaries. Additional roads within the Clark Mountain area have been identified as possible decommissioning candidates; additional surveys and subsequent NEPA analysis are needed.

DEQ Response: *We stated a few times in the report that the CNF has plans to obliterate approximately 30% of the roads in the UNFCRS, and in no way intend to belittle this effort by the statement quoted. We appreciate receiving data for the numbers for the miles of roads obliterated in the three watersheds mentioned, and have added them to the report. We think the CNF efforts to decommission roads are exactly the kinds of measures that are needed to restore water quality. The statement quoted, however, appears in our discussions of many of the watersheds discussed in Section 6. The intent of the statement is to encourage the CNF to continue to look carefully at the road drainage and maintenance situation with roads that remain part of their system.*

Sections 6.2 Cold Springs Creek and 6.3 Cool Creek:

There are statements under both these sections that indicate there was no (or little) sediment delivery to Cold Springs and Cool Creeks during the 1995-96 landslide event. The report also noted that the surveys conducted by Clearwater BioStudies Inc. indicated definite effects of mass failure derived sediment in the stream channels. Information provided to your agency regarding the 1995-96 landslides in Cold Springs and Cook creeks was incorrect. There were, in fact, 11 landslides in the Cold Springs creek watershed (including Cool Creek) that delivered between 600 and 2, 800 cubic yards of sediment to the streams. In Cool Creek, there were three landslides that delivered between 300 and 1,200 yards of sediment to the streams. This information is consistent with the comments made in the Clearwater BioStudies Inc. report.

DEQ Response: *We appreciate the clarification and have made the changes in the text. We had noted the discrepancy between the CNF landslide data set and the Clearwater BioStudies Inc. report, and this new information clears up the problem.*

Section 6.5 Deception Gulch:

The forest has designated Deception Gulch and the adjacent drainages within the previously private-owned lands as the highest watershed restoration priority within the Upper North Fork Clearwater River Subbasin. Approximately 93 percent of the roads within the Deception Gulch drainage are scheduled for decommissioning or placement in long-term intermittent use (LTIU). Within the Deception Gulch drainage, approximately 38 and 11 miles of road have been approved for decommissioning (road obliteration) or LTUI, respectively, under the Deception Gulch Road Obliteration/OHV Train NEPA documents (Decision Notice signed July 19, 1999). In addition, 3.0 miles of road are being proposed for LTIU under the Middle Black EIS analysis. Project implementation would be scheduled for 2001-2010.

Watershed restoration was started in the Deception Gulch area in 1999 with 16 and 3.4 miles of road miles decommissioned (road obliteration) or placed in long-term intermittent use (LTIU), respectively, in the Comet Creek and face drainages along the mainstem North Fork Clearwater River. An additional 27 and 5 miles of road within the smaller face drainages along the mainstem North Fork Clearwater River have been approved for decommissioning (road obliteration) or LTIU, respectively, under the

Deception Gulch Road Obliteration/OHV Trail NEPA documents (Decision Notice signed July 19, 1999). Finally, approximately 45 and 29 miles of road within the smaller face drainages along the mainstem North Fork Clearwater River are proposed for decommissioning (road obliteration) or LTIU, respectively, are being proposed under the middle Black EIS analysis; implementation would be scheduled between 2001-2010.

DEQ Response: *This is certainly good news in terms of improving the sediment condition of Deception Gulch and meeting the sediment load reduction targets of the TMDL. We expect that documentation of these plans should be sufficient as an implementation plan for the Deception Gulch sediment TMDL.*

Section 7.1.5, Surrogate Water Temperature Targets:

The "Canopy Closure/Stream Temperature Evaluation" process that was used to determine surrogate water temperature targets is most likely valid for smaller headwater streams. Conclusions based on information presented in this section, such as the miles of stream segments with inadequate shade and the number of stream miles requiring 100 percent shade, need to be tempered with reality. Riparian areas along streams do not naturally exhibit 100 percent canopy cover for the entire length of the streams. Natural events (fires, landslides, wind events) may affect riparian vegetation along small stream segments or entire streams. In addition, larger streams (i.e. Middle Creek, lower Orogrande Creek) have larger stream widths that do not allow for a high canopy closure. The process does show utility in providing support that various streams may never reach water temperature standards naturally.

DEQ Response: *The point is well taken and clarification is important. We have added the following statement to section 7.1.5, "Riparian areas along streams do not naturally exhibit 100 percent canopy cover for the entire length of the streams. Natural events (fires, landslides, wind events) may affect riparian vegetation along small stream segments or entire streams. In addition, larger streams (i.e. Middle Creek, lower Orogrande Creek) have larger stream widths that do not allow for a high canopy closure. We have not attempted to sort out these site specific conditions in relation to the CWE predictions, but leave this for the land managers as they develop their implementation plans."*

Section 7.2.1. Sediment Loading Capacity:

In the fourth paragraph the statement "In general, the roads in Deception Gulch are mostly in very good shape or are closed and vegetated" is not correct. Road surveys indicated while most of the roads were closed and were somewhat vegetated, most were not in good shape. Based on the active erosional sites and high mass wasting potential found in these field surveys, the Deception Gulch and surrounding drainages were designated a high priority for watershed restoration.

DEQ Response: *The correction has been made.*

Section 7.2.2 Sediment Load:

In this section, three of the Forest Plan standards are discussed in relation to Deception gulch: geomorphic threshold (Basic), Low fish, and Minimum Viable. The Forest would never manage this watershed at the Low Fish or Minimum Viable standard as these standards have sediment levels that exceed the watershed geomorphic threshold. Therefore, some clarification is needed into how the forest interprets its standards. The current Forest Plan standard for Deception Gulch is "B" channel, Cutthroat Low Fish, which equates to 225 percent sediment over natural. In the case of Deception Gulch, the Low Fish standard (255%) exceeds the estimated geomorphic threshold of 163 percent sediment over natural. Because the geomorphic threshold equates to the Basic standard of, "maintain the stability, equilibrium, and function (physical and biologic)" of all streams, a higher fisheries standard is needed to meet or exceed the Basic standard. A Forest Plan amendment would be in order to change the standard from low fish (225%) to moderate fish (150%) to meet or exceed the Basic standard criteria. This amendment will take place in the Decision Notice for the Middle-Black Analysis. In the interim, we will manage the watershed below the 163% geomorphic threshold.

DEQ Response: *We appreciate the information that the Forest is proposing to manage Deception Gulch to meet their moderate fish standard. Similar to our response above, this plan on the part of the CNF should help insure that targets for the Deception Gulch will be met. We note that the Deception Gulch sediment TMDL continues to use 225 percent over background as the target to meet the state's water quality standards.*

For the purposes of clarification, we reiterate our rationale for choosing the 225 percent over background target. Once we decided that Deception Gulch is not fully supporting its beneficial uses, at least in part because of sediment, then we had to decide what would be an appropriate target load for sediment where beneficial uses would be supported. Our discussion in section 7.2.2 of the different CNF standards helped us identify the 225% over background as an appropriate target. We have added the following paragraph to section 7.2.2 to clarify this reasoning:

"We consider that for a population to be 'viable', it must have enough individuals and enough interconnected, suitable habitats to have a high probability of long-term persistence. Thus, if a population is indeed 'viable' as defined by the CNF, then the waters in which the population occurs would also meet the following definition of waters protected for 'salmonid spawning' in Idaho's water quality standards: 'waters that provide or could provide a habitat for active, self-propagating populations of salmonid fishes.' Therefore, the CNF goal of 'minimum viable,' if met, would support salmonid spawning. The CNF goal of 'low fishable,' which is defined as water providing a harvestable surplus in addition to maintaining viability, would exceed the minimum standard of salmonid spawning as defined by Idaho's water quality standards, subsection 100.01(b). Idaho's water quality standards are silent on harvest goals. Idaho considers harvestable surpluses to be a fisheries management issue, not an issue of meeting water quality standards."

We, therefore, applied the 225 percent over background as our target based on a conclusion that the CNF standard of "minimum viable" probably equates to Idaho's standard for salmonid spawning, but we allowed for a margin of safety by choosing the sediment loading for the next more stringent CNF standard, "low fishable." We assumed that the actual numbers for percent loading over background of the different CNF standards are more-or-less correct. And, as noted above in the added paragraph, we applied that target number by virtue of how it comports with Idaho's water quality standards, and not because it is a particular CNF standard or fisheries harvest goal.

In addition, as we note in the report, we conducted a logic test of the 225 percent over background target by comparing the results of implementing sediment reductions to meet this target to conditions of other watersheds in the subbasin where salmonid spawning is being supported. We concluded that the reductions in roads and mass failures that would be required to meet this target would result in lower road and mass failure densities in Deception Gulch than in watersheds with similar landtypes where salmonid spawning is being supported.

In another test of the numbers associated with this target, we compared the results predicted by WATBAL with those predicted by CWE, and found them to be reasonably close. We recognize that the CNF has confidence in WATBAL because it was developed and validated on the CNF. The primary author of this report has worked extensively with CWE. The fact that both models predict similar current loading from roads and mass failures, and require similar amounts of reduction to meet the target, indicates that the numbers are reasonable within our ability to understand the situation. The fact that the CNF is setting a target for this watershed that exceeds the TMDL target should assure USEPA and other concerned parties that in fact Idaho's water quality standards will be attained.

Sections 7.2.5 Surrogate Sediment Load Reduction Targets and 7.2.6. Sediment Reduction Margin of Safety:

In both these sections the recommendation is made, "that within the next few years the CNF obliterate all roads on hazardous landtypes..." It is not possible for the Clearwater National Forest to accomplish this recommendation. We cannot obliterate all roads on hazardous landtypes, including the 225 (mentioned), 729, 730, 734, and 735 roads. These roads provide access to the watershed for management and fire control. We can most likely agree to obliterate half the 42 miles of roads, concentrating on the roads on hazardous landtypes. We can also agree to reduce the mass wasting hazard on roads that will not be obliterated. We may need up to five years to accomplish this task. We would like to see a statement to the effect that accomplishment of the recommendation is dependent upon funding. Although we intend to make road obliteration in this watershed a high priority, if the Forest is not funded by Congress to do road obliteration, we cannot accomplish the work.

DEQ Response: *We have made the recommended changes to read as suggested. In fact, we were over-prescriptive in designating which roads and mass failures should be*

controlled. This is a decision to be made by the land managers in the process of developing an implementation plan. The bottom line of the implementation plan for non-point source pollution is that the land manager(s) (the CNF in this case) demonstrate that they will meet the sediment reduction target – a 45% sediment reduction in the case of Deception Gulch. The choice of where and how to do this is largely a decision of the land manager(s).

