# Lower Salmon River and Hells Canyon Tributaries Assessments and TMDLs



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# Acknowledgments

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# Abbreviations, Acronyms, and Symbols

| | |
|---|---|
| **§303(d)** | Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section |
| **µ** | micro, one-one thousandth |
| **§** | Section (usually a section of federal or state rules or statutes) |
| **ADB** | assessment database |
| **AU** | assessment unit |
| **AWS** | agricultural water supply |
| **BAG** | Basin Advisory Group |
| **BLM** | United States Bureau of Land Management |
| **BMP** | best management practice |
| **BOD** | biochemical oxygen demand |
| **BOR** | United States Bureau of Reclamation |
| **Btu** | British thermal unit |
| **BURP** | Beneficial Use Reconnaissance Program |
| **C** | Celsius |
| **CFR** | Code of Federal Regulations (refers to citations in the federal administrative rules) |
| **cfs** | cubic feet per second |
| **cm** | centimeters |
| **CWA** | Clean Water Act |
| **CWAL** | cold water aquatic life |
| **CWE** | cumulative watershed effects |
| **DEQ** | Department of Environmental Quality |
| **DO** | dissolved oxygen |
| **DOI** | U.S. Department of the Interior |
| **DWS** | domestic water supply |
| **EMAP** | Environmental Monitoring and Assessment Program |
| **EPA** | United States Environmental Protection Agency |
| **ESA** | Endangered Species Act |
| **F** | Fahrenheit |
| **FPA** | Idaho Forest Practices Act |
| **FWS** | U.S. Fish and Wildlife Service |
| **GIS** | Geographical Information Systems |
| **HUC** | Hydrologic Unit Code |
| **I.C.** | Idaho Code |
| **IDAPA** | Refers to citations of Idaho administrative rules |
| **IASCD** | Idaho Association of Soil Conservation Districts |

**IDFG** Idaho Department of Fish and Game

**IDL** Idaho Department of Lands

**IDWR** Idaho Department of Water Resources

**INFISH** the federal Inland Native Fish Strategy

**IRIS** Integrated Risk Information System

**km** kilometer

**$km^2$** square kilometer

**LA** load allocation

**LC** load capacity

**m** meter

**$m^3$** cubic meter

**mi** mile

**$mi^2$** square miles

**MBI** Macroinvertebrate Biotic Index

**MGD** million gallons per day

**mg/L** milligrams per liter

**mm** millimeter

**MOS** margin of safety

**MRCL** multiresolution land cover

**MWMT** maximum weekly maximum temperature

**n.a.** not applicable

**NA** not assessed

**NB** natural background

**nd** no data (data not available)

**NFS** not fully supporting

**NPDES** National Pollutant Discharge Elimination System

**NRCS** Natural Resources Conservation Service

**NTU** nephelometric turbidity unit

**ORV** off-road vehicle

**ORW** Outstanding Resource Water

**PACFISH** the federal Pacific Anadromous Fish Strategy

**PCR** primary contact recreation

**PFC** proper functioning condition

**ppm** part(s) per million

**QA** quality assurance

**QC** quality control

**RBP** rapid bioassessment protocol

**RDI** DEQ's River Diatom Index

**RFI** DEQ's River Fish Index

**RHCA** riparian habitat conservation area

**RMI** DEQ's River Macroinvertebrate Index

**RPI** DEQ's River Physiochemical Index

**SBA** subbasin assessment

**SCR** secondary contact recreation

**SFI** DEQ's Stream Fish Index

**SHI** DEQ's Stream Habitat Index

**SMI** DEQ's Stream Macroinvertebrate Index

**SRP** soluble reactive phosphorus

**SS** salmonid spawning

**SSOC** stream segment of concern

**STATSGO** State Soil Geographic Database

**TDG** total dissolved gas

**TDS** total dissolved solids

**T&E** threatened and/or endangered species

**TIN** total inorganic nitrogen

**TKN** total Kjeldahl nitrogen

**TMDL** total maximum daily load

**TP** total phosphorus

**TS** total solids

**TSS** total suspended solids

**t/y** tons per year

**U.S.** United States

**U.S.C.** United States Code

**USDA** United States Department of Agriculture

**USDI** United States Department of the Interior

**USFS** United States Forest Service

**USGS** United States Geological Survey

**WAG** Watershed Advisory Group

**WBAG** *Water Body Assessment Guidance*

**WBID** water body identification number

**WET** whole effluence toxicity

**WLA** wasteload allocation

**WQLS** water quality limited segment

**WQMP** water quality management plan

**WQRP** water quality restoration plan

**WQS** water quality standard

# Executive Summary

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

This document addresses the water bodies in the Lower Salmon River and Hells Canyon (Snake River) Subbasins that have been placed on Idaho's current §303(d) list.

This subbasin assessment (SBA) and TMDL analysis have been developed to comply with Idaho's TMDL schedule. The assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Lower Salmon River and Hells Canyon (Snake River) Subbasins, located in central Idaho.

## Subbasins at a Glance

The Lower Salmon River Subbasin, identified in Idaho WQS with Hydrologic Unit Code (HUC) 17060209, is comprised of 65 water bodies, located in west central Idaho, and includes the Salmon River from its mouth to French Creek. The subbasin encompasses approximately 794,000 acres, draining into the Snake River at river mile 188.2. Private lands comprise the majority of the subbasin, followed by the United States Forest Service (USFS), Bureau of Land Management (BLM), Idaho Department of Fish and Game (IDFG), and Idaho Department of Lands (IDL).

Elevations within the subbasin range from approximately 900 feet at the mouth to over 8,000 feet. The Salmon River flows through a canyon that ranges from 2,000 to more than 5,000 feet deep. Upland areas of the subbasin may include steep and rugged mountains or plateaus with rolling and moderate slopes. Lower elevation areas are dominated with grassland habitats, while breaklands may have patterned grassland and timbered sites. The moderately sloped plateau areas may be cultivated, pasturelands, or forested areas. Higher elevation areas are forested.

The subbasin provides habitat for listed spring/summer chinook salmon, sockeye salmon, fall chinook salmon, steelhead trout, and bull trout. Other species found in the subbasin include westslope cutthroat trout, rainbow/redband trout, Pacific lamprey, white sturgeon, brook trout, mountain whitefish, smallmouth bass, bridgelip sucker, large-scale sucker, speckled dace, sculpins, redside shiners, and pike minnow (BLM 2008).

Nine water bodies in the Lower Salmon River subbasin are addressed in this document and they include: Billy Creek, Cottonwood Creek, Allison Creek, Rice Creek, Rock

Creek, Graves Creek, John's Creek, Deep Creek, and Deer Creek. A characterization of each sub-watershed is included in Section 1.2.

The Hells Canyon (Snake River) Subbasin is identified in Idaho WQS as HUC 17060101, and is comprised of 28 water bodies. The subbasin encompasses approximately 347,000 acres, extending from Hells Canyon Dam to the confluence with the Salmon River. This section of the Snake River is characterized as a rapid flowing, narrow river with steep canyon walls and stretches of white water. The flow and volume is almost completely dictated by the outflow from Hells Canyon reservoir. This segment, from the dam to the confluence with the Salmon River, supports recreational uses such as boating, rafting, and sport fishing year round.

Hells Canyon is a 10-mile wide canyon located along the border of eastern Oregon and western Idaho in the United States. It is North America's deepest river gorge at 7,993 feet and the most important feature of Hells Canyon National Recreation Area. The canyon was carved by the waters of the Snake River and plunges more than a mile below the canyon's west rim on the Oregon side and 8,000 feet below the peaks of Idaho's Seven Devils Mountains range to the east. The area is inaccessible by road.

Two water bodies within the subbasin—Wolf Creek and Divide Creek—are addressed in this document.

## Key Findings

Nine tributaries to the lower Salmon River Subbasin, and two tributaries to the Hells Canyon Subbasin, were listed as not meeting state water quality standards in Section 5 of Idaho's 2008 Integrated Report (Figures A and B). Section 303(d) of the Clean Water Act states that waters that do not meet water quality standards are required to have total maximum daily loads (TMDLs) developed to bring them into compliance with water quality standards.




**Figure A. Monitoring Sites within the Lower Salmon River Subbasin**

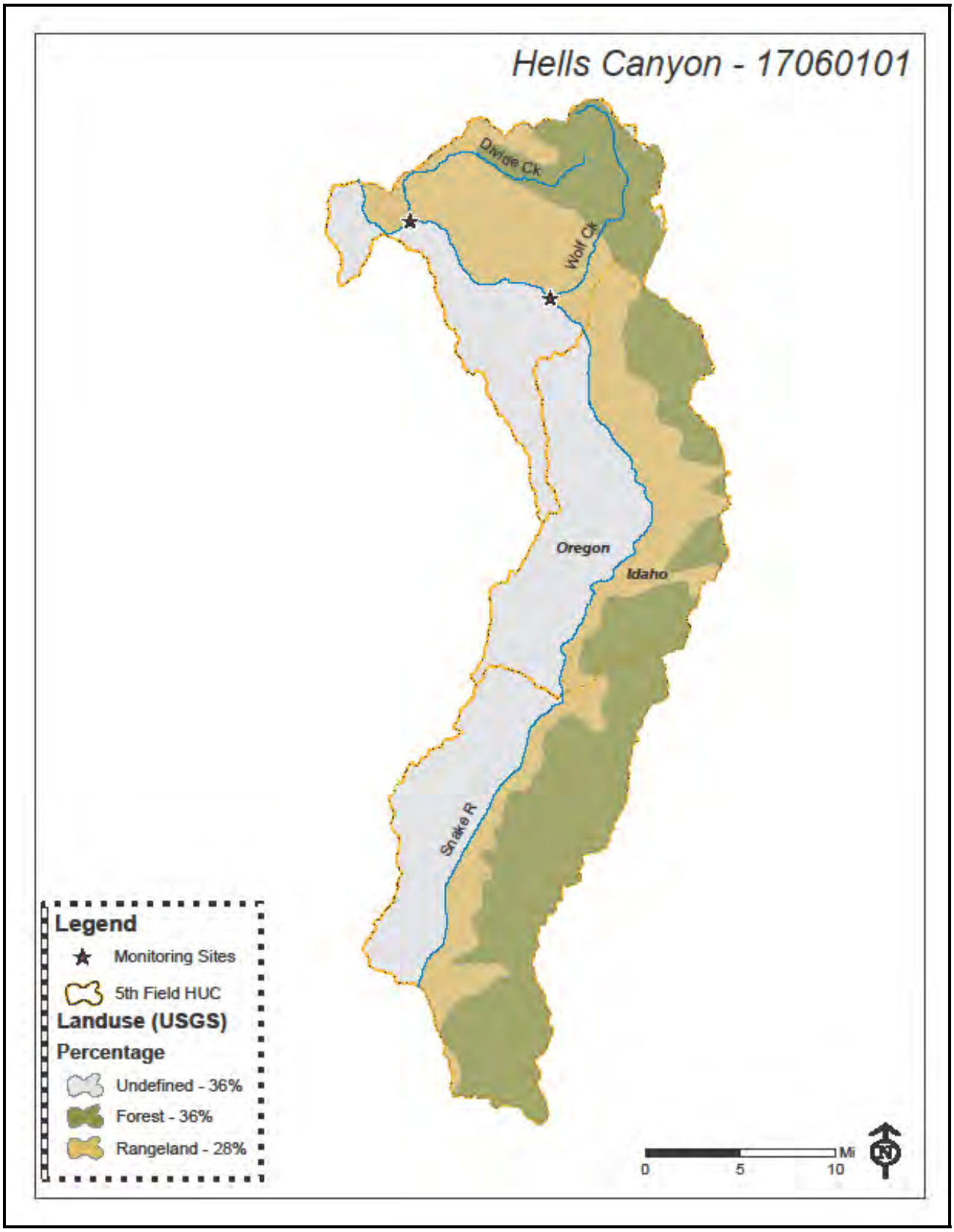



**Figure B. Monitoring Sites within the Hells Canyon Subbasin**

Designated and existing beneficial uses for the assessed water bodies include cold water aquatic life and salmonid spawning (Table A). Primary contact recreation and secondary contact recreation beneficial uses are also designated and existing. Water quality must be sufficiently maintained to meet these uses. The water bodies addressed by this TMDL are listed in Table B.

**Table A. Lower Salmon River and Hells Canyon Subbasins beneficial uses of §303(d) listed streams.**

| Water Body | Uses[a] | Type of Use |
|---|---|---|
| Cottonwood Creek | CW, SS, SCR | Existing |
| Billy Creek | CW, SCR | Existing |
| Rice Creek | CW, SS, SCR | Existing |
| Allison Creek | CW, SS, SCR | Existing |
| John's Creek | CW, SCR | Existing |
| Rock Creek | CW, SS, PCR | Designated |
| Graves Creek | CW, SS, SCR | Existing |
| Deep Creek | CW, SS, SCR | Existing |
| Deer Creek | CW, SS, SCR | Existing |
| Wolf Creek | CW, SS, SCR | Existing |
| Divide Creek | CW, SS, SCR | Existing |

[a] CW – cold water, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation

**Table B. §303(d) Segments in the Lower Salmon River and Hells Canyon Subbasins.**

| Stream Name* | Assessment Unit | Description | 2008 Integrated Report Listing |
|---|---|---|---|
| Wolf Creek* | ID17060101SL024_04 | Basin Creek to Mouth | Sediment, Temperature |
| Wolf Creek* | ID17060101SL025_02, ID17060101SL025 _03 ID17060101SL025 _04 | Source to Basin Creek | Sediment |
| Divide Creek* | ID17060101SL028_02 | Source to Mouth | Sediment |
| Divide Creek* | ID17060101SL028_03 | Source to Mouth | Sediment, Temperature |
| Cottonwood Creek | ID17060209SL003_02 | Source to unnamed tributary | Sediment |
| Billy Creek | ID17060209SL004_02 | Source to Mouth | Unknown |
| Rice Creek | ID17060209SL007_02 | Rice Creek Tributaries | Sediment |
| Allison Creek | ID17060209SL028_03 | West Fork to Mouth | Sediment |
| John's Creek | ID17060209SL057_02 | Rock Cr. source to Graves Creek | Sediment |
| Rock Creek | ID17060209SL056_04 | Graves Creek to Mouth | Sediment |
| Rock Creek | ID17060209SL057_03 | Source to Graves Creek | Sediment |
| Graves Creek | ID17060209SL058_02 ID17060209SL058_03 | Headwaters to unnamed tributary, unnamed tributary to Rock Creek | Sediment |
| Deep Creek | ID17060209SL060_02 | Deep Cr. source to unnamed tributary | Nutrients Temperature, Bacteria, Sediment |
| Deer Creek | ID17060209SL062_02 ID17060209SL062_02a | Deer Creek tributaries, Source to West Fork Deer Creek | Sediment |

*Water body is in Hells Canyon Subbasin

## Overall Monitoring Results

A water quality sampling project was conducted by DEQ personnel beginning in March 2007 and continued on a bi-weekly basis for approximately one year. Specific parameters that were sampled for included total phosphorus (TP), nitrite+nitrate-nitrogen (NO2+NO3-N), ammonia (NH3-N), E. coli bacteria, total suspended solids (TSS), stream temperature, flow, and dissolved oxygen. Instantaneous sampling occurred approximately every two weeks at 11 sites throughout the Lower Salmon River and Hells Canyon Subbasins. The monitoring site locations are described in Table C and their locations are shown in Figures A and B.

**Table C. Monitoring station locations.**

| Monitoring Station | Stream Name | Location |
|---|---|---|
| Snake R. # 1* | Wolf Creek | At the Mouth of Wolf Creek |
| Snake R. # 2* | Divide Creek | At the Mouth of Divide Creek |
| Salmon R. #1 | Billy Creek | At the Mouth of Billy Creek |
| Salmon R. #2 | Cottonwood Creek | At the Mouth of Cottonwood Creek |
| Salmon R. #3 | Allison Creek | At the Mouth of Allison Creek |
| Salmon R. #4 | Rice Creek | At the Mouth of Rice Creek |
| Salmon R. #5 | Rock Creek | At the Mouth of Rock Creek |
| Salmon R. #6 | Graves Creek | Just Upstream of the confluence with Rock Creek |
| Salmon R. #7 | John's Creek | Upstream of Culvert on Lake Road |
| Salmon R. #8 | Deep Creek | Below culvert and Road Crossing on Deep Creek Road |
| Salmon R. #9 | Deer Creek | Larabee Meadows |

*Tributaries to Hells Canyon Subbasin (17060101)

Based on the data collected at these locations, bacteria, sediment, and temperature TMDLs have been developed (Table D). The TMDL has been revised to provide waste load allocations for future growth based on water quality standards and associated TMDL targets. Background amounts are included with the gross non point source load allocations.

**Table D. Summary of assessment outcomes.**

| Water Body Segment/ Assessment Units (AUs) | Pollutant | TMDL(s) Completed | Recommended Changes to §303(d) List/ 2008 Integrated Report | Justification |
|---|---|---|---|---|
| Wolf Creek, Basin Creek to Mouth ID17060101SL024_04 and ID17060101SL025_02, _03, _04 | Temperature | Yes | Place in section 4a* | TMDL completed |
| Wolf Creek, Basin Creek to Mouth ID17060101SL024_04 and ID 17060101SL025_02, _03, _04 | Sediment | No | Remove pollutants from list of impairments | SBA completed |
| Divide Creek, Source to Mouth ID17060101SL028_02 and _03 | Temperature Bacteria | Yes | Place in section 4a* | TMDL completed |
| Divide Creek, Source to Mouth ID17060101SL028_02 and _03 | Sediment | No | Remove pollutants from list of impairments | SBA completed |
| Cottonwood Creek, Source to unnamed tributary 17060209SL003_02 | Sediment | No | Remove pollutants from list of impairments | SBA completed |

| Water Body Segment/ Assessment Units (AUs) | Pollutant | TMDL(s) Completed | Recommended Changes to §303(d) List/ 2008 Integrated Report | Justification |
|---|---|---|---|---|
| Cottonwood Creek, Source to unnamed tributary 17060209SL003_02 | Bacteria | Yes | Place in section 4a* | TMDL completed |
| Billy Creek, Source to Mouth ID17060209SL004_02 | Unknown | Bacteria, Sediment | Place in section 4a* | TMDL completed |
| Allison Creek, West Fork to Mouth ID17060209SL028_03 | Bacteria | Yes | Place in section 4a* | TMDL completed |
| Allison Creek, West Fork to Mouth ID17060209SL028_03 | Sediment | No | Remove pollutants from list of impairments | SBA completed |
| Rice Creek, Rice Creek tributary ID17060209SL007_02 ID17060209SL007_03 | Bacteria Temperature | Yes | Place in section 4a* | TMDL completed |
| Rice Creek, Rice Creek tributary ID17060209SL007_02 | Sediment | No | Remove pollutants from list of impairments | SBA completed |
| Rock Creek, Source to Grave Creek and Grave Creek to Mouth ID17060209SL057_03 ID17060209SL056_04 | Sediment, Bacteria, Temperature | Yes | Place in section 4a* | TMDL completed |
| Graves Creek, Headwaters to unnamed tributary, unnamed tributary to Rock Creek ID17060209SL058_02 ID17060209SL058_03 | Sediment | No | Remove pollutants from list of impairments | SBA completed |
| Graves Creek, Headwaters to unnamed tributary, unnamed tributary to Rock Creek ID17060209SL058_02 ID17060209SL058_03 | Bacteria | Yes | Place in section 4a* | TMDL completed |
| John's Creek, Rock Creek source to Graves Creek ID17060209SL057_02 | Sediment, Temperature Bacteria | Yes | Place in section 4a* | TMDL completed |
| John's Creek, Rock Creek source to Graves Creek ID17060209SL057_02 | Nutrients | No | Move to section 5** | SBA |
| Deep Creek, source to unnamed tributary ID17060209SL060_02 | Sediment Bacteria | Yes | Place in section 4a* | TMDL completed |
| Deep Creek, source to unnamed tributary ID17060209SL060_02 | Nutrients, Temperature | No | Remove pollutants from list of impairments | SBA completed |
| Deer Creek, Deer Creek tributary ID17060209SL062_02 and _02a | Sediment | No | Remove pollutants from list of impairments | SBA completed |

* Refers to section 4a of the integrated report (DEQ 2005), which is the section of the report for waters with completed TMDLS.