The CNF Forest Supervisor goes on to make the following point:

Perhaps more importantly, we strongly disagree with the statement (Section 6.0: Water Quality Data summary and Conclusions, first paragraph*),* "Due to time constraints, we are not evaluating any water bodies not included on the 303(d) list even though we suspect a large number of them in the UNFCRS do not meet the temperature standards. We recommend that these water bodies be considered for formal 303(d) listing and evaluated in the next round of TMDL development starting in 2006." There are over 200 named streams in the Upper North Fork Clearwater River Subbasin that most likely cannot meet the current EPA bull trout water temperature standard or State temperature standard for salmonid spawning. In 1999, the Forest monitored water temperatures at 87 sites on 75 streams within the North Fork Clearwater River drainage. The bull trout water temperature standard (expressed as a consecutive seven-day average of daily maximum temperatures) of not to exceed 10°C during the June through September period was met on only one stream (Birch Creek). These 75 streams are located both in non-roaded and non-harvested watersheds (i.e. Fourth of July, Black, Fern, Toboggan, Train creeks) as well as roaded and harvested watersheds (i.e. Birch Creek). Listing several hundred more streams where we can do nothing to decrease stream water temperature is not the answer. The standards must be modified to meet natural stream temperature ranges that exist in these watersheds. Until that step is accomplished, streams will be listed as WQLS and TMDL's will be developed where there is no solution or closure to the problem.

We are also concerned that many streams you are recommending for TMDL development for stream temperature in the UNFCRS are already meeting beneficial uses (China, Cold Springs, Cool, Cougar, Gravey, Grizzly, Laundry, Marten, Middle, Lower Orogrande, Sugar, Swamp, Sylvan, Tamarack, and Sneak creeks). These same streams had high MBI's and two or more age classes of fish, indicating that beneficial uses are met. Because of this, these streams were dropped from the 303(d) list for sediment. The recommendation to add them back to the list for temperature appears inconsistent. The fact that beneficial uses are met, yet water temperatures exceed the standards, further indicates that the standards need modification. We recommend, before the 2006 TMDL development, that the DEQ correct the water temperature standards to reflect natural conditions and ranges of variability within these watersheds.

Again, we appreciate the opportunity to comment on this document. If you have any questions or comments regarding this letter or conditions in the North Fork of the Clearwater River, please contact Pat Murphy or Dick Jones at 208-476-4541.

DEQ Response: *The point about the need to "correct the water temperature standards to reflect natural conditions and ranges of variability within these watersheds" is well taken, and we at DEQ are aware of the problem. We received virtually the same comment from the Idaho Department of Lands (included herein). Since comments for the UNFCRS are received at the DEQ Lewiston Regional Office, we have forwarded your comments via memorandum to the DEQ State Water Quality Programs Administrator. Our intent with this memo is to assure the commenters that we have raised this question to the appropriate level within DEQ.*

With respect to the CNF point in the second paragraph above that there is an inconsistency between what qualifies for full support of beneficial uses for sediment as opposed to temperature as pollutants, a similar point was made by IDL. The difference lies with how "narrative" and "numeric" water quality standards are interpreted and applied. Numeric standards leave little or no room for interpretation, while narrative standards are applied based on assessment of local conditions and support of beneficial uses. Correction of the state's water temperature standards will provide more consistency between the two types of standards, but discrepancies will continue to occur because of the different nature of the two types of standards. In the UNFCRS, we thought it was important to identify the pollutant most likely to be causing problems; therefore, we developed TMDLs for temperature rather than sediment.

In fact, for water bodies that are to be protected for bull trout spawning and rearing, we think temperature is a problem, and stream temperatures need to be reduced. It seems reasonably clear to us after having looked at the UNFCRS that bull trout restoration will require stringent management for water temperature control.

Mr. Samuel N. Penney, Nez Perce Tribal Chairman

Mr. Samuel N. Penney, Nez Perce Tribal Chairman, provided a number of comments to the document, as follows:

The Nez Perce Tribe appreciates the opportunity to comment on the Total Maximum Daily Load (TMDL) for the Upper north Fork of the Clearwater River. Portions of the Upper North Fork of the Clearwater River are within the Tribe's ceded territory. The Tribe continues to exercise its treaty-reserved hunting, gathering, and fishing rights in these areas.

The Tribe commends the Idaho Department of Environmental Quality (DEQ) on the hard work and effort put forth completing this document. We believe that this draft forms a good framework up which to develop a final TMDL.

General Comments

Water Body Assessment Guidance

Of major concern to the Tribe is the continued reliance this TMDL places on the 1996 Waterbody Assessment guidance (WBAG). The TMDL utilizes this WBAG to make significant determinations, including decision to not proceed with completing a TMDL.

As you know, the Environmental Protection Agency has expressed significant concern with the WBAG. In fact, DEQ is currently completing the development of a new assessment process. Allowing the continued use of the 1996 WBAG prevents the meaningful achievement of the Clean Water Act's goals of restoring and maintaining the chemical, physical, and biological integrity of the nations' waters.

Given the development of a new WBAG, the Tribe would recommend that DEQ postpone finalization of this document pending the approval of the new assessment guidance. While the Tribe recognizes that DEQ is under a court approved schedule for completing TMDLs, there is a process for seeking an extension of the deadline. Further, given the ongoing lawsuit over the TMDL schedule, there may be an opportunity to seek an extension through settlement discussions with EPA and the plaintiffs. Compromising the scientific and legal defensibility of the TMDL in order to meet the TMDL schedule is not consistent with the goals of the Clean Water Act and with DEQ's legal obligations to produce a TMDL that will lead to achievement of water quality standards.

DEQ Response: *We appreciate the Tribe's concerns about the 1996 WBAG process and understand that both the Tribe and USEPA are hopeful that the new WBAG process will change the support status calls for some of the water bodies in the UNFCRS. We have in fact made significant determinations using the 1996 WBAG process, but in the mode known as the "WBAG plus" where we consider other data. We think determinations made in this mode are as stringent, or perhaps more so, as will be possible under the new WBAG. In the final analysis, however, given the need to continue developing TMDLs to*

meet the court agreed upon schedule, we use the tools we have available, and the 1996 WBAG plus is the process we have in place.

We do not believe that there is any good justification for postponing the finalization of this document, especially in light of what we expect to be full and rapid implementation of water quality improvement plans by the CNF. We think we have made a fair assessment of the subbasin, and that for the most part, the new WBAG will also indicate that beneficial uses are being fully supported. The CNF's comments above with respect to Deception Gulch, and their plans for road closures and full implementation of INFISH standards indicate that they are moving rapidly to bring all streams under their jurisdiction into compliance with state and federal water quality standards. In fact, given ongoing watershed restoration activities of the CNF, there are good reasons to conclude that the TMDLs in this document are unnecessary.

WATBAL

This TMDL extensively utilizes information obtained from the Forest Service's WATBAL erosion model. The WATBAL erosion model has been shown to chronically underestimate potential sedimentation mainly due to the lack of an effective method to model and predict mass failure. R. Hickley, *Evaluating the WATBAL Sediment Loading Model*, at 233-242. WATBAL assumes incorrectly that sediment sources generated from roads and logging heal after four and six years, respectively. This assumption is clearly far from reality, especially in a subbasin, such as the North Fork, that contains highly erosive soils.

Sediment loading modeling by WATBAL "have been invariably underestimated, potentially settling the state for the long-term damage to the stream." *Id*. Use of WATBAL provides estimated sediment delivery rates that are low enough so that additional sediment can be generated by human activities without affecting fish habitat or water quality. Use of the WATBAL model in the TMDL should be carefully reconsidered understanding the limitations in the model.

DEQ Response: *In fact, this TMDL uses very little WATBAL derived information. We present some selected WATBAL derived data as general background information, but have not made any decisions based on WATBAL. Generally, DEQ has been requested to present all available data for subbasin assessments. WATBAL derived data are the most complete data sets for this subbasin, and we concluded that it is important to present some of the results. However, according to DEQ standards, WATBAL data does not qualify as adequate for making beneficial use support calls. Support status calls for each watershed were made using BURP data and data from the CNF bio-physical studies (which are not WATBAL based).*

In the case of the sediment TMDL for Deception Gulch, we note in the report that WATBAL sediment delivery predictions were in fact about 50 percent less than CWE predictions. We used the CWE predictions to produce the sediment budget for Deception Gulch. In the case of the sediment target for Deception Gulch, if WATBAL underpredicts

sediment delivery, then it also underpredicts the targets derived through WATBAL analyses, i.e., the amount of allowable sediment for a given fisheries goal. Since we use CWE predictions and individual mass failure assessments to produce the sediment budget, use of an underpredicted sediment target would result in an extra margin of safety.

Specific Comments

3.3 Cultural Characteristics

There is no mention of cultural use by the Nez Perce Tribe. The document needs to address these issues.

DEQ Response: *We apologize for the oversight. We have added the following paragraph to this section:*

"The Nez Perce people have been residents in the study area for over 8,000 years. The UNFCRS is within the Nez Perce Tribe's ceded territories. The Treaty of 1855 reserved fishing, gathering, 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. The fishery, and the waters supporting it, are revered by the Nez Perce for the life and sustenance these resources have given, and continue to provide, to Tribal members."

6.0 Water Quality Data Summary and Conclusions

The proposal to delist all streams except Deception Gulch for sediment is of concern. As stated in the document, there are several attributes of the subbasin that cause sediment to be of concern for water quality. At lower elevations over-steepened slopes are susceptible to erosion and mass wasting. In fact, many landslides have occurred. Soils in the subbasin are highly erodible and, when exposed during road construction and other disturbances, are difficult to stabilize. Rain-on-snow events can lead to huge amounts of runoff, and produce large amounts of sediment. Timber harvest has denuded many slopes. As reported in the document, during the 1995-96 season there were 370 landslides reported in the subbasin due to storm events. Anthropogenic disturbance accounts for almost 60% of those mass failure events. Given the level of sediment sources to streams in the subbasin, we question the conclusion that sediment is not a water quality pollutant of concern.

DEQ Response*: We agree that sediment is a water quality pollutant of concern in the UNFCRS. We present considerable data and discussion of sediment. However, in the end, we determined that sediment is not degrading water quality below the state standards, except in Deception Gulch. The water quality assessment process, as prescribed by the Clean Water Act, must use specific standards set by the state and approved by USEPA. Concern for sediment as a pollutant can only be translated into a TMDL if it exceeds the specific state's standards. For sediment the criteria are*

narrative, thus we rely upon bioassessment techniques, as formalized in WBAG, to gage sediment affects on beneficial uses.