** Refers to section 5 of the integrated report (DEQ 2005), which is the section of the report for waters that are impaired (their water quality is limited) and need TMDLs.

In the lower Salmon and Snake Rivers Subbasins, nine water bodies had E. coli concentrations that exceeded the geometric mean criterion of 126 cfu/100 ml (Table E). The bacteria TMDLs have been developed to trigger the implementation of best management practices (BMPs) to ensure that the secondary contact recreation beneficial use is maintained for the protection of human health. The bacteria TMDLs should guide the implementation of BMPs designed to limit bacteria loading, such as off site watering, exclusions, and waste management practices that address the sources of bacteria.

## Bacteria DNA Analysis

Water samples were analyzed for the presence/absence of human gene biomarkers by polymerase chain reaction (PCR) DNA analytical technology to determine if fecal pollution from human sources was a source of bacteria loading to the monitored water bodies. The DNA analytical results are shown in Table E.

**Table E. DNA analytical results.**

| Water Body | Sample Date | Human Bacteroidetes ID DNA Analytical Result | Human Enterococcus ID DNA Analytical Result |
|---|---|---|---|
| Wolf Creek | 7/17/2008 | Human Gene Biomarker Detected | Negative |
| Divide Creek | 7/17/2008 | Negative | Negative |
| Cottonwood Creek | 7/17/2008 | Negative | Negative |
| Billy Creek | 7/17/2008 | Human Gene Biomarker Detected | Negative |
| Rice Creek | Not Assessed | Not Assessed | Not Assessed |
| Allison Creek | 7/16/2008 | Human Gene Biomarker Detected | Negative |
| John's Creek | 7/16/2008 | Negative | Negative |
| Rock Creek | 7/16/2008 | Human Gene Biomarker Detected | Human Gene Biomarker Detected |
| Graves Creek | 7/16/2008 | Negative | Negative |
| Deep Creek | Not Assessed | Not Assessed | Not Assessed |
| Deer Creek | Not Assessed | Not Assessed | Not Assessed |

As shown in Table E, human gene biomarkers were detected at four sites: Wolf Creek, Billy Creek, Allison Creek, and Rock Creek. The magnitude, or percent contribution, of bacteria loading to these water bodies from human sources is unknown since the analysis was strictly to determine presence/absence.

The DNA analytical results reported as negative means that the strain (Human Bacteroidetes or Enterococcus or both) used as an indicator of human fecal contamination was absent in the submitted sample. Further monitoring to assess other possible sources

of bacteria, such as cattle or wildlife, could be conducted in the future within these sub-watersheds to help prioritize implementation efforts.

### Temperature

Analysis of the existing continuous temperature data documented five water bodies where Idaho's temperature criteria for the cold water aquatic life beneficial use were violated (Table D). The temperature TMDLs included in this document apply a potential natural vegetation (PNV) approach, which establishes specific shade targets for each water body based on riparian plant communities. The temperature TMDLs require an increase in riparian shade in order to restore stream temperatures to background conditions.

Analysis of the dominant benthic macroinvertebrate community from a 2008 BURP survey (site 2008SLEWA021) within John's Creek identified pollutant-tolerant taxa that are able to occupy habitats with low dissolved oxygen and high nutrient concentrations. Additionally, visible slime growths were observed during site visits, and nuisance vegetation growths are occurring in-stream. This implies that impairment to the cold water aquatic life beneficial use is a result of excessive nutrient loading, and that nutrient loading needs to be reduced in order to achieve full support of the beneficial use.

Currently, the lack of nutrient data restricts the ability to adequately calculate loads and any necessary load reductions. Therefore, it is recommended that John's Creek be listed in Section 5 of Idaho's next integrated report for nutrients. It is assumed that reducing excessive nutrient loading will cause a shift in the composition of the benthic macroinvertebrate community structure toward those organisms that usually occupy habitats with reference conditions.

### Sediment

Sediment TMDLs were developed for control points where concentrations greater than the load capacity were measured. Each of the sediment TMDLs allocates a gross concentration to all sources of sediment upstream of the established control points. Sediment TMDLs have been developed for Rock Creek, ID17060209SL056_04, which applies to 057_03 and John's Creek, ID17060209SL057_02, as well; for Billy Creek, ID17060209SL004_02; and for Deep Creek, ID17060209SL060_02 (Table D). Reducing sediment by implementing best management practices in and around John's Creek will also reduce nutrient loading, and will limit downstream impacts to Rock Creek.

## Public Participation

The Lower Salmon River WAG met during the development of the draft TMDL and provided input and advice to DEQ. The WAG has advised DEQ that since the Lower Salmon River and Hells Canyon Tributaries Assessments and TMDLs are based on a limited amount of sampling and data, field verification should be conducted, to account for the most current conditions, before the prioritization and implementation of projects. During the April 24, 2009 WAG meeting, the WAG voted unanimously to send the document to EPA for final approval.

# 1. Subbasin Assessment – Watershed Characterization

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

This document addresses the water bodies in the Lower Salmon River Subbasin and Hells Canyon (Snake River) Subbasin that have been placed on Idaho's current §303(d) list.

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

## 1.1 Introduction

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

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

### Background

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

CWA in Idaho, while the EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt water quality standards and to review those standards every three years (Idaho's water quality standards must be approved by EPA). 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 that do not meet water quality standards. Waters identified on this list require further analysis. An SBA and TMDL provide a summary of the water quality status and allowable TMDL for water bodies on the §303(d) list. The Lower Salmon River and Hells Canyon Subbasin Assessments and TMDLs provide the summary for the currently listed waters in those subbasins.

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

Some conditions that impair water quality do not receive TMDLs. The EPA does consider certain unnatural conditions, such as flow alteration, human-caused lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutants to be "pollution." However, 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.

## 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 the following:

- Aquatic life support–cold water, seasonal cold water, warm water, salmonid spawning, modified
- Contact recreation–primary (swimming), secondary (boating)

- Water supply–domestic, agricultural, industrial
- Wildlife habitats
- Aesthetics

The Idaho legislature designates beneficial uses for water bodies. Industrial water supply, wildlife habitats, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body has not been classified, then cold water and primary contact recreation are used as additional default designated uses when the water body is assessed.

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

- Determine the degree of designated beneficial use support of the water body (i.e., is the water body 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 locations of pollutant sources.
- Determine the causes and extent of the impairment when water bodies are not attaining water quality standards.

## 1.2 Physical and Biological Characteristics

This section provides information on the physical and biological characteristics for the Lower Salmon River and Hells Canyon Subbasins. Topography and climate for the entire subbasin is followed by more specific information about each stream.

### Lower Salmon River Subbasin

The Lower Salmon River Subbasin, identified in Idaho WQS as Hydrologic Unit Code (HUC) 17060209, is comprised of 65 water bodies located in west central Idaho and includes the Salmon River from its mouth to French Creek. The subbasin encompasses approximately 755,000 acres, draining into the Snake River at river mile 188.2. Private lands comprise the majority of the subbasin, followed by the United States Forest Service (USFS), BLM, Idaho Department of Fish and Game (IDFG), and Idaho Department of Lands (IDL).

The Salmon River is characterized as a steep rocky canyon where the channel alternates between large pools and boulder dominated rapids. The gradient is approximately 0.23%. Mean annual discharge for the Salmon River was estimated at 11,210 cubic feet per second (cfs) at the White Bird Gage Station (river mile 53.7, 0.1 mile upriver from White Bird Creek) (BLM 2008). The period of record for discharge is August 1910 through September 1917, and October 1919 to the present.

Flow data obtained from the United States Geological Survey (USGS) Web site (2008) shows that the lowest flow recorded for the Salmon River at Whitebird was 1,000 cfs on January 4, 1995, and the maximum flow recorded was 130,000 cfs on June 17, 1974. Minimum mean monthly flows were estimated at 4,242 cfs in January and maximum mean monthly flows at 38,650 cfs in June. The average high mean daily flow during spring runoff is 44,800 cfs and the average low mean daily flow in late summer is 4,340 cfs (BLM 2008)

The Columbia River basalt group is the most extensive rock type in the Lower Salmon River subbasin. The Lower Salmon River Canyon includes drainages developed in basalt by stream and river erosion, resulting in deeply incised valleys with vertical walls. Differential erosion of basalt flows creates narrow flat benches giving the appearance of a series of distinct layers or stairsteps along the hillsides. Soils developed in basalt are typically loam to clayey loams. Mineralogy of basalt consists mostly of plagioclase and pyroxene with accessory olivine and iron oxides. Weathering of basalt produces only limited amounts of mica and clay which results in a fine to medium textured soil with low to medium erodibility (BLM 2008).

Elevations within the subbasin range from approximately 900 feet at the mouth to over 8,000 feet. The Salmon River flows through a canyon that ranges from 2,000 to more than 5,000 feet deep. Upland areas of the subbasin may include steep and rugged mountains or plateaus with rolling and moderate slopes. Lower elevation areas are dominated with grassland habitats, while breaklands may have patterned grassland and timbered sites. The moderately sloped plateau areas may be cultivated, pasturelands, or forested areas. Higher elevation areas are forested.

The subbasin provides habitat for listed spring/summer chinook salmon, sockeye salmon, fall chinook salmon, steelhead trout, and bull trout. Other species found in the subbasin include westslope cutthroat trout, rainbow/redband trout, Pacific lamprey, white sturgeon, brook trout, mountain whitefish, smallmouth bass, bridgelip sucker, large-scale sucker, speckled dace, sculpins, redside shiners, and pike minnow (BLM 2008).

Nine water bodies in the Lower Salmon River subbasin are addressed in this document and they include: Cottonwood Creek, Billy Creek, Rice Creek, Allison Creek, John’s Creek, Rock Creek, Graves Creek, Deep Creek, and Deer Creek. A characterization of each sub-watershed is included in this chapter.

## Hells Canyon (Snake River) Subbasin

Hells Canyon is a 10-mile wide canyon located along the border of eastern Oregon and western Idaho. It is North America's deepest river gorge at 7,993 feet and the most important feature of Hells Canyon National Recreation Area. The canyon was carved by the waters of the Snake River and plunges more than a mile below the canyon's west rim on the Oregon side and 8,000 feet below the peaks of Idaho's Seven Devils Mountains range to the east. The area is inaccessible by road.

The Hells Canyon (Snake River) Subbasin is identified in Idaho WQS as HUC 17060101, and is comprised of 28 water bodies. The subbasin encompasses approximately 347,000 acres, extending from Hells Canyon Dam to the confluence with the Salmon River. This section of the Snake River is characterized as a rapid flowing, narrow river with steep canyon walls and stretches of white water. The flow and volume is almost completely dictated by the outflow from Hells Canyon reservoir. This segment, from the dam to the confluence with the Salmon River, supports recreational uses such as boating, rafting, and sport fishing, year-round.

Two water bodies within the subbasin—Wolf Creek and Divide Creek—are addressed in this document.

## Climate

Climate in central Idaho varies significantly with latitude, elevation, and topography—dominated by pacific maritime air masses and prevailing westerly winds. Approximately 80% of the average annual total precipitation occurs during fall, winter, and spring months. Cyclonic storms, consisting of a series of frontal systems moving east, produce long duration, low-intensity precipitation during this period of the year. In winter and spring, these inland maritime systems are characterized by prolonged gentle rains, fog, cloudiness, and high humidity, with deep snow accumulations at higher elevations (such as in Winchester). This pattern tends to cause high in-stream flows beginning in March, with flash events lasting through June as precipitation and snowmelt runoff occur, and low summer base flows from July through late September.

Data from long term weather stations located in three towns that are dispersed throughout the Lower Salmon River subbasin (Grangeville, Winchester, and Riggins) are summarized below. Average annual maximum temperatures range from approximately 67 $^{o}$F to 54 $^{o}$F, while average annual minimum temperatures range from 42 $^{o}$F to 32 $^{o}$F (Tables 1-3). Figures 1-3 display the 30-year averages of temperature and precipitation for Grangeville, Winchester, and Riggins, Idaho (Western Regional Climate Center 2008).

**Table 1. Monthly climate summary for Grangeville, Idaho (8/1/1948 through 12/31/2006).**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Average Max. Temperature (F)** | 36.9 | 42.3 | 48.3 | 56.1 | 64.0 | 71.4 | 81.8 | 81.7 | 71.9 | 59.0 | 44.7 | 37.9 | 58.0 |
| **Average Min. Temperature (F)** | 21.5 | 24.5 | 27.7 | 33.0 | 39.5 | 45.8 | 50.7 | 49.8 | 42.3 | 34.7 | 27.9 | 22.6 | 35.0 |
| **Average Total Precipitation (in.)** | 1.55 | 1.28 | 2.19 | 2.78 | 3.48 | 2.87 | 1.24 | 1.14 | 1.68 | 1.90 | 1.83 | 1.55 | 23.48 |
| **Average Total SnowFall (in.)** | 10.5 | 7.1 | 8.4 | 3.4 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 6.1 | 10.9 | 48.0 |
| **Average Snow Depth (in.)** | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 |

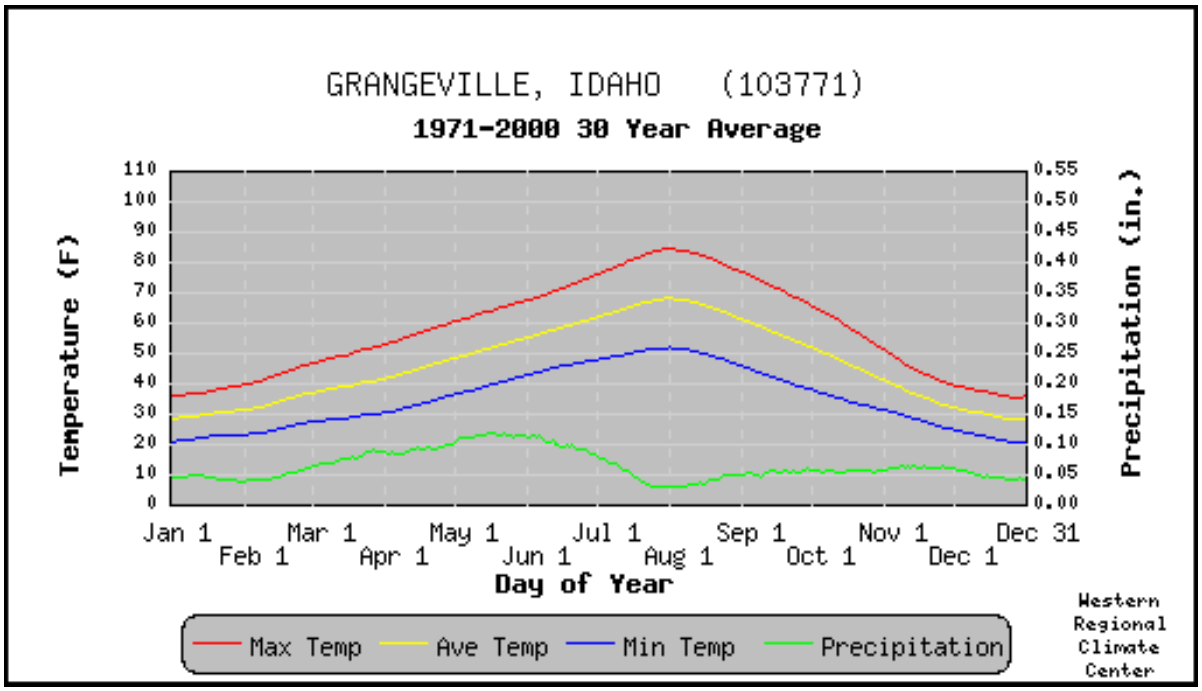



**Figure 1. Monthly Climate Summary for Grangeville, ID (1971-2000)**

**Table 2. Monthly climate summary for Winchester, Idaho (7/1/1965 through 12/31/2006).**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Average Max. Temperature (F)** | 35.1 | 39.3 | 44.4 | 51.4 | 59.7 | 67.1 | 76.8 | 77.8 | 68.4 | 56.3 | 41.9 | 35.0 | 54.4 |
| **Average Min. Temperature (F)** | 19.8 | 21.8 | 25.6 | 30.6 | 36.6 | 42.3 | 46.2 | 45.7 | 39.4 | 32.5 | 25.9 | 19.9 | 32.2 |
| **Average Total Precipitation (in.)** | 2.10 | 1.61 | 2.41 | 2.72 | 3.02 | 2.15 | 1.23 | 1.15 | 1.42 | 1.91 | 2.35 | 1.94 | 23.99 |
| **Average Total SnowFall (in.)** | 19.5 | 13.1 | 15.9 | 9.7 | 2.2 | 0.2 | 0.0 | 0.0 | 0.2 | 2.1 | 13.0 | 17.7 | 93.4 |
| **Average Snow Depth (in.)** | 7 | 6 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 2 |

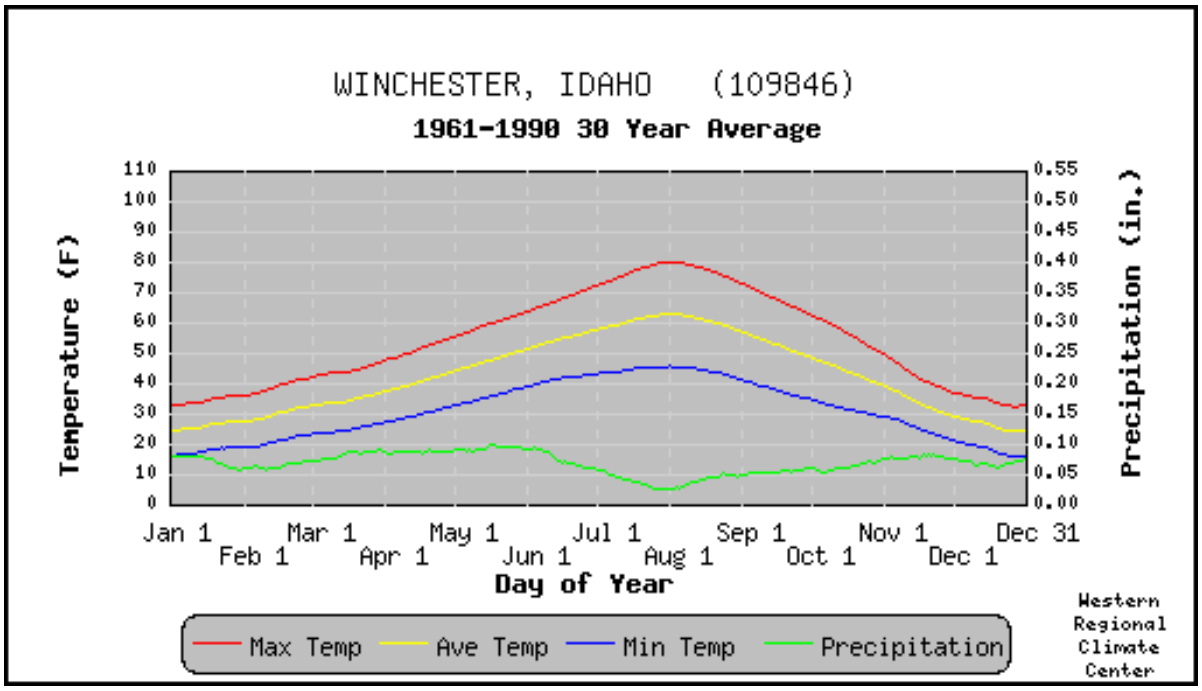



**Figure 2. Monthly Climate Summary for Winchester, ID (1961-2000)**

**Table 3. Monthly Climate Summary for Riggins, Idaho (1/1/1940 through 12/31/2006).**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Average Max. Temperature (F)** | 41.8 | 49.4 | 57.3 | 66.0 | 74.2 | 81.5 | 92.6 | 92.4 | 81.6 | 67.4 | 50.9 | 42.5 | 66.5 |
| **Average Min. Temperature (F)** | 27.8 | 30.8 | 34.6 | 39.5 | 45.9 | 52.4 | 58.3 | 57.9 | 50.4 | 41.9 | 34.5 | 29.3 | 41.9 |
| **Average Total Precipitation (in.)** | 1.21 | 1.09 | 1.63 | 1.76 | 2.23 | 1.92 | 0.80 | 0.81 | 1.15 | 1.31 | 1.53 | 1.36 | 16.78 |
| **Average Total SnowFall (in.)** | 2.8 | 1.2 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 2.0 | 6.8 |
| **Average Snow Depth (in.)** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