While there were a large number of mass failures in the 1995-96 event, a better indicator of their potential effect is the delivery of sediment to a stream. We specifically looked at sediment delivery data and compared them 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 sediment TMDLs are not necessary.

We continue this response by pointing out that the objective of the state's water quality standards is not to preserve water in pristine condition. Our goal in assessing the water quality in a subbasin is not to determine whether any degradation has taken place or not, but rather to determine whether degradation that has taken place is of a nature and extent that it exceeds the state's water quality standards. What we have observed in the UNFCRS subbasin is that what most people would consider as huge amounts of anthropogenic sediment can be added to these water bodies and they are resilient enough to continue to support their beneficial uses, in terms of salmonid spawning as defined by the state's water quality standards. Our task has been to try to identify and quantify the level of sediment input beyond which beneficial uses will not be supported. We think we have erred on the side of protecting beneficial uses in our analyses, as defined in Idaho's water quality standards.

In particular, we disagree with the use of the presence of fish as evidence that sediment is not a water quality pollutant of concern. Under the current WBAG guidelines, fish density per age class is not considered in determination of salmonid spawning beneficial use, a stream can have serious degradation due to sediment and still support fish. Even in streams where greater numbers of fish are observed, sediment can still be having a large impact on water quality. Again, we suggest that the new WBAG guidelines be used. Also, measures such as cobble embeddedness and percent fines are much more accurate determinants of sediment impacts to water quality.

DEQ Response: *While we agree that sediment is a water quality pollutant of concern in the UNFCRS, our use of presence of age classes of fish is the state's prescribed metric at this time to determine beneficial use status. We understand that the Tribe thinks that this metric is inadequate and is hopeful that the metric will be changed to include fish density and population trend measurements. Given the relatively strong fish populations in the UNFCRS, we doubt that metrics being included in the new WBAG would change many, if any, of the support status calls.*

We disagree that cobble embeddedness and percent fines would be more accurate measures of the effects of sediment as a pollutant. While they can be related more directly to use impairment at a given location, they are highly variable conditions naturally and it would be very difficult to sort out natural conditions and human-caused effects in relation to the beneficial uses of a water body. In other situations, other habitat measures such as depth and type of pools could be the limiting factor for aquatic use.

The state has chosen aquatic life indicators of water quality because we think they are most applicable across the broad range of conditions found in our streams and rivers.

We support the conclusions on water quality that there are undoubtedly a large number of streams not currently on the § 303(d) list that do not meet Idaho state water quality standards. We hope that the recommendation that they be considered for formal § 303(d) listing and evaluation during the TMDL development starting in 2006 will be followed through.

DEQ Response: *We have already submitted these recommendations in a memorandum to the water quality monitoring division of DEQ. This is the first step in the formal process in evaluating these streams for water quality condition and possible 303(d) listing.*

Additionally, we suggest that entries in Table 6.1 be alphabetized for easier reference.

DEQ Response: *Good suggestion, the table is changed.*

Cougar Creek

The document states that sediment is "building up in the system," that there is high cobble embeddedness, and that there will not be a TMDL. Further, the TMDL states that salmonids do not occur in the upper reaches of the watershed speculating that this is "most likely the result of natural barriers." It is unclear if there is information to support this contention. Is it possible that habitat in the upper reaches is impaired by the sediment in the system?

Grizzly Creek

The document indicates that sediment may be building up in the Grizzly Creek watershed "either through input or inability to move it though the system very well." Further, the Clearwater Biostudies report indicates logging activities occurring to the stream side, in violation of Idaho law. Given the impact of these activities and the build up of sediment, a TMDL is warranted for this watershed to reduce further loading.

DEQ Response: *Cougar and Grizzly Creeks are side by side and have very similar conditions. Both are affected by logging debris and sediment. Both are in unstable geologic landscapes. Both are supporting populations of salmonids in their lower reaches, but do not have any salmonids in their upper reaches. Both were glaciated in their upper reaches approximately 12,000 years ago, such that fish populations were likely extirpated at that time. Migration barriers in their mid reaches have kept salmonids from repopulating the upper reaches. The Clearwater Biostudies report identifies 2-3 meter high water falls in their mid reaches that act as migration barriers. So, while the point is well taken that sediment from logging probably is impairing these systems, the existing data and metrics result in a conclusion that salmonid spawning,*

where fish have access, is being fully supported and the state's water quality standards are being met.

Hem Creek

The document indicates that temperature exceedences in Hem Creek are a natural condition. What action will DEQ take to delist this stream?

DEQ Response: *Hem Creek is currently 303(d) listed for sediment, not temperature. We are proposing that Hem Creek be delisted for sediment, based on our assessment that it is fully supporting its beneficial uses. Simply, during the next round of 303(d) list development by the state, Hem Creek will not be listed as impaired by sediment. Since it is not currently listed for temperature, we will not list it for temperature either. While Hem Creek does exceed the state's water temperature standard, the watershed is in near pristine condition and we concluded that the stream temperature is natural.*

Upper Orogrande Creek

Despite the conclusions of the WBAG that this watershed is not meeting its beneficial uses, the document concludes that a TMDL for sediment is not required for this watershed. It is unclear what scientific and legal support there is for this decision. IDAPA § 58.01.02.053 requires that the WBAG be utilized to make determinations regarding beneficial use support. As stated above, DEQ may wish to postpone the finalization of this TMDL pending the approval of the new WBAG, which may provide an improved method for assessing sediment impacts on beneficial uses.

DEQ Response: *Upper Orogrande Creek is 303(d) listed for sediment. However, when we examined the data in terms of sediment sources and physical presence of sediment in the stream, we did not find any convincing evidence that sediment is a problem. Very few major sediment sources occur across the landscape, and the channel is mostly cobble-sized material with very little fine sediment. When one considers that upper Orogrande is in a highly weathered granitic landscape, low cobble embeddedness is strong evidence that sediment is not a problem.*

When we compared this to the temperature data, where the evidence is convincing that temperature is a problem, we concluded that the lack of beneficial use support is the result of temperature impairment, rather than sediment. We used the fairly extensive existing field data (CWE and temperature monitoring) to clarify the true pollutant of this water body. We believe this meets the legal intent of TMDLs within the CWA, and is scientifically defensible.

Osier Creek

The document notes that Osier Creek is listed on the § 303(d) list for sediment, temperature, flow, and habitat alteration. However, flow and habitat alteration are not addressed in the assessment and there was no TMDL completed for these pollutants.

DEQ Response: *To present, USEPA has accepted DEQ's position that flow and habitat alteration are not pollutants and, as such, do not require a TMDL. On Feb. 12, 1998, USEPA, in accepting the Paradise Creek TMDL, wrote, " First, EPA has not reached a resolution regarding habitat modification and flow alteration as pollutants under §303(d) of the Clean Water Act." USEPA has formalized this policy in their recently approved rule-making where flow and habitat alteration are classified as "pollution," as opposed to "pollutants," and as such, will not be subject to TMDLs because there is no pollutant to be assessed for loading and allocation. The likely pollutants that would be associated with flow and habitat alteration in Osier Creek are temperature and sediment. We assessed Osier Creek for both of these, and concluded that heat loading needed to be decreased through increased shading. Increased shading will improve the flow and habitat alteration situation. The CNF's implementation of INFISH with 300-foot no-cut buffers will restore stream flow and habitat to near natural conditions.*

Tamarack Creek

The document indicates that sediment is a problem for Tamarack Creek. WATBAL modeling, which tends to underestimate delivery, shows a high level of sediment delivery into Tamarack Creek. The CNF bio-physical survey indicates that sediment is a limiting factor in salmonid production (a beneficial use of Tamarack Creek). Given this information, a TMDL should be completed for this watershed.

DEQ Response: *While observed sediment levels are higher than we'd like, we find they are not so high as to be precluding full support of salmonid spawning. We state in the report that we too think that sediment is a problem in Tamarack Creek. However, based on the metrics used by the state process, water quality in fact meets the state's standards and no TMDL is required. Road density in the watershed is low, and virtually none of the roads are within 100 feet of a stream. The high levels of sediment seen by the CNF crew were noted the year after the 1995-96 rain-on-snow event, at which time they also observed cutthroat trout. The presence of a strong population of cutthroat trout shows that the water body is supporting its beneficial uses.*

Tumble Creek

It is unclear what data is utilized to support the contention that only brook trout utilize this watershed. Did DEQ conduct follow up surveys along additional stretches of the stream to confirm this contention? What sort of IF&G coordination occurred? Absent compelling evidence to the contrary, DEQ should assume that other trout species (i.e., rainbows) utilize Tumble Creek and therefore conduct a temperature TMDL for this watershed.

DEQ Response: *Data about brook trout presence in this stream come from both BURP data and the Clearwater Biostudies Report of a stream survey conducted in 1997. Neither the Clearwater Biostudies team nor the BURP crew identified other species of salmonids in Tumble Creek. The Idaho Department of Fish and Game does not have any*

current data on Tumble Creek, nor do they have any historical data for the presence of any other species. The WBAG process requires the use of relatively current data, all of which indicate that brook trout is the only species present in this water body.

As stated above, it is likely that the conclusion that WATBAL is underestimating sediment delivery to Tumble Creek is correct.

It is unclear from the document what supports the conclusion that the lack of fish in the upper reaches is a result of natural migration barriers. Given the high cobble embeddedness (70%), it may be possible that the beneficial uses of the upper watershed are impaired by sediment. Given this uncertainty, a TMDL should be completed.

DEQ Response: *The Clearwater Biostudies report clearly identifies significant migration barriers in the middle reaches of Tumble Creek. While 70 percent cobble embeddedness is relatively high, this is highly weathered granitic terrain where cobble embeddedness is naturally high. We conclude that the lack of salmonids in the upper reaches is the result of the migration barriers, which were clearly identified in the Clearwater Biostudies report. We assume that if the water quality in the lower reaches meets water quality standards, then the water in the upper reaches must also meet water quality standards, absent any direct evidence to the contrary.*

Sneak Creek

The high road density and amount of canopy removal in the watershed are sources of concern for sediment impacts. WATBAL modeling predicts "a 90% over background sediment delivery from roads in the watershed." As stated above, WATBAL underestimates sediment delivery, not overestimates sediment delivery as stated in the document. There is nothing to support the notion that WATBAL is overestimating as opposed to underestimating sediment delivery.

Further, the CNF Biophysical survey indicates that high levels of cobble embeddedness are a limiting factor for salmonid production. This is confirmed by DEQ's own cobble embeddedness value of 34%.