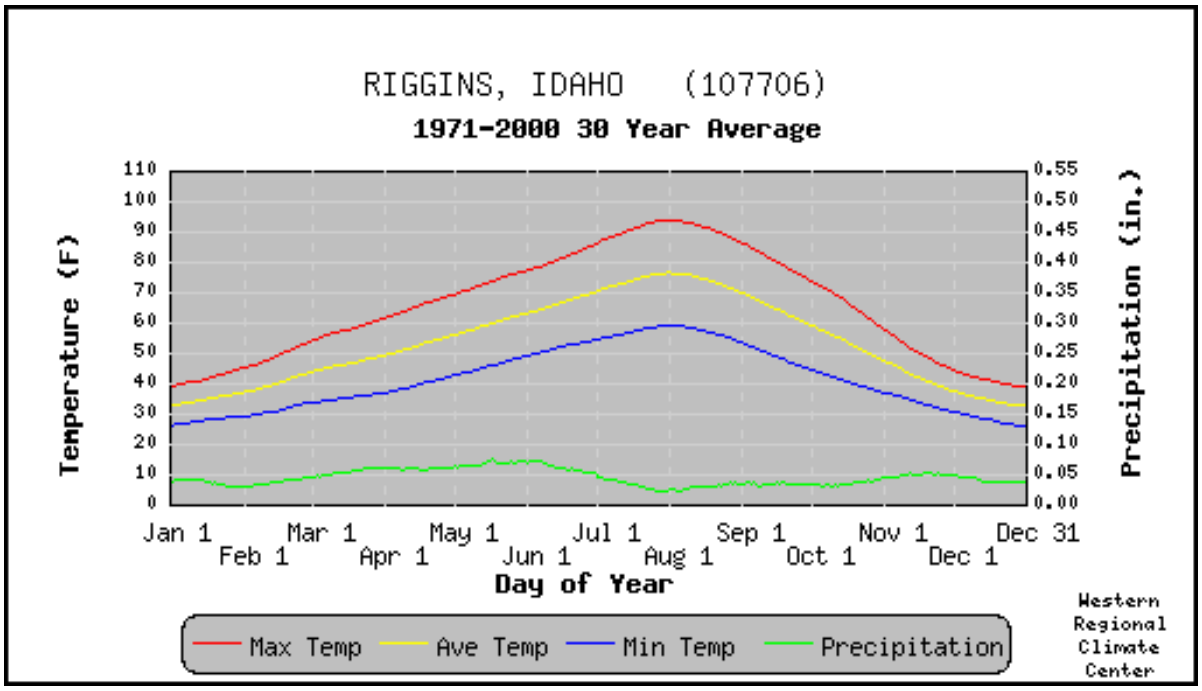



**Figure 3. Monthly Climate Summary for Riggins, ID (1971-2000).**

During the majority of the period monitored (2007), the North Central Prairie as well as the North Central Canyon locations received significantly less precipitation (negative 5.41 inches and 4.84 inches departure from normal, respectively). Additionally, total annual precipitation for 2006 was less than normal throughout the subbassin. The extreme deficit in precipitation in 2007 and below normal precipitation during 2006, coupled with higher than normal ambient air temperatures (+1.1-1.6 $^{o}$F) resulted in relatively low base flows.

## Subwatershed Characteristics (Salmon River Tributaries)

### *Cottonwood Creek (17060209SL003_02 and 03)*

Cottonwood Creek is a third order tributary to the Salmon River and the watershed is approximately 12,500 acres in size, flowing into the Salmon River at river mile 15.0. Elevations range from approximately 1,100 feet at the mouth to 5,000 feet near the headwaters. Cottonwood Creek is classified as an A type channel—primarily riffle type habitat (75%). Stream gradients range from 4% to 9%. Flows range from 1 to 50 cfs, and base flows are low (BLM 2008). During the 2007-2008 monitoring season, Cottonwood Creek went dry, which has also been documented in the past during drought conditions (BLM 2008). Flows ranged from approximately 14 cfs to 0.0 cfs.

The predominant land uses in the watershed include livestock grazing and timer harvest, and a road parallels Cottonwood Creek for its entire length. The watershed provides spawning and rearing habitat for steelhead/rainbow trout (BLM 2008)

### *Billy Creek (17060209SL004_02)*

Billy Creek is a second order tributary to the Salmon River and the watershed is approximately 3,000 acres in size, with a majority of the drainage under private ownership. Elevations in the watershed range from nearly 1,000 feet at the mouth to approximately 4,800 feet near the headwaters. Billy Creek flows into the Salmon River at rive mile 16.3. The majority of the lands within the lower portion of the drainage are canyon grasslands with the upper portion of the drainage consisting of patterned timbered/grasslands in the breaklands. The lands within the drainage are grazed by cattle. A road parallels Billy Creek along its entire length, and roads ford Billy Creek at two locations in the lower reach. A ranch house and barn, are located on private lands near the mouth of the creek. Because of private lands within the drainage, public access is restricted (BLM 2008).

Billy Creek may provide limited spawning and rearing habitat for steelhead/rainbow trout (BLM 2008). A 2004 Beneficial Use Reconnaissance Program (BURP) survey conducted by DEQ documented the presence of rainbow trout (Site ID: 2004SLEWA057). Billy Creek is classified as an A type channel near the mouth. Flows recorded during the 2007-2008 monitoring season ranged from 3.2 to 0.1 cfs.

### *Rice Creek (17060209SL007_03)*

Rice Creek is a third order tributary, approximately 16 miles long, and flows into the Salmon River at river mile 37.7. The watershed encompasses approximately 31,000 acres, with elevations ranging from 1,500 to 5,500 feet. The Columbia River basalt group is the common geologic parent material found in the Rice Creek drainage. Drainages developed in basalt by stream erosion consist of deeply incised valleys with vertical to nearly vertical walls. Differential erosion of basalt flows creates narrow flat benches giving the appearance of a series of distinct layers of stair-steps along the hillsides. Soils developed in basalt are typically loams to clayey loams. Landforms common to the erosion of metamorphic rocks tend to be very steep sided and narrow valleys of varying length. Basalt produces a medium to fine textured soil with low to medium erodibility.

The Rice Creek drainage flows through a steep sloped canyon, which divides the upland plateau areas of Doumecq Plains (east side) and Joseph Plains (west side).

The stream bottoms are very narrow and confined, generally 30 to 100 feet wide. The dominant channel type is A3, with small segments of B3 channel types. Stream gradients average 4 to 8%. The dominant stream habitat types consist of riffles/cascades (75%), runs (10%), and pools/pocket water (15%). Pools are generally shallow with poor to fair in-stream cover. Rice Creek has flows ranging from three to 100 cfs. Rice Creek and its tributaries generally have high sediment transport capacity due to the high stream gradient (BLM 2008).

Flows during the 2007-2008 monitoring season ranged from approximately 66 cfs to 1.8 cfs (base flow). High flows, estimated at approximately 100 cfs or greater, prohibited sampling in May 2007. Additionally, the Salmon River floods the lower section of Rice Creek every year at the mouth when high flows occur.

The watershed provides spawning and rearing habitat for steelhead, and potentially for spring/summer Chinook juvenile rearing and bull trout subadult/adult rearing. A full fish passage barrier—20 foot falls—at all flows occurs at stream mile 5.4. Rainbow/redband trout have been documented above the falls (BLM 2008).

### *Allison Creek (17060209SL028_03)*

Allison Creek is a third order tributary to the Salmon River. The watershed encompasses approximately 13,000 acres, and flows into the Salmon River at river mile 96.1. The creek is 8 miles long, and the lower 3 miles flow through private property. Land uses in the watershed include timber harvest, private land development, and livestock grazing. A large portion of the watershed is under ownership of the USFS.

Allison Creek provides spawning and rearing habitat for steelhead/rainbow trout and spawning adults have been documented in the creek (BLM 2008). The stream is classified as an A type channel—predominantly riffle type habitat with drop pools, and pocket water near the margins. A 2003 BURP survey conducted on the second order segment of the creek document the presence of rainbow trout (22 individuals) and young of the year (yoy). Wetted widths range from 10 to 15 feet throughout the summer. Mean annual discharge is estimated at 26 cfs, with flows ranging from 9 cfs to 58 cfs (BLM 2008). Flows during the 2007-2008 monitoring season ranged from approximately 6 cfs to 38 cfs.