DEQ Response: *Sneak Creek, along with Grizzly and Cougar Creeks discussed above, was one of the watersheds most recently entered after the CNF learned how to build better roads so they are more stable and produce less sediment. A CWE analysis of the roads conducted last summer by the TMDL team indicates that the roads in Sneak Creek are producing very little sediment. We, therefore, take our on-the-ground CWE results as strong evidence that sediment from roads is not a problem. Only one mass failure was recorded from the 1995-96 event. We simply do not find evidence for sediment production in this watershed.*

The level of cobble embeddedness compares as well to the situation in Grizzly and Cougar Creeks with similar geologies and landtypes. It may be natural or in part the result of sloppy logging several years ago, but we did not find any anthropogenic source

from which we can conclude that sediment delivery in an ongoing problem. If we could have identified a major, ongoing anthropogenic sediment source, we would have looked more closely at the need for a sediment TMDL.

The data seems to indicate that a TMDL should be conducted for channel stability or sediment to address the problems in this watershed.

DEQ Response: *Certainly, no evidence exists that channel stability is a cause for a TMDL – the Clearwater Biostudies team surveyed the whole stream and did not identify any instance of channel instability and gave the stream perfect ratings. A sediment TMDL is not required because the water body is supporting its beneficial uses as evidenced by the presence of moderate densities of rainbow and cutthroat trout.*

The Tribe appreciates the opportunity to comment on this TMDL. If you have any questions regarding these comments, please do not hesitate to contact Barbara Inyan in the Water Resources Division. Thank you.

Mr. Robert McKnight, Area Supervisor, Idaho Department of Lands, Clearwater Supervisory Area

Mr. Robert McKnight, Area Supervisor of the Idaho Department of Lands, Clearwater Supervisory Area provided several comments, as follows:

Comments on the Upper North Fork Clearwater River TMDL

Consistency

After reading several subbasin assessments, it was very apparent that there is a terrible lack of consistency between them. For example, all subbasin assessments do not evaluate the support of beneficial uses the same way. Some evaluate data (BURP data and other pertinent information) as directed in the Water Body Assessment guide to determine support status. Others use the Water Body Assessment guide, but may alter their final decision based on other observations or data not used in the Guide. Finally, some subbasin assessments seem to ignore the Water Body Assessment Guide altogether and make support determinations using their own form of analysis which often is unsubstantiated.

DEQ Response: *The WBAG definitely allows and even encourages consideration of "outside data." The extent to which this is done varies with varying levels of available data and varying levels of skill and time for DEQ staff to gather and process that data. The bottom line, however, is that most of the inconsistencies are the result of growing pains at DEQ as we've geared up to do many TMDLs at the same time that our 1996 WBAG process has been called into question. We agreed to not use the 1996 WBAG for future assessments, but are constrained to keep producing TMDLs to meet the agreed upon court schedule. This leaves the regional TMDL writers to individually address the shortcomings of the 1996 WBAG in ways with which they are most comfortable, and largely in the absence of much guidance from Boise because the Boise program people are in the throes of developing the new WBAG.*

We attempted to address this by defining "WBAG plus" as a bridge between the old and the new. The "plus" was to represent a stronger push to use data beyond BURP and to supplement WBAG with data and procedures published by others. We even allowed that overwhelming evidence might be used to overturn a BURP-based assessment. Inevitably, this resulted in inconsistencies among the TMDL authors.

We hope the situation will be improved with the new WBAG, which is currently out for public comment. While no guidance can address all situations, we expect the new WBAG will help alleviate the high degree of inconsistency noted.

We found the same inconsistency on how different subbasin assessments evaluate water temperature. Some subbasin assessments evaluate stream temperature and require temperature TMDL's when State or Federal standards are exceeded. Other subbasin assessments review stream temperature, but even when temperature exceedences occur,

they suggest putting off a TMDL until DEQ further evaluates the temperature standards. Finally, other subbasin assessments do not even mention temperature or suggest temperature TMDL's should be developed, even when one could clearly argue that there are temperature problems.

DEQ Response: *If a water body is not currently 303(d) listed for temperature, there is no obligation to consider developing a TMDL for temperature at this time. It may well be that temperature problems exist for currently unlisted water bodies, and it is no secret that many, if not most, water bodies in Idaho will fail to meet current criteria. We want to do temperature TMDLs where water temperature truly is a problem and is correctable. We do not have the luxury of assessing all water bodies in a subbasin, though some are pushing us to do exactly that. Thus, it has been left largely to the discretion of the regional TMDL writers to address temperature problems as they have time and see fit.*

The decision to proceed with some temperature TMDLs for the UNFCRS was largely based on a desire to establish a methodology for doing temperature TMDLs and to begin sorting out how to determine whether or not temperature exceedances are significant and correctable. In order to keep the exercise within the bounds of our time and resources, we focussed on currently listed water bodies in the UNFCRS, recognizing that probably most of the water bodies in the subbasin exceed the temperature standards. Please review the CNF comments above as they summarize the extent of temperature exceedances in this subbasin.

Finally, There appears to be an inconsistency between the level of disturbances that are allowed before sediment and temperature TMDL's are developed. The stream temperature standards are set near the optimum for the various fishes they apply to. Even though it is recognized that fish will thrive in warmer temperatures, the standards are set at near what is believed to be the best for fish. It doesn't even seem to matter that these standards are unachievable in many natural/undisturbed conditions.

DEQ Response: *It does matter to DEQ whether criteria are achievable, but the burden of proof is ours and there are some real skeptics. Historically, water quality criteria have not been set at the optimum, and we do not think this is the intent of the CWA. For example, with toxics, the optimum standard would be zero (for copper or PCBs, as examples), but we do allow some level of these pollutants up to what we think will support beneficial uses such as fishing. In the case of temperature standards, we have gotten ourselves into a bit of a box due to lack of understanding the natural variability of water temperature when the standards were established. Now we find it very difficult to convince certain critical players that Idaho's water quality standards for temperature are inconsistent with natural variability and the intent of the CWA.*

Without going into detail, suffice it to say that Idaho's water temperature standards for salmonids were set two decades ago based on laboratory studies that were not designed to address general in-stream temperature conditions. The results were incorporated into Idaho's standards when little was known or understood about natural temperature regimes in Idaho, and when few were concerned about stream water temperatures in

Idaho. We have since learned differently, and need to come up with a new set of water quality standards for salmonid spawning that make sense in our current knowledge base.

On the other hand, when evaluating what is acceptable as far as sediment delivery is concerned, it appears that all that really matters is that a fishery exists in the stream (2 or more age classes). It doesn't matter if the fishery is suppressed or going down hill, just as long as a fishery exists. The strategies used to evaluate these two pollutants make it difficult to understand what the goals of developing TMDLs are. Do we want to maintain and protect optimum stream conditions or should it be acceptable to maintain something considerably less just as long as the beneficial use still occurs?

DEQ Response: *(Part of our response to this question is the difference between "numeric" and "narrative" criteria, which is discussed above in our response to the CNF about inconsistencies between the two types of standards.)*

However, beyond that, DEQ is under strong pressure to raise the bar, so to speak, in terms of what qualifies as the lower limit for occurrence of fish and/or other aquatic life for a stream to be in full support of its beneficial uses. The criteria included in the new WBAG currently out for public comment is DEQ's attempt to meet this demand. Pertinent to this comment, however, is the point that the state water quality standards are not designed to maintain optimum water quality conditions, but conditions adequate to support the designated beneficial uses as defined in the WBAG. In the case of the narrative sediment standard for salmonid spawning, we agree that the current WBAG is a bit weak, and we've tried to raise that standard with the new WBAG. In the case of the numeric water temperature standards for salmonid spawning, we argue that the current standards are too restrictive and need to be changed to be consistent with the rest of our standards and/or the real world. If and when the temperature standards are revised, we will revisit the temperature TMDLs presented in this document.

The commenter is correct in observing that so long as a fishery is sustaining itself, albeit marginally, full support is there and narrative criteria are evidently met. The steady decline of fish populations is a concern and may indicate a decline in water quality (threatened but not yet impaired), or it may indicate other fisheries management problems.

These inconsistencies are very frustrating for land managers or anyone else concerned with the TMDL process and could result in lawsuits and even the refusal of individuals to implement TMDL's. All subbasin assessments should have similar outlines, evaluate beneficial uses with the same methodology, and use a similar procedure for developing TMDL's. This type of consistency will result in a better understanding for landowners, managers or operators on what it takes to protect beneficial uses and an overall better acceptance of this process.

Temperature Issues

We strongly approve of using the CWE temperature model to evaluate whether stream temperature standards are met. This model is simple enough for landowners and managers to use, and when implemented on the ground it has proven quite accurate. This is not too surprising as this model was developed from actual stream temperature data collected in Idaho. More complex models that use numerous variables such as humidity, air temperature and wind speed are difficult to understand and more difficult to implement, and often do not gain you more accuracy. As stated in this assessment, shade and elevation are clearly the driving force as far as stream temperature goes and in statistical tests these variables explained over 60-70% of the variation that occurs in stream temperature. In addition, variables such as wind speed, air temperature and humidity are all highly correlated with canopy cover and/or elevation and as a result these variables are essentially covered in the CWE model.

Where the CWE process clearly shows that water temperature is a problem because a lack of canopy cover occurs over the stream, the Idaho Department of Lands plans to manage these stream zones using the CWE Target Stream Canopy Closure tables. In many cases the trees exist but are not yet large enough to provide acceptable canopy coverage. There is a limited number of species that naturally occur in the riparian areas and most are slower growing. Much of the large white pine has died due to white pine blister rust. We would consider a stream as recovered once acceptable canopy cover levels are restored or once the stream reaches a natural level of canopy. This would be similar to the logic that was used to preclude Hem Creek from a temperature TMDL, which we approve of. It makes no sense to have a temperature TMDL on a stream that has natural levels of canopy occurring over it. It should also be noted that canopy coverages shown in the report do not address other factors such as topography, geography, channel type, and natural openings. All of these can provide or influence shading on a stream.

DEQ Response: *Factors such as topography, geography, channel type, and natural openings are expected to be addressed by the land manager in the process of developing the implementation plan, consistent with the FPA CWE process. We have revised the discussion for the development of temperature TMDLs in this document (Section 7) to more specifically address these other effects on temperature. We strengthened the discussion of the importance of shade to maintaining stream temperature as the basis of using percent stream shading as the surrogate measure of heat loading.*

However, land managers should clearly recognize that the pollutant is heat and that, in fact, the requirements of the TMDL will not be fulfilled until stream temperatures have been reduced enough to meet the state's standards. We believe that canopy restored to its fullest and most effective shading capacity of the so-called "natural conditions" for a given water body will reduce stream temperatures to near natural conditions, and should be sufficient for removing a water body from the 303(d) list. However, many water bodies have been manipulated to such a degree that it is relatively inconceivable that the so-called "natural" stream protection conditions could be fully restored. It is expected

that the land managers will address these conditions in their implementation plans for temperature reduction, recognizing at all times that the final measure for effectiveness of the implementation plan is in fact reduction of stream temperatures to meet the state's water quality standards.

The major problem we have with the temperature TMDL's being developed in this subbasin assessment is the temperature standards (Federal and State) are unrealistic. We realize this is not necessarily something that can be addressed in this subbasin assessment, but these comments need to be brought out so something can be done about it. For example, the State temperature standard for cutthroat trout is, between April 1st and August 1st the maximum water temperatures must not exceed 13°C with the maximum daily average no greater than 9°C. For most people, the implications of these temperatures are not clear because most don't realize what type of water temperatures we should expect by August 1st and because most don't realize what a 9°C daily average really means. To help clarify how restrictive this standard is, it's important to understand the following two points. First, the warmest stream temperature of the year typically occurs within one week of August 1st. Second, a 9°C daily average applied during the warmest part of the year is about the same as a 9.7°C MWMT (this was determined using regression equations developed by Sugden et al. 1998). Remember, the Federal Bull Trout standard so many people have problems with is, the MWMT shall not exceed 10°C, so believe it or not, the State standard for cutthroat trout is actually more restrictive than the Federal Bull Trout Standard.

DEQ Response: *We, for the most part, agree with this statement that both the federal and Idaho's temperature standards for bull trout and salmonid spawning are unrealistic. That was not the understanding, or even a consideration, when the current criteria were developed over 20 years ago. We have transmitted these comments to the appropriate authorities at DEQ. Efforts are under way within DEQ and among USEPA and the states of Washington, Idaho, and Oregon to come up with more realistic standards. The temperature TMDLs in this document will be recalculated if and when the temperature standards are revised. In the meantime, we note in the TMDL where we think the current temperature standards will not be achieved. Particularly, it is those stream reaches where the CWE relationship predicts a need for greater than 100% canopy closure to be able to attain the temperature standards, which is generally all stream segments below about 4,000 feet elevation for streams supporting cutthroat trout or protected for bull trout.*

Clearly, any professional fish biologist will tell you that preferred stream temperatures for cutthroat trout are well above 10°C. If you apply this temperature standard to the CWE temperature model, it tells you that a MWMT of 9.7°C can only be maintained above 4,100 feet in elevation. Because DEQ tends to monitor water temperatures near the mouth of streams, almost every single watershed in the North Fork Clearwater River with cutthroat trout will violate this standard. This temperature standard obviously doesn't make sense especially since almost every stream in the Upper North Fork Clearwater river has cutthroat trout and many are considered to be strong populations.

An important question that needs to be answered is, should a stream that arguably has a strong and stable cutthroat trout population have a temperature TMDL?

DEQ Response: *We agree that TMDLs should not be written for streams that have strong populations of cutthroat trout when salmonid spawning is the beneficial use. But, we at DEQ feel compelled to consider whether water quality is adequate for bull trout recovery in those streams that have been identified for bull trout protection. Idaho state code and regulations are not clear on this issue and in the UNFCRS we have chosen the option of trying to address water temperature issues specific to bull trout in response to the federal regulations. There are no bull trout in any of the 303(d) listed streams that are protected for bull trout. We did not have information about what bull trout life stages should exist in any given reach of these water bodies, but we still concluded that summer temperature is likely limiting to most bull trout life stages in these streams and that temperature TMDLs are needed. Even if the temperature standard supported by IDL for bull trout (presumably 12°C MWMT, as stated below) were enacted, most of these 303(d) listed streams still would exceed it.*

Unfortunately, this subbasin assessment doesn't recognize the inadequacies of the temperature standard for cutthroat trout. This subbasin assessment states, where temperature TMDL's are recommend on cutthroat trout streams, enough canopy cover should be maintained over the stream to provide a 9°C daily average through August 1st. If you look in the appendices, the amount of canopy cover that it recommends be maintained over the stream will not provide a 9°C daily average through August 1st. The target canopy cover amounts being recommended, according to the CWE model, will maintain a maximum summer temperature of 16°C or a MWMT of 15°C. These temperatures far exceed the 9°C daily average through August 1st, however, we believe this is a much more realistic temperature standard.

DEQ Response: *This was an error in our understanding of the conversion tables in the CWE manual. We have made the corrections using the original CWE equations.*

We also believe the federal bull trout temperature standard (10°C MWMT) is too low, especially since it is difficult to find streams in Idaho that will meet this standard. In fact, Trestle Creek (tributary of Pend Oreille lake), which arguably has one of the strongest bull trout populations in the world, does not even meet this standard. Recently, an independent expert in this field evaluated the federal bull trout standard and concluded after reviewing the pertinent literature that an appropriate maximum criterion for bull trout would be a 12°C MWMT (Adams 1999). What Adams means by appropriate is this is the temperature that bull trout appear to do the best in. This doesn't mean bull trout will not thrive in warmer temperatures as many strong populations do exist in warmer water temperatures.

DEQ Response: *See comment above.*

Another problem we have with the temperature TMDL's is they are not being applied where the actual beneficial use is occurring. For example, cutthroat trout tend to spawn

in small streams (1st, 2nd, and 3rd order streams), so it doesn't make sense that the spawning temperature standard is being applied to larger stream reaches where these fish are not spawning. Cutthroat trout do rear in larger stream reaches, so it would make sense that a preferred rearing temperature be maintained in these areas. However, the only rearing temperature standard that DEQ uses is the cold water biota standard, which is, the maximum water temperature shall not exceed 22°C. This standard is obviously inappropriate, as native salmonids (except white fish) will avoid this warm of temperature. Typically, as water temperatures exceed 16-18°C, salmonids will migrate to where cooler water temperatures occur. Obviously, an acceptable rearing temperature needs to be developed for salmonids.

DEQ Response: *Hopefully, this sort of information can be built into new water temperature standards for the state. We recognize that fish use different stream reaches for different life stages, but have not yet come up with a proposal that describes the scientific reality as needed in a state code and, at the same time, addresses the concerns of different interest groups.*

Finally, there is concern about the reliability of temperature data collected from only one sample location which, coincidentally, is one of the most open canopied segments of stream. This one sample site cannot, realistically, represent 37.6 miles of streams.

DEQ Response*: While this is true, one of the values of the CWE model is that it not only predicts the high temperatures in the lower reaches, but shows how temperatures change with elevation and canopy change in other parts of the watershed. In the end, assuming acceptance of the CWE model, the major question for most streams is not whether the continuous temperature recording site is representative of a water body, but whether the stream exhibits spatial temperature variation as predicted by CWE, or whether it has particular heat loading characteristics that should be addressed by other methods.*

Obviously, there are some serious issues that need to be addressed before temperature TMDL's portray what various fishes really require or prefer. What we recommend is, defer the development of temperature TMDL's until the DEQ and the EPA can work out more realistic standards. This is the same thing that is being recommended in other subbasin assessments. This does not mean we would ignore protecting water temperatures, as the Department would continue to apply the current CWE standards when managing riparian areas. We strongly believe these temperature standards will fully protect any fish populations in our management area. If one takes a close look at the data available, it would be hard to argue that the temperature standards used in the CWE table will not support strong/healthy fish populations.

DEQ Response: *We do not agree with the recommendation to defer temperature TMDLs, because it has in the past been an excuse for inaction on temperature problems, which we think are numerous. In the UNFCRS, we are taking a more active approach and trying to identify where temperature TMDLs make sense, in spite of the standards. Changes in the standards are going to require some in-depth analysis of the temperature problems as they occur across Idaho. Temperature TMDLs are one way of doing this*

analysis. Using the CWE model, temperature TMDLs are relatively easy to do, and will be just as easy to redo when more appropriate temperature standards are adopted. The TMDLs of the UNFCRS are showing in no uncertain terms that current standards are inappropriate for a whole subbasin, not just a few streams. In addition, using CWE gives some physical understanding to how stream temperatures are distributed across a landscape. This knowledge and understanding needs to be more widespread to build the necessary technical skill and political will to change the standards.

Brook Trout

For Tumble Creek, it is stated that a temperature TMDL is not needed because brook trout are the only salmonid of record. We have problems with this reasoning, especially if it is going to be used in other streams where sampling indicates only brook trout occur. Brook trout are not a native species and they have been found to out compete native cutthroat trout and bull trout. In fact, brook trout are considered as a pollutant in many bull trout problem assessments and recovery plans. In northern Idaho, streams that are occupied only by brook trout most likely historically supported native species such as cutthroat trout and bull trout. Research indicates that a decline in habitat conditions (warmer temperatures or more sediment) is often all it takes to give brook trout a competitive advantage over cutthroat trout or bull trout. The temperature standard for brook trout is, the daily average temperature must not exceed 9°C from October 1st to April 1st. Outside of this period a daily maximum of 22°C will be allowed. This type of standard will prevent cutthroat trout or bull trout from ever recolonizing streams where brook trout have taken over. This is in direct conflict with the State and Federal bull trout problem assessments or recovery plans.

DEQ Response: *We appreciate concerns about the state's water quality standards classifying brook trout in the same category as native salmonids. On the continuum of excellent to terrible water quality, brook trout as an indicator of beneficial uses being supported is on the low end of being acceptable. A line has to be drawn somewhere between indicators of acceptable and unacceptable water quality, and the presence of brook trout has been placed on the acceptable side of the line. People can and will argue whether the line is drawn appropriately, but that is the standard at this time. We note, however, that all the temperature standards for beneficial uses are under review by DEQ and USEPA. We have forwarded these comments with respect to brook trout to the appropriate authority for consideration.*

The issue of what the presence of brook trout means in relation to the existence of other salmonid species is outside the bounds of the Clean Water Act. How brook trout interact with bull trout is an issue for the Endangered Species Act, and the effects of brook trout in relation to cutthroat is a fisheries management issue. Tumble Creek is not identified as a bull trout recovery stream; otherwise, we would have assessed it against the bull trout temperature standard.

We especially hope this type of call will not be made where the only fish sampling that occurred was near the mouth of the stream or in limited areas. In many streams, brook

trout may be the only species that occur in the lower reaches while cutthroat trout or even bull trout could occur in the upper reaches.