### *Rock Creek watershed (17060209SL056_04, 057_02 and 03, 058_02 and 03)*

Rock Creek is a fourth order tributary and flows into the Salmon River at river mile 39.1. The watershed encompasses approximately 58,000 acres. State lands include 840 acres and BLM lands include 95 acres, with the remaining area privately owned. Elevations in the watershed range from approximately 6,100 feet near the headwaters to 1,300 feet at the mouth. Larger tributaries within the drainage include Graves Creek which flows into Rock Creek at stream mile 3.8, and John's Creek and Telcher Creek, which flow together at stream mile 9.7 to form Rock Creek. The topography and climate of the watershed varies significantly from hot, dry, and extremely steep dissected canyon grasslands near

the mouth of the drainage, to a more gently sloping and moist forest in the headwaters on Grangeville Mountain.

Three monitoring sites were established within the watershed: one at the mouth of Rock Creek, one near the confluence of Rock and Graves Creek in Graves Creek, and John's Creek near Lake Road on the Camas Prairie.

The lower reaches of Rock Creek flows through a steeply-sloped canyon with a wide stream bottom that is approximately 200 feet in width. The upper reaches flow through a moderately sloped plateau area (Camas Prairie). Tolo Lake occurs in the Telcher Creek drainage and is a shallow water lake, which is approximately 45 acres in size. Idaho Department of Fish and Game (IDFG) owns approximately 20 acres of land that borders approximately 50% of the shoreline. The majority of the lands within the lower drainage are a combination of canyon grasslands and some patterned timbered/shrub areas within the current riparian or existing flood plains. The upper elevation plateau areas of the watershed are primarily used for agriculture.

Land uses within the watershed include agricultural, rangeland, and forested lands. The majority of the agricultural land, which constitutes the majority of the land use, occurs on gently sloping to moderately steep slopes. These very deep, moderately well to well-drained soils formed in loess occur on plateaus. The average annual precipitation is approximately 23.5 inches (near Grangeville). The major crops grown within the watershed are winter wheat, spring barley, and spring wheat. Other important crops that are grown are spring peas, oats, lentils, rape, and canola.

Rock Creek provides spawning and rearing habitat for rainbow/steelhead. No chinook salmon or bull trout use has been documented in the creek. The lower stream reach and mouth area may potentially be used by juvenile chinook salmon and subadult/adult bull trout and cutthroat trout for rearing, however, such use would be considered uncommon. Rock Creek has no fish passage barriers. No fish passage barriers have been identified for the lower 5 miles of Grave Creek. Steep gradient, cascades, and small falls restrict fish passage in the lower reach of John's Creek and Telcher Creek. Adult steelhead have been documented in Rock Creek and Grave Creek. Other fish species documented in Rock Creek include suckers, dace, pike minnow, and chisel mouth (BLM 2008). Two BURP surveys (2003 and 1997) conducted in the lower reaches of Rock Creek documented the presence of rainbow trout, long nose dace, and bridgelip suckers. Two BURP surveys in the same years on Graves Creek also documented the presence of rainbow trout and long nose dace. A 2008 BURP site on John's Creek did not observe any fish species.

Rock Creek is classified as having a B channel type, and flows are estimated to range from 2 to 100 cfs. This drainage has experienced flood events which have resulted in severe channel and floodplain scouring (BLM 2008). Discharge measured during the 2007-2008 monitoring season ranged from approximately 100 cfs during spring runoff to approximately 2 cfs during base flow conditions. Discharge measured in Graves Creek ranged from 20 cfs to approximately 0.9 cfs. The highest recorded discharge in John's Creek was 21 cfs, before going dry in late July 2007.

### *Deep Creek (17060209SL060_02)*

Deep Creek, a third order tributary to the Salmon River, is approximately 13,000 acres in size, and flows into the Salmon River at river mile 20.8. Elevations in the watershed range from approximately1,100 feet at the mouth to 5,700 feet on Cottonwood Butte. The majority of the drainage is privately owned, and the lower portion of the drainage is canyon grasslands with the upper portion of the drainage consisting of patterned timbered/grasslands in the breaklands. The moderately sloped plateau areas are timbered or farmlands. Cottonwood Butte is timbered. The lands within the drainage are grazed by cattle. The majority of the timbered areas have been logged (BLM 2008).

Deep Creek provides spawning and rearing habitat for steelhead/rainbow trout. A BURP survey conducted in 1997 on the lower segment of the creek documented the presence of rainbow trout and two unspecified Pacific salmon/trout. No BURP surveys have been conducted on the second order segment of Deep Creek where in-stream monitoring occurred.

Deep Creek is characterized as an A type channel. Flows are estimated to range from 0.5 cfs to 50 cfs (BLM 2008). Flow data generated on the second order segment of the watershed during 2007-2008, beginning in the middle part of July 2007. ranged from approximately 20 cfs to 0.0 cfs.

### *Deer Creek (17060209SL062_02 and 02a)*

The Deer Creek watershed is approximately 26,000 acres in size and flows into the Salmon River at river mile 13.8, with its headwaters originating on Craig Mountain. Land ownership within the drainage consists of 12,774 acres (50%) Idaho Department of Fish and Game (IDFG), 7,049 acres (27%) Nez Perce Tribe (NPT), 3,673 acres (14%) private, 1,161 acres (4%) Bureau of Land Management (BLM), and 961 acres (3%) Idaho Department of Lands (IDL). Deer Creek is approximately 17 miles in length, and elevations in the drainage range from nearly 1,100 at the mouth to 5,000 feet on Craig Mountain.

The Columbia River basalt group is the common geologic parent material for the Deer Creek watershed. It consists of a series of extrusive volcanic flows measuring 2,000 to 4,000 feet in thickness. The basalt is about 15 million years old and postulated to have flowed from a gigantic meteorite crater located in southeastern Oregon. Drainages developed in basalt by stream erosion consist of deeply incised valleys, with vertical to nearly vertical walls. Differential erosion of basalt flows creates narrow flat benches giving the appearance of a series of distinct layers or stair steps along the hillsides. Soils developed in basalt are typically loams to clayey loams. Landforms common to erosion of metamorphic rocks tend to be very steep sided and narrow valleys of varying length (BLM 2008).

Deer Creek provides spawning and rearing habitat for steelhead trout and rearing habitat for juvenile spring/summer chinook salmon in the lower reaches. A full fish passage barrier occurs at stream mile 4.0, which consists of a 17-foot falls. Deer Creek falls occurs near stream mile 6.9, and consists of an 80-foot falls. The mouth section may provide habitat for rearing subadult/adult bull trout and cutthroat trout when stream conditions are suitable. No documentation of bull trout or cutthroat trout is known to

exist for the drainage. Redband/rainbow trout (sympatric) are found in the drainage. However, further genetic analysis is needed regarding redband/rainbow trout occurring above fish passage barriers.

Brook trout are the most common fish species occurring in the upper drainage (upstream from stream mile 7.0) (BLM 2008). BURP surveys conducted in the watershed have also documented rainbow trout in the lower reaches of the watershed and brook trout in the Larabee Meadow section (upper).

The lower 7–mile portion of Deer Creek flows through a steep sloped "V" shaped canyon and the dominant channel type is A. The upper portion of the drainage flows through a low gradient meadow, and B and C channel types are common. The lower portion of the drainage primarily consists of canyon grasslands with patterned grasslands and timbered areas in the breaklands. The upper portion of the drainage flows through a moderately sloped plateau area with meadow areas surrounded by forest lands (BLM 2008).

A monitoring site was established in the upper section within Larabee Meadows in 2007. Data generated during 2007 and 2008 is discussed in section 2.4.

## Snake River Tributaries

### *Wolf Creek (17060101SL024_04 and 025_02, 03, and 04)*

Wolf Creek is a fourth order tributary to the Snake River and the watershed encompasses approximately 27,000 acres, flowing into the Snake River at river mile 202. Wolf Creek originates on the Joseph Plains area at an elevation of approximately 4,800 feet near Boles, and flows in a general south to southwest direction to it's confluence with the Snake River at an elevation of approximately 1,050 feet. In the lower reach, the dominant channel type is A—steep gradient with riffle-pool habitat. Discharge measurements recorded in 2007 and 2008 ranged from nearly 37 cfs to approximately 1 cfs during the low-flow baseflow season.

Land uses in the watershed consist of ranching and timber harvest, with rural residences in the upper sections of the watershed. A partial fish barrier exists in Wolf Creek near stream mile 0.7 (John'son 2008). No BURP surveys have been conducted within the watershed, but adult steelhead have been observed in the upper reaches of the creek (John'son 2008). The Idaho Department of Fish and Game conducted 19 snorkeling (fish-counting) surveys on Wolf Creek from 1985 through 1991 and identified numerous steelhead and trout fry.

### *Divide Creek (17060101SL028_02 and 03)*

Divide Creek is a third order tributary to the Snake River and the watershed encompasses approximately 19,500 acres, flowing into the Snake River near river mile 193. Divide Creek originates on the Joseph Plains area at an elevation of approximately 4,800, west of the Wolf Creek drainage, and flows in a general west to south direction to its confluence with the Snake River at an elevation of approximately 1,000 feet. Channel types within the watershed consist primarily of A and B reaches, with bankfull widths, on average, of 3 meters. Land uses in the watershed consist of ranching and timber harvest, with rural residences in the upper sections of the watershed

Four BURP surveys have been conducted within the watershed: three sites on the third order segment, and one site on the second order segment. Rainbow trout (potential steelhead) and unspecified Pacific Salmon/trout were observed in the third order segment of Divide Creek. Craig John'son, Fisheries Biologist with the United States Bureau of Land Management (BLM), stated that the Divide Creek watershed supports spawning and rearing of steelhead (John'son 2008).

A monitoring site was established near the mouth in 2007. During bi-weekly visits, discharge measurements were recorded, which ranged from 15 cfs to approximately 0.2 cfs. Data generated from these monitoring events is shown in section 2.4.