DEQ Response*: As we noted in a comment to the Nez Perce Tribe above, the fish sample for Tumble Creek included the whole creek because it was done as part of the CNF's bio-physical study of the stream.*

What we recommend is, on streams that support only brook trout and don't have barriers that would prevent native species from recolonizing it, than standards that would support the native species of concern be applied. Based on the reasoning provided in Tumble Creek, for landowners who want fewer restrictions, it would be more advantageous for them to encourage the invasion of brook trout.

DEQ Response: *While this reasoning may be true and the recommendation could be useful, the state water quality standards do not discriminate between species.*

Sediment Issues

We approve of using the CWE process to evaluate roads and sediment delivery to streams. The Department of Lands plans on using CWE road data and other pertinent information if needed and available to determine where and why problems occur. This same data can be used to determine how to reduce the current sediment load a well as how to prevent it from occurring in the future.

It was determined in this subbasin assessment that Deception Gulch does not protect its beneficial uses because of sediment, and a sediment TMDL was developed. To reduce the sediment loading into Deception Gulch, it was recommended that the Clearwater National Forest obliterate all of the roads on high hazard landtypes. Obliterating roads is not the only technique that can be used to reduce mass failures and sediment delivery to streams, and should not be the only alternative to reduce sediment delivery. What we suggest is, recommend how much sediment delivery has to be reduced by, and then suggest different alternatives that may be effective in reducing mass failures or surface erosion. It should be up to the landowner to determine what techniques to pursue to reduce the sediment delivery. It should not matter how sediment delivery is reduced just as long as it is reduced.

DEQ Response: *This statement by IDL is correct. The primary reason we moved beyond simply determining by how much sediment must be reduced to recommendations about how to do it is because the CNF had already indicated that this would be their approach. In other cases, we would not be so bold as to determine what a land manager must do to attain the desired sediment reduction.*

Typically, focusing restoration efforts on hazardous landtypes as recommended in Deception Gulch, will give a landowner the biggest bang for the buck as far as reducing sediment delivery goes. However, on table 5.1 it shows that those watersheds that have the highest percentage of roads on high-risk landtypes had some of the lowest number

and density of failures. You may want to revisit how to determine these high-risk landtypes, as at first glance they seem to predict the opposite of what you'd expect. This discrepancy could be explained if the watersheds with the most high-risk landtypes have the newest road on them. This should be investigated further before relying on these hazard ratings.

***DEQ Response*:** *The noted discrepancy in Table 5.1 is as postulated. Those watersheds with a high percentage of high risk landtypes and low density of failures are those watersheds like Cougar and Grizzly which were roaded for logging in the 1980s after the CNF had learned to engineer for the problem; therefore, the roads are much more stable.*

Many of the sediment delivery values (back ground, current and acceptable amounts) are developed by models, which are not necessarily accurate. As a result, we should not lose track that the reason we develop TMDL's is to insure that beneficial uses are protected. Regardless of what our models say we need to always verify that our streams are responding. Often it may take considerably less or more than models indicate to restore and protect beneficial uses.

DEQ Response: *This comment is true. The TMDL process requires the development of implementation plans to meet the loading reductions. The results of the implementation plans are to be monitored with the goals of insuring that streams are responding and beneficial uses are being returned.*

We are not comfortable using the WATBAL model to predict sediment delivery rates as in some research on it has proved unreliable (contact Douglass Fitting for more information).

DEQ Response: *As we noted in above to a similar comment from the Nez Perce Tribe, we have not used the WATBAL model in any of the critical calculations or determinations for this problem assessment and TMDL (see comment above for more detail).*

Miscellaneous

On page 22 it is mentioned that some evidence suggests that canopy removal will result in lower flows in the latter part of the year, which could possibly alter stream temperature. This statement is misleading as the vast majority of the data indicates that canopy removal will result in increased low flows. The most notable case where timber harvest decreases summer low flows is on the coast where most of the summer precipitation comes from fog drip off of trees. This is not an issue in northern Idaho.

On page 35 it is stated that China Creek is not listed by either the Federal or the State Bull Trout Problem Assessment as a stream to protect for bull trout. China Creek is a tributary of Moose Creek and according to the State Bull Trout Problem Assessment, Moose Creek has a high importance to bull trout. As far as we are aware, China Creek has not been surveyed for bull trout, but because of its close proximity to known bull trout streams it should be managed as if bull trout occur there.

The Rosgen channel types are incorrect for Hem Creek, Laundry Creek, Sylvan Creek, Tamarack Creek, and Tumble Creek. Based on Rosgen's Classification Scheme, an "AA" channel Is > 10% in grade, an "A" channel is 4-10% in grade, a "B" channel is 2-4% in grade and a "C" channel is <2% in grade.

DEQ Response: *It is unclear from the comment where in the text this error occurs. However, both the DEQ BURP data and the CNF bio-physical data are generated by field crew observations. BURP crews, for example, use a modified Rosgen channel classification to record their field observations. The Rosgen classification includes other descriptive parameters for each reach channel type, and the field crews rely on a broad range of characteristics to decide on a channel type. It is not surprising that some of the observed slopes for the channel types fall outside the slope ranges given in the theoretical classification.*

For the purposes of this report, we assume that the channel types as identified by the field crews are correct. Since the channel type is presented as background and setting information, but does not figure in any of the status calls or calculations, we have not returned to the field to ensure that all the channel type calls at all locations in the report are correct.

On page 64 it is indicated that stream widening, which can increase solar input in temperature, is usually caused by the deterioration and/or removal of streamside vegetation. It should be pointed out that stream widening can be caused by agradation, which is often a response to increase sediment delivery.

DEQ Response: *Added to text of report.*

It would be nice to have the 303(d) listed stream names on the maps provided in the appendices. As is, we had to pull out the U.S. Forest Service maps to determine which streams occur where.

Mr. Curry Jones, Environmental Protection Specialist, USEPA, Region 10

Comments on the Upper North Fork Clearwater River Subbasin and TMDL

Water Quality Data Summary and Conclusions

General Comments

1. Section 6.0 proposes to delist eighteen (18) 303(d) listed waters for sediment. These waters should remain 303(d) listed for the following reasons:

The public notice developed for the Upper North Fork Clearwater TMDL did not inform the public that a delisting proposal was also included within the TMDL. The delisting proposal should go under a separate letterhead allowing the public to also comment on the delisting proposal as well.

DEQ Response: *The Subbasin Assessment and TMDL will continue to recommend the delisting for sediment of these water bodies as a conclusion of the examination and analysis of the data presented. Although DEQ believes the subbasin assessment/TMDL notice for the Upper North Fork Clearwater to have been sufficient, we will likely make a formal public notice pulling together proposed delistings from several subbasin assessments before submittal to USEPA for consideration.*

Because the new Water Body Assessment Methodology (WBAM) should address concerns raised by EPA in a May 6, 1999, letter from Randy Smith to Stephen Allred on the 1996 Water Body Assessment Guidance. EPA suggests that the Idaho Department of Environmental Quality (DEQ) postpone delisting these waters identified in Table 6.1 to allow the new WBAM to be used to determine if the beneficial use is actually impaired.

DEQ Response: *It is the state's position that proposals to delist should continue apace with the development of the subbasin assessments and TMDLs. The subbasin assessments as they are currently being conducted meet the requirements of the CWA and Idaho code.*

In the case of the water bodies of the UNFCRS, deferring delisting based on a potential beneficial use impairment decision would not help resolve the major pollution issues. The subbasin assessment has concluded that temperature and not sediment is the primary pollutant causing impairment. Temperature TMDLs have been written for all except two of the listed water bodies. One of these two, Hem Creek, is in near pristine condition. The other, Tumble Creek, currently supports brook trout in numbers that will likely meet the new WBAM requirements.

Based on these reasons stated above, the following changes in the subbasin assessment are suggested.

DEQ Response: *Based on the state's reasoning above, we do not respond to the specific comments on Sections 6.1 through 6.18. We believe the assessments in Section 6 are*

appropriate as presented. We believe that for all the water bodies of the UNFCRS, except Deception Gulch, water quality is not truly impaired due to excess sedimentation. We believe we have presented adequate documentation to support this position.

Specific Comments

1. *Page 35, Section 6.1, Forth Paragraph*, Move Fourth Paragraph on Page 35 to Page 36, First Paragraph, Include suggested rewording, "Because it is not clear whether or not China Creek is truly impaired due to excess sedimentation, a TMDL will not be developed at this time. China Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment."

2. *Page 36, Section 6.2, Fifth Paragraph*, Move Fifth Paragraph on Page 36 to Page 37, Third Paragraph, Include suggested rewording, "Because it is not clear whether or not Cold Springs Creek is truly impaired due to excess sedimentation, a TMDL will not be developed at this time. Cold Springs Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment."

3. *Page 37, Section 6.3, Second Paragraph*, Move Second Paragraph on Page 38 Sixth Paragraph, Include suggested rewording, " Because it is not clear whether or not Cool Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Cool Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment."

4. *Page 39, Section 6.4, Third Paragraph*, Move Third Paragraph on Page 39 to Page 40 First Paragraph, Include suggested rewording, "Because it is not clear whether or not Cougar Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Cougar Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment."

5. *Page 41, Section 6.6, Second Paragraph*, Move Second Paragraph on Page 42 to Sixth Paragraph, Include suggested rewording, "Because it is not clear whether or not Gravey Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Gravey Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment."

6. *Page 43, Section 6.7, Third Paragraph*, Move Third Paragraph on Page 43 to last Paragraph on Page 43, Include suggested rewording, "Because it is not clear whether or not Grizzly Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Grizzly Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment. "

7. *Page 44, Section 6.8, Fifth Paragraph*, Move Fifth Paragraph on Page 44 to Last Paragraph on Page 45, Include suggested rewording, "Because it is not clear whether or not Hem Creek is truly impaired due to excess sedimentation, a TMDL will not be

develop at this time. Hem Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment."

8.*Page 45, Section 6.9, First Paragraph*, Move First Paragraph on Page 46 to Fifth Paragraph on Page 46, Include suggested rewording, "Because it is not clear whether or not Laundry Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Laundry Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment."

9. *Page 47, Section 6.10, Fifth Paragraph*, Move Fifth Paragraph on Page 46 to Fifth Paragraph on Page 46, Include suggested rewording, "Because it is not clear whether or not Laundry Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Laundry Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment. "

10. *Page 48, Section 6.11, Fifth Paragraph*, Move Fifth Paragraph on Page 48 to Second Paragraph on Page 49, Include suggested rewording, "Because it is not clear whether or not Middle Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Middle Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment. "

11. *Page 50, Section 6.12, Fifth Paragraph*, Move Fifth Paragraph on Page 50 to the Last Paragraph on Page 51, Include suggested rewording, "Because it is not clear whether or not upper Orogrande Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Upper Orogrande Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment."

12. *Page 53, Section 6.13, Fifth Paragraph*, Include suggested rewording in this paragraph, "Because it is not clear whether or not Lower Orogrande Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Lower Orogrande Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment. "

13. *Page 54, Section 6.14, Fifth Paragraph*, Move Fifth Paragraph on Page 54 to the third paragraph on Page 53, Include suggested rewording, "Because it is not clear whether or not Osier Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Osier Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment. "

14. *Page 56, Section 6.15, Fourth Paragraph*, Move Fouth Paragraph on Page 56 to the second paragraph on Page 57, Include suggested rewording, "Because it is not clear whether or not Sugar Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Sugar Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment. "

15. *Page 58, Section 6.16, Second Paragraph*, Move Second Paragraph on Page 58 to Fifth paragraph, Include suggested rewording, "Because it is not clear whether or not Swamp Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Swamp Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment. "

16. *Page 59, Section 6.17, Second Paragraph*, Move Second Paragraph on Page 59 to sixth paragraph, Include suggested rewording, "Because it is not clear whether or not Sylvan Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Slyvan Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment. "

17. *Page 60, Section 6.18, Third Paragraph*, Move Third Paragraph on Page 60 to the Last Paragraph on Page 60, Include suggested rewording, "Because it is not clear whether or not Tamarack Creek is truly impaired due to excess sedimentation, a TMDL will not be develop at this time. Tamarack Creek will be re-evaluated using the new Water Body Assessment Methodology to determine if the waterbody is impaired due to sediment. "

DEQ Response: *Based on the state's reasoning above, we do not respond to the specific comments on Sections 6.1 through 6.18. We believe the assessments in Section 6 are appropriate as presented. We believe that for all the water bodies of the UNFCRS, except Deception Gulch, water quality is not truly impaired due to excess sedimentation. We believe we have presented adequate documentation to support this position.*

Temperature TMDL

Page 64, Section 7.1.1 and Section 7.1.3 (Second Paragraph). The Temperature TMDL identifies the loading capacity as 10 C Maximum Weekly Maximum Temperature (MWMT). The TMDL then indicates that load reductions were developed and distributed appropriately throughout the watershed. What is the thermal loading being reduced and allocated. The TMDL should identify some form of a thermal loading such as BTU/ft^2/day or Langleys/day or percentage reduction in stream temperature necessary to 10 C MWMT. Although these thermal loading measures may be of limited use to land management agencies, these loading measures do provide the basis for linking the shade targets to a thermal load reduction required to meet the prescribed loading capacity and water quality standard for temperature.

DEQ Response: *We question the need for the linkage USEPA requests by noting that an increase in shade translates directly to a decrease in the manageable portion of the heat load and a corresponding decrease in water temperature. This is well documented in models such as SSTEMP. Nonetheless we have restructured all of Section 7 to show the linkages being requested. For different shading reduction targets, we identify the associated thermal loading reduction in terms of watts per square meter. We hope having done this once, it need not be repeated in other TMDLs which follow this same approach.*

Page 65, Section 7.1.3, Paragraph 4, First Sentence, The temperature TMDL indicates that heat load reductions are defined in terms temperature exceedences and heat capacity temperatures for each waterbody. Based on this, what temperature exceedence is the TMDL trying to control for? This can be determined by developing frequency distribution plot of the MWMT for each subwatershed (all years combined or seperate out years). The critical temperature you would then be controlling for is the lethal temperature that occurs most frequently. Based on this, then you can develop your temperature reduction targets needed to meet the 10 C.

DEQ Response: *The temperature exceedance that the TMDL is trying to control is shown in the plots for each water body presented in Appendix 3. We have identified the time period of late July through early August as the critical time period for which we are controlling temperatures. We are not controlling for lethal temperatures – we are controlling for the temperatures defined in the state standards. We develop our temperature reduction targets based on stream shading as the surrogate target, with percent shading at a given elevation being the target.*

Page 67, Section 7.1.5, Paragraph 2, The section indicates that loading capacities for the three impaired streams were developed using the Cumulative Watershed Effects relationship. 1. How were the loading capacities developed using CWE when the loading capacities are already identified in Section 7.1.1?

DEQ Response: *This section has been rewritten and now addresses this comment.*

In using other appropriate measures or TMDL surrogates (as provided for in 40 CFR 130.2(I)), the linkage back to the attainment of water quality standards is critical. The temperature TMDL for the Upper North Fork Clearwater River subbasin does not provide a clear linkage back to attainment of water quality standards. The following elements are critical when using TMDL surrogates:

The temperature TMDL should then identify temperature and/or thermal (i.e., thermal units - *j/m^2/sec or btu/ft^2/day*) reduction targets needed to attain water quality standards. This reduction in stream temperature and/or thermal loading provides the basis for the linkage to the shade targets identified in Appendix 4 of the Upper North Fork Clearwater River TMDL (Table 1).

Table 1 - Example Temperature Allocation / Load Reductions

Heat Loading Capacity (equivalent to water quality standard)	Current Heat Loading	Required Heat Loading Reductions	CWE Shade Targets Needed to Meet Heat Loading (Mean Shade by Stream Reach)
450 BTU/ft^2/day	675 BTU/ft^2/day	50% Reduction	80% Shade (Amount of Shade Needed to meet the Heat Loading Capacity

DEQ Response: *We have now included the kinds of relations you note. The newly rewritten parts of Section 7 clearly link heat loading to the surrogate targets. We continue to present load reductions in terms of the surrogate target, percent shade, because it is the only measure that makes sense for implementation. The relations between percent shade and insolation heat load are presented in Sections 7.1.1, 7.1.2, and 7.1.3 such that they may be easily calculated by anyone who needs them. The CWE shade and elevation versus water temperature regression provides a quantified linkage between shade and water temperature.*

Concerns with Cumulative Watershed Effects (CWE) Model as the only Tool in the Temperature TMDL

As stated in the October 30, 2000, comment letter on the Upper North Fork Clearwater River Subbasin Assessment, EPA has some concerns regarding the use of the Cumulative Watershed Effects (CWE) process in the development of the temperature TMDL for the Upper North Fork Clearwater River subbasin. EPA understands that DEQ has contracted with Western Watershed Analyst to complete a comparison study between the Stream Segment Temperature Model (SSTEMP) and CWE to determine if both yield similar results. If the results from Western Watershed Analyst show that the modeling results between CWE and SSTEMP are similar, the TMDL should take the next step to integrate a thermal loading component, as displayed in Table 1 above.

DEQ Response: *We have done as you requested. The Western Watershed Analysts results are included as an appendix to the document. Although we have done as requested, we believe we have gone beyond what is required, and note that the exercise will add little if any utility to the TMDL nor change its implementation.*

Sediment TMDL

Page 62, Paragraph 3, The TMDL sets a goal of 225% over background sediment load (= 430 tons/year) as the level beyond which sediment loading would be considered excessive. Based on this goal, Deception Creek, as defined by the Clearwater National Forest, would only be protected and expected to meet a *Low Fishable* goal. Under this *Low Fishable* goal, Deception Creek would only be expected "to maintain habitat potential that supports a minimal harvestable surplus of fish." The designated beneficial use which is to be protected is salmonid spawning. Currently the Idaho WQS do not sub-categorize the salmonid spawning use. Therefore it is not appropriate to establish a "low fishable" goal for salmonid spawning for this particular waterbody. By taking an approach, which interprets the salmonid spawning use for this waterbody to be "low fishable" you are effectively establishing a sub-category of the salmonid spawning use. This is inconsistent with the current WQS in Idaho. Idaho could establish sub-categories for the salmonid spawning beneficial use, but this would require a formal revision to their water quality standards. Again, this does not currently exist in Idaho's WQS. EPA believes that refining beneficial uses by establishing sub-categories is by far a much

better and accurate approach than an approach which would try to define uses more broadly so that they fit all waters.

***DEQ Response**: We are merely making an interpretation of our water quality standards. We are not establishing a new use. We are establishing that the CNF "low fishable" goal meets or exceeds full support of salmonid spawning as codified in Idaho administrative rules. To further understand our response here, please review our response above to the CNF's comment about our use of their "low fishable" goal.*

There is some confusion between CNF data and goals, and our use of their data in establishing the narrative standard for sediment in Deception Gulch to meet Idaho's water quality standards. Salmonid spawning is the beneficial use that must be supported under Idaho's water quality standards. The CNF's data were analyzed to determine what level of sediment could be tolerated and still support salmonid spawning. We did not intend to establish a sediment target that approaches pristine conditions because we believe there is a level of sediment over background that meets the state's water quality standards and the intent of the CWA.

The CNF's "low fishable" goal is not being considered as a subcategory of salmonid spawning. What we're essentially looking at is a continuum of sediment that could be added to Deception Gulch, and deciding at what level salmonid spawning would no longer be supported; what loading still meets water quality standards? The CNF, based on their data, has determined that a viable population of fish would be supported at 450% sediment loading over background, and that with 225% sediment loading over background, that fish population would also support low fishing pressure. By selecting 225% over background as our TMDL target, we are not creating a subcategory of salmonid spawning that equates to low fishable. We are in fact establishing a 100% margin of safety over the CNF's conclusions that 450% sediment loading over background would support a viable population. It is coincidence that the CNF's low fishable category corresponds to what we determined is needed as a margin of safety.

Because the goal of water quality standards is to set a level of protection necessary to prevent degradation of an existing use, this TMDL should identify a background sedimentation rate which would prevent further degradation of the existing use. How was the level of fishability determined for streams in the Upper North Fork Clearwater River?

***DEQ Response:** Using the WBAG plus process, we determined that salmonid spawning was not being fully supported in Deception Gulch, and the existing use is less than the target being set for this water body. For the other water bodies being assessed, the existing use equates to the salmonids present. Fishability is not an existing use under Idaho water quality standards. In fact, however, if fishability were an existing use, the UNFCRS has stable or improving populations of fish. Given the CNF's active program of road obliteration and their full implementation of INFISH, one could not argue that any degradation of existing use is occurring as a function of sediment.*

Appendix 15. Response to USEPA Recommendations for Revisions

Appendix 15. Response to USEPA Recommendations for Revisions

October 2003

Mr. David Mabe, State Water Quality Programs Administrator for DEQ submitted the *Upper North Fork Clearwater Subbasin Assessment and Total Maximum Daily Loads* to USEPA for approval on March 26, 2001. On December 10, 2001, DEQ received a letter dated December 6, 2001, from Mr. William Stewart, Region 10, USEPA, recommending further revisions. The letter and DEQ's responses follow:

USEPA Letter

December 6, 2001

Dear Tom:

This is in regard to our telephone conversation on December 4, 2001 concerning the *Upper North Fork of the Clearwater River Subbasin Assessment and TMDL*. This is to clarify my understanding of our conversation and to identify changes that we are recommending for the document.