## 1.3 Cultural Characteristics

### Population and Land Use

Populated areas within the Lower Salmon River Subbasin are moderately distant from each other. The larger towns of Riggins and White Bird are centered around the Highway 95 corridor. Rural residences on the Joseph Plains area on or near Wolf and Divide Creeks are sparse. Shown in Table 4 is an estimate of the population for the towns or populated areas that are incorporated within the Lower Salmon River Subbasin as of July 1, 2006 (Idaho Dept. of Labor, 2008). Populations of Slate Creek, Keuterville, and Lucille are unknown, but are estimated to be less than 100 individuals.

**Table 4. Population estimate for towns near or within the lower Salmon River Subbasin (July 1, 2006 estimate).**

| Town Name | Population |
|---|---|
| Riggins | 407 |
| Lucile | <100 |
| Slate Creek | <100 |
| White Bird | 108 |
| Keuterville | <100 |

The Lower Salmon River subbasin includes a total of 793,600 acres. Bureau of Land Management (BLM) lands within the subbasin total 51,761 acres (7%). Private lands comprise the majority of the subbasin, followed by United States Forest Service (USFS), BLM, Idaho Department of Fish and Game (IDFG), and Idaho Department of Lands (IDL).

Common land uses within the Lower Salmon River Subbasin on non-federal lands include agriculture, logging, roads, livestock grazing along the river corridor, recreation, transportation along U.S. Highway 95, urban development, residences, and water uses. Historically, mining was a major land use along the Salmon River and in the Florence area. Common land uses that occur on federal lands include timber harvest, roads,

livestock grazing, mining, and recreation. These land uses have had varying levels of effects on riparian areas, water quality, stream channels, and fish habitat.

Land uses within the Hells Canyon Subbasin include livestock grazing along the river corridor, timber harvest, recreation, agriculture, and residences. Figures 4 and 5 generally display the different types of lands in relation to the monitored water bodies in each subbasin.




**Figure 4. Land Uses within the Lower Salmon River Subbasin**

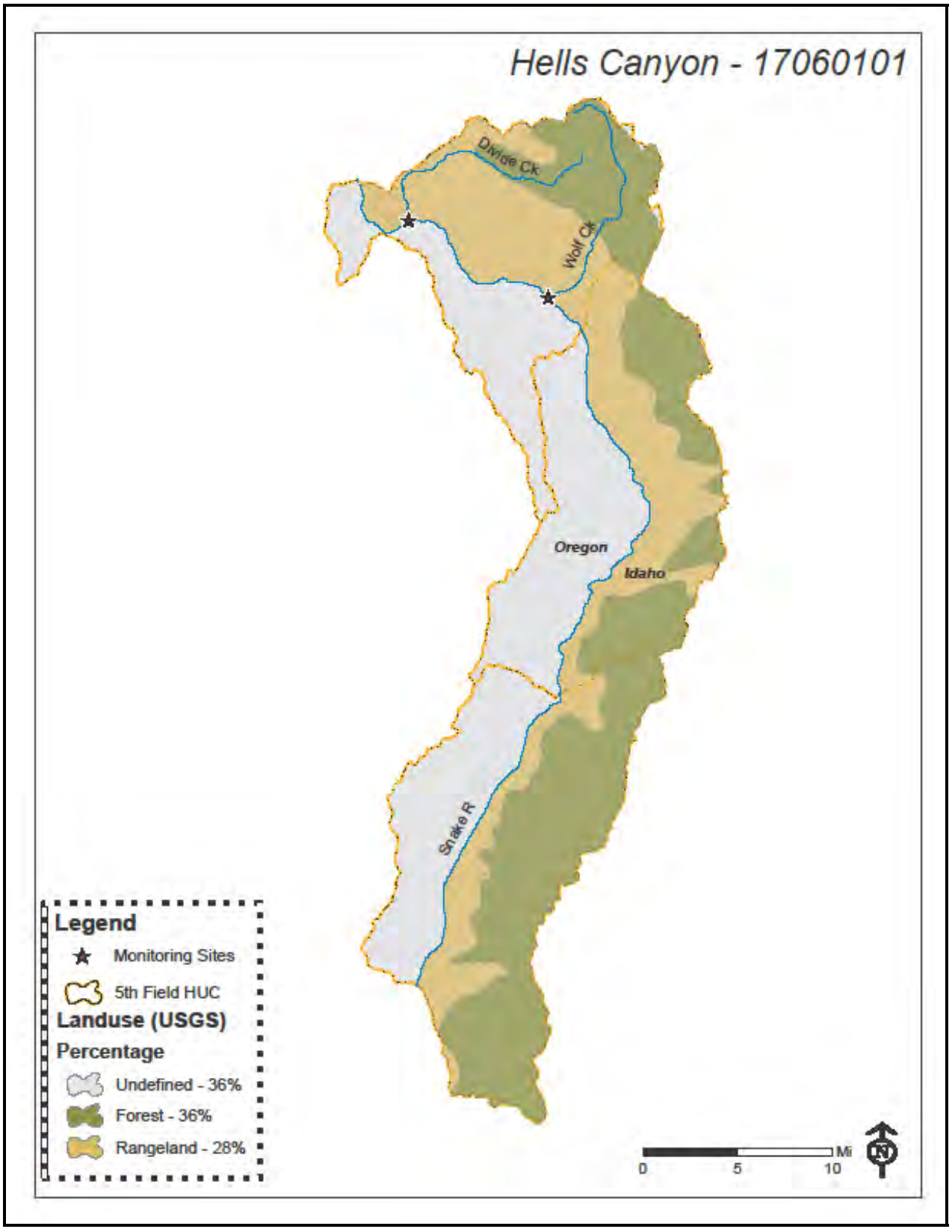



**Figure 5. Land Uses within the Hells Canyon Subbasin**

## History

The historic narrative below was obtained from the United States Bureau of Land Management (BLM) Web site (BLM 2008).

### *Pre-Historic - (before written records)*

The first human inhabitants of the Lower Salmon River were Native Americans who lived in the canyon over 11,000 years ago. Climatic conditions were cooler than today. People probably relied on deer, elk, small game, fish, and a multitude of plant resources found in the canyons and the surrounding area for nourishment.

The climate changed around 8,500 years ago with a peak in aridity and much hotter conditions than today. The human inhabitants adapted to the new conditions by becoming less reliant on big game for food and placing a greater dietary emphasis on plant, river mussel, and fish resources. The climate slowly moderated with increasing precipitation and cooler temperatures by 4,000 years ago. During this period, the use of plant resources and river mussels continued to increase, with big game remaining part of the diet.

Pits related to villages from those periods can still be seen today along the Lower Salmon River. The people who lived in these riverside villages hunted deer, elk, and mountain sheep and relied on salmon, steelhead trout, and mussels as important food sources.

As the area's population increased, people began to move seasonally with the migrations of large game animals, although they continued to winter in permanent villages composed of pit houses. The importance of salmon, steelhead, and root crops as food sources grew. Roots of the cous, found in river canyons, and camas, common in moist upland meadows and prairies, were eaten raw or baked and stored for winter use.

Around 1720, the Nez Perce Indians, long-time inhabitants of the Lower Salmon River area, obtained horses and a new era was born. Horses enabled the Nez Perce to travel greater distances and expand their already extensive trade networks. Trading and hunting trips into what are now Oregon and Montana became common.

Rock art created by pre-historic and historic inhabitants of the Lower Salmon River area is still visible in many places. Pictographs, designs painted on the surface of rocks, can be found along the river. The function of pictographs is unknown. They may have been drawn to represent events, serve as trail markers, or send messages to others. Along the Lower Salmon River, the pictographs are usually red. The paint was made by grinding ochre, or iron oxide, and mixing it with oil or grease and resin.

### *Historic (after written records began)*

The historic period of the Lower Salmon River region begins with the arrival of Meriwether Lewis and William Clark in 1805. It was the first significant contact between the Nez Perce Indians and the Euro-Americans. Lewis and Clark traveled along the Clearwater River to the north. Although they did not visit the Lower Salmon River, Sergeant Ordway, a member of their party, traveled to an area around the confluence of the Salmon and Snake Rivers. Soon after, fur trappers began to enter the region. One of the first was Donald McKenzie, who arrived at the confluence of the Little Salmon and

Salmon Rivers, near Riggins, in 1811. He traveled along the Salmon River to the White Bird area before continuing north on his search for areas rich in fur.

In 1855, the Nez Perce Indians signed a treaty that established a reservation, with the understanding that the tribe would retain control over most of their territory, which included the entire Lower Salmon River. But in 1860, gold was discovered on Nez Perce land, creating pressure from Euro-Americans to change the reservation boundaries. In 1863, a new treaty was drafted which greatly reduced the tribe's territory. Only a portion of the Nez Perce agreed to this new treaty. Those who did not agree were forced to move into the new treaty area in 1877. Before moving to the reservation at Lapwai, several young Indians camped at Tolo Lake near Grangeville and killed some of the white settlers along the Salmon River near White Bird. This instigated a confrontation between the U.S. Army and the Nez Perce Indians which erupted into the Nez Perce War.

The first battle was fought at what is now the White Bird Battlefield on June 17,1877. After this initial fight in which no Indians were killed, Chief Joseph and other Nez Perce chiefs led their party across the Salmon River at Horseshoe Bend, near the mouth of Slate Creek. They traveled across Joseph Plains to the west, then turned north and crossed back over the Salmon River near Billy Creek. From Billy Creek they went east, passing Cottonwood and continued that direction until they arrived in the area of Missoula, Montana. The party then turned south into Idaho, then east through Yellowstone National Park, then north to Montana where they were captured in October of 1877, only a few miles from the Canadian border. About 750 Nez Perce people began this arduous journey of 1,170 miles. After fighting almost the entire way, only 418 Nez Perce were still with the group when they were captured. The others had been killed or escaped. The trail the party followed has been designated the Nez Perce National Historic Trail.