After careful evaluation of the Cumulative Watershed Effects (CWE) method, it is our conclusion that results generated by the CWE nomographs do not provide an accurate or precise means to predict stream temperature response. We concluded that using CWE results as TMDL shade targets may result in a prediction that underestimates the level of shade needed. This is because CWE, like many models, is not a precise or accurate tool for predicting stream temperature response. The data on which it relies to calculate predictions of shade is very limited and the assumptions of the approach only address two of the many variables that affect stream temperature.

In the Upper North Fork of the Clearwater River TMDL, the IDEQ has used CWE to predict how much shade is sufficient at any given elevation to meet the state's water quality standards and uses these results as TMDL targets. While we recognize that CWE can be a useful screening tool to help land managers, we are concerned about the accuracy in predicting stream temperature response. EPA and DEQ have agreed to adopt sideboards to shore up the limitations in the method. The following changes are recommended for the Upper North Fork of the Clearwater River TMDL targets.

In Appendix 4 through Appendix 11 of the document, the column titled TARGET CANOPY (%) should be modified to reflect the following:

- If the existing canopy (%) is less that what CWE predicts is necessary to achieve the state's water quality standards, it is acceptable to use CWE results as the interim TMDL target and no change is necessary in the target.

- If the existing canopy (%) is greater than what CWE predicts is necessary to achieve the state's water quality standards, the TMDL target canopy (%) should be set at the existing canopy (%). This will ensure that CWE derived predictions will not result in a reduction of shade below current levels in impaired water bodies.

These changes reflect an agreement reached between Regional EPA management and Dave Mabe in a meeting held on October 10, 2001.

In the subbasin assessment under "*7.2.2 Excess Sediment Load*," there is a discussion concerning the Clearwater Nation Forest Plan (USFS 1987). Paragraph one states, "According to the CNF Forest Plan (USFS 1987), the water quality objective for this watershed is 255 percent over background (about 430 tons per year loading), which is described as "Low Fishable." Amendment No. 26 of the Clearwater National Forest Plan updates the water quality objectives in Appendix K of the CNF Forest Plan for Deception Gulch and other streams in the watershed. Deception Gulch is now listed by the USFS as a Moderate Fishable stream which would indicate a target of 150 percent increase of sediment over natural yields for no more than 10 out of 30 years. Please find a copy of Appendix B of *Forest Plan Amendment No. 26* attached.

One method to set targets for the Deception Gulch sediment TMDL would be to use sediment data from similar streams in the Clearwater River watershed which are fully meeting their beneficial uses as reference conditions. I believe this would help in the development of defensible targets for this TMDL. A table comparing natural background, percent over natural loading, modeling results, mass failures, etc. for reference streams and Deception Gulch would go a long way in explaining and supporting the targets.

Please feel free to give me a call at (208) 378-5753 if you want to discuss this matter further.

Sincerely,

William C. Stewart

cc: Marti Bridges
Christine Psyk

DEQ Response:

Appendix 4 through Appendix 11 have been changed as recommended. The temperature TMDLs in this document show the targets calculated using the method recommended by USEPA.

The sediment TMDL for Deception Gulch has been substantially revised to clarify the choice of target. As recommended, Table 16 has been added showing comparisons of numerous data types between Deception Gulch and a suite of reference watersheds with similar geology, landforms, and stream characteristics, one of which is unroaded. A discussion of the reference data has been added, showing its relation to the selected targets. Additional data from the Clearwater National Forest (CNF) have been added, showing that Deception Gulch supports a healthy population of salmonids, including juveniles.

In addition, the CNF has provided the data contained in the following table identifying roads that have been treated in Deception Gulch and the surrounding area. As pointed out by the CNF, "[i]t is difficult to separate out what is Deception Gulch alone. Some of the road oblit is in face drainages and in Comet Creek." However, if one simply looks at work done in fiscal year 2002 when all work was in Deception Gulch, 15 miles of roads were treated, which is about 75% of the recommended number of miles of roads to be treated by the TMDL. It is safe to assume that the majority, if not most, of the roads treated were on high risk landtypes, since the TMDL had identified that as a problem. A similar number of miles of roads were scheduled to be treated in fiscal year 2003, but funding was lost at the last minute. The CNF has a plan in place to meet the targets of the TMDL. It is reasonable to expect that the CNF will exceed the targets set by the TMDL once funding is acquired to finish the plan.

Table 15-1. Road obliteration in Deception Gulch and the surrounding area.

Roads	FY[1]	Road Number	Watershed	Oblit-erated	Aban-doned	LTIU[2]	Expend-iture	Comments[3]
				(mi)	(mi)	(mi)	$	
Deception and Comet	**99**		**Deception and Upper North Fork**					
		729	Comet Creek	0.7		1.1		1st 4.4 miles on system - mtc level 3
		729A	North Fork	1.6		2.3		LTIU paid for by NFIF
		74568	Comet Creek	1.4				
		74572	North Fork	1.0				
		74573	North Fork	1.4				
		74574	North Fork	0.5				
		74575	North Fork	1.1				
		74576	North Fork	0.3				
		729-T1	North Fork	0.3				
		729-T3	North Fork	0.6				
		729-T4	North Fork	0.9				
		729-T7D	Comet Creek	0.7				
		729A-T1/T4	North Fork	0.6				
		729A-T5	North Fork		0.7			
		729A-T6	North Fork		0.5			
		729A-T7	North Fork		0.5			
		729A-T8	North Fork		0.8			

Roads	FY[1]	Road Number	Watershed	Oblit-erated	Aban-doned	LTIU[2]	Expend-iture	Comments[3]
				(mi)	(mi)	(mi)	$	
		729A-T9	North Fork		0.9			
		729A-T10	North Fork		0.8			
		729A-T11	North Fork		0.1			
		729A-T12	North Fork		0.6			
Deception and Comet Totals				**11.1**	**4.9**	**3.4**		
730 Road and spurs	**01**		**Deception and Upper North Fork**				**25,000**	**$6,378**
		730		5.4		5.0		Approximately 7 miles to have ATV trail constructed
		730A		0.6				
		730B			0.5	0.2		
		730C				0.5		
		730E			0.5			
		732		1.2				
		5444				0.2		
		74554		0.4		0.4		
		74567		0.5		0.8		
		74569		1.0				

Roads	FY[1]	Road Number	Watershed	Oblit-erated	Aban-doned	LTIU[2]	Expend-iture	Comments[3]
				(mi)	(mi)	(mi)	$	
		830054		0.2				
		830059		0.9				
		830071			0.3			
		830311			0.8			
		830312			0.2			
		830313			0.2			
		830319			0.2			
		830320		0.1				
		830321		0.1				
		830323		0.8				
		830385			0.3			
		830403			0.1			
		830405			0.1			
		830415			0.3			
		830416			0.1			
		830417		0.1				
		830422			0.1			
		830425			0.1			
		830426			0.2			
		830476		0.6				

Roads	FY[1]	Road Number	Watershed	Oblit-erated	Aban-doned	LTIU[2]	Expend-iture	Comments[3]
				(mi)	(mi)	(mi)	$	
		830500			0.3			
		730-T101			0.1			
		74554-T1				0.4		
		74554-T1A			0.1			
		74554-T2				0.2		
		830311-T1			0.3			
730 Road and spurs Totals				**11.9**	**4.65**	**7.7**		
Road 729 and spurs	**01**		**North Fork Face Drainages**				**25,000**	
		729B		1.8		0.1		
		74571		0.7				First 0.8 and last 0.2 miles to be ATV trails
		74571				0.5		
		830072		0.7				
		830073			0.4			
		830399			0.2			Left open to ATV use
		830400			0.2			
		830401			0.1			
		830402			0.1			

Roads	FY[1]	Road Number	Watershed	Oblit-erated	Aban-doned	LTIU[2]	Expend-iture	Comments[3]
				(mi)	(mi)	(mi)	$	
		830404			0.3			
		830427			0.1			
Road 729 and spurs Totals				**3.2**	**1.4**	**0.6**		
Deception Gulch 02	**02**		**Deception Gulch**				**Equipment costs only**	
		734A		1.0		0.8	4,945	LTIS segment was abandoned
		74557		0.1			495	
		830063		1.3			6,429	
		830063/T1			0.1			
		830066		1.3			6,429	
		830067		0.7			3,462	
		5442				0.7		LTIS segment was abandoned
		830062		1.1			5,440	
		830062/T1			0.4			Abandoned
		830309			0.4			Abandoned
		830067/T1			0.1			Abandoned
		830067/T2			0.1			Abandoned
		830067/T3			0.1			Abandoned

Roads	FY[1]	Road Number	Watershed	Oblit-erated	Aban-doned	LTIU[2]	Expend-iture	Comments[3]
				(mi)	(mi)	(mi)	$	
		830067/T4			0.1			Abandoned
		830067/T5			0.1			Abandoned
		830067/T6			0.1			Abandoned
		830067/T7			0.1			Abandoned
		830067/T8			0.1			Abandoned
		830067/T9			0.1			Abandoned
		830067/T10			0.1			Abandoned
		830067/T11			0.1			Abandoned
		830067/T12			0.1			Abandoned
		830067/T13			0.1			Abandoned
		830067/T14			0.1			Abandoned
		830067/T15			0.1			Abandoned
		830065		1.3			6,429	Big draws/wide road
		830288		0.2			989	Big draws/wide road
		830069		0.2			989	Big draw/strong outslope
		830068			0.5			Abandoned
		830239		0.2			989	
		830289			0.2			Abandoned
		830064		1.0			4,945	Big draws/wide road
		830476		1.4			6,923	Big draws/wide road

Roads	FY[1]	Road Number	Watershed	Oblit-erated	Aban-doned	LTIU[2]	Expend-iture	Comments[3]
				(mi)	(mi)	(mi)	$	
		830306		0.6			2,967	Big draws/wide road
		5445				0.6	2,967	One third abandoned; two thirds 10% outslope
		830060		0.3			1,484	Seeps
Deception Gulch 02 Totals				**10.7**	**3.1**	**2.1**	**55,882**	

[1] FY = fiscal year
[2] LTIU = long term intermittent use
[3] **Comments** are as received from the CNF and may not be fully meaningful in this document