### *Mining*

Mining began along the Salmon River in 1860 with the discovery of fine, or "flour," gold. The area was mined intensively through the 1880s. Mining activity continued through the early 1900s with another large influx of miners during the Depression years of the 1930s. Miners used several methods to extract gold from placer deposits, the loose gravel and soil deposited by the river in terraces. In the widely used hydraulic method, water was transported from a nearby stream into a reservoir or pressure box where it funneled into a large moveable nozzle called a "hydraulic giant." A stream of high pressure water was then used to break up the hillside. The excavated material was carried away in sluice boxes with artificial riffles installed to catch the heavier gold. The larger rocks were pitched out into tailing piles. Today evidence of hydraulic mining, high vertical banks, extensive rock tailing piles and remnants of ditches, canals, and reservoirs can be seen along the Lower Salmon River. The total amount of gold removed from this area is unknown. Miners also attempted to mine copper north of White Bird and near the Salmon and Snake River confluence.

The presence of Chinese immigrants, who came to work the newly discovered gold fields along the Lower Salmon River in the 1860s, forms an interesting part of the area's history. Most Chinese mining along the river occurred between 1870 and 1900. Immigrants left extreme poverty in their homeland and came to America to work and save money so they could return to China as wealthy individuals. The Chinese

maintained much of their native culture since they planned on returning home, although many eventually decided to stay. They were often victims of discrimination, frequently chased off their claims, robbed, and sometimes murdered. The laws of many mining districts prohibited the Chinese from mining. Since the mineral values along the Lower Salmon River were comparatively low, the Chinese were generally allowed to mine there without much interference. The Chinese who lived along the river usually built rock structures containing a fireplace with a wooden framework over the top, probably covered with canvas. Many of these rock structures are still standing today. An excellent example can be found just below Half 'n Half rapids.

Mining was prohibited on land within 1/4-mile of the Lower Salmon River in 1986 when the BLM withdrew the area from mineral entry.

### *Agriculture and Ranching*

Although most of the land along the Lower Salmon is not suitable for agriculture, some gardens and orchards were planted along the river. Some miners, especially the Chinese, maintained garden plots at their mine sites. Most of the land along the Lower Salmon River is, however, suited to ranching. Settlers brought the first cattle to the region in the early 1860s. Grazing from 1890 to 1940 was unrestricted and quite heavy, much heavier than would be acceptable today. Sheep were also brought to the area. Feuds arose between cattle and sheep ranchers over use of the range. The feuds sometimes resulted in poisoned water holes, crop destruction, and even murder. All land along the Lower Salmon River is still grazed today, primarily from November through May. Ranching continues to be an important part of the regional economy.

### *Transportation*

Ferries were critical to move both people and livestock across the forbidding barrier of the Lower Salmon River in the days before bridges were built. By the early 1900s, many areas in Idaho were settled with a system of trails and roads that led to small communities, homesteads, and mines. The stage road between White Bird and Riggins was completed between 1894 and 1898. When highway 95 was constructed in 1931, it obliterated most of the stage road. Northern Pacific completed the first railroad survey along the river from Salmon to Lewiston in 1872. However, construction was not feasible due to high cost. From 1920 to 1940, a road from Rock Creek to White Bird, paralleling the Lower Salmon River, was planned to shorten the distance between Cottonwood and White Bird. The road was under construction in 1939 but was abandoned in 1940, reportedly because of political pressure from the nearby town of Grangeville, which would have been bypassed. A 3-mile segment of that road now provides access to the Pine Bar Recreation Site, and a 3-mile segment also allows access from White Bird to Lyons bar.

### *Boating History*

Nez Perce Indians used canoes, ranging from 15 to 40 feet long, and water-tight skin boats on the Lower Salmon River. A fur trapping expedition attempted to boat the Salmon River in a small skin canoe in 1832. The Journey ended in failure when two men drowned and two others walked out of the canyon. Surveyors conducting the 1872

Northern Pacific railroad survey traveled much of the river in boats built in Salmon, Idaho. In the 1870s boating on the Salmon River began in earnest when large wooden scows were built to transport mining supplies down river. These scows were probably patterned after similar boats used on the Mississippi River a century before. The scows, 32 feet long and 8 feet wide, with double hulls and 3-fot high gunwales, could be built in three days. They were steered by two boatmen operating "sweeps," two 22- to 28-foot poles with 12- to 14-foot blades, set on a pivot, one on the bow and one on the stern. At the end of each trip, the scows were dismantled and the wood was sold for building materials since there was no way to get them back upstream. This is how the Salmon River earned the nickname "River of No Return." The most famous river man on the Salmon in the early days was Captain Harry Guleke, who piloted scows down the river from 1896 through the 1930s. His trips included a National Geographic Expedition in 1935. Although you won't see wooden scows on the river today, you can see a replica built for the Idaho Centennial in 1990 on display at the Visitor Center in Riggins on Highway 95.

The first known trip on the Salmon River with inflatable craft occurred in 1929 when four men paddled two 9-1/2-foot rubber boats from Shoup to Riggins. Wooden dory-style boats first appeared in 1936. In 1947, Glen Wooldridge, a Rogue River veteran, ran a 32-foot plywood boat with a 33-horsepower outboard motor upstream from Riggins to Salmon, forever tarnishing the river's "no return" reputation.

Boating as we know it today with kayaks, canoes, rafts, and other crafts began on the Salmon River in the mid-1970s and continues to evolve.

### *Snake River*

The earliest known settlers in Hells Canyon were the Nez Perce tribe. Others tribes visiting the area were the Shoshone-Bannock, northern Paiute, and Cayuse Indians. The mild winters and ample plant and wildlife attracted human habitation. Pictographs and petroglyphs on the walls of the canyon are a record of the Indian settlements.

In 1806, three members of the Lewis and Clark Expedition entered Hells Canyon along the Salmon River. However, they turned back without seeing the canyon. It wasn't until 1811 that the Wilson Price Hunt expedition explored Hells Canyon while seeking a shortcut to the Columbia River. Hunger and cold forced them to turn back, as with many explorers who were defeated by the canyon's inaccessibility. There remains no evidence in the canyon of their attempts; their expedition journals are the only record.

The early miners were next to follow. In the 1860s, gold was discovered in river bars near what is now the Hells Canyon National Recreation Area, and miners soon penetrated Hells Canyon. Gold mining was not profitable here and evidence remains of their endeavors visible along the corridor of the Snake River. Later efforts concentrated on hard-rock mining, requiring complex facilities, and evidence of the history of these developments are on view today, especially near the mouth of the Imnaha River. In the 1880s, there was a short-lived homesteading boom but the weather was too severe for farming and they soon gave up. Some ranchers still remain today operating within the boundaries of the National Recreation Area.

## Economics

The principal industries in the Lower Salmon River Subbasin are recreation and tourism, agriculture, ranching (stock raising and production), and silviculture. Cities and towns are isolated from Hells Canyon; guides and outfitters that live in surrounding communities rely on the Hells Canyon reach of the Snake River for recreational uses.

Year-long recreational uses, such as white water rafting, jet boating, and sport fishing, are vital to local economies like Riggins, White Bird, and Grangeville, that depend on the continuation of these recreational activities. The Lower Salmon River receives approximately 350,000 recreation visits per year. The majority of these visits occur on developed recreation sites and involve short visits lasting less than 1/2 hour. Primary activities during these visits include use of restroom facilities, picnicking, swimming, and other general leisure activities. Other major activities include float boating (30,000 daytime and 7,000 overnight visits). The majority of the day use occurs between French Creek and Lucile. The majority of the overnight use occurs below Hammer Creek (river mile 53). Fishing (10,000 visits per year estimated), including bank fishing, accounts for 40% of the total use (BLM 2008).

Agricultural crop production, associated agribusinesses, ranching, and logging are the dominant income sources for families on the Camas Prairie and private land owners in the sub-watersheds. Other major employers in the subbasin include the U.S. Forest Service, BLM, Bennett Forest Industries, school districts, and local and county governments. Snowmobiling as well other recreational activities provide additional revenue to the local communities.

# 2. Subbasin Assessment – Water Quality Concerns and Status

This section identifies the applicable water quality standards (WQS) for the water quality limited water bodies in the two subbasins, describes the relationship between pollutants and beneficial uses, and provides a summary and analysis of the existing water quality data.

## 2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

Section 303(d) of the Clean Water Act (CWA) states that water bodies that are unable to support their beneficial uses and that do not meet water quality standards must be listed as water quality limited. Subsequently, these waters are required to have TMDLs developed to bring them into compliance with water quality standards.

### About Assessment Units

Assessment units (AUs) define the waters of the state of Idaho. These units and the methodology used to describe them can be found in the Water Body Assessment Guidance, second edition (Grafe et al. 2002). Stream order is the main basis for determining AUs. Using AUs fulfills the fundamental requirement of the 305(b) report, which is required under the Clean Water Act, wherein states report on the condition of all the waters of the state. Because AU numbers are an extension of water body identification numbers—and water quality standards are specific for each water body with an identification numbers—there is now a direct tie to the water quality standards for each AU, so that beneficial uses defined in the water quality standards are clearly tied to streams on the landscape.

However, the new framework of using AUs for reporting and communicating needs to be reconciled with the legacy of 303 (d)-listed streams. Due to the nature of the court-ordered 1994 303(d) listings, and the subsequent 1998 303(d) list, all segments were added with boundaries from "headwater to mouth." In order to deal with the vague boundaries in the listings, and to complete TMDLs at a reasonable pace, DEQ set about writing TMDLs at the watershed scale (according to hydrologic unit code [HUC]), so that all the waters in a given drainage are considered for TMDL purposes, and have been since 1994.

The boundaries from the 1998 303(d)-listed segments have been transferred to the new AU framework, using an approach quite similar to how DEQ has been writing SBAs and TMDLs. All AUs contained in the listed segment were carried forward to the 2002 303(d) listings now identified in Section 5 of the integrated report. AUs not wholly contained within a previously listed segment, but partially contained (even minimally), were also included on the 303(d) list. This was necessary to maintain the integrity of the 1998 303(d) list and to maintain continuity with the TMDL program. These new AUs will lead to better assessment of the need for water quality listing and de-listing.

When assessing new data that indicate full support, only the AU that the monitoring data represents will be removed (de-listed) from the 303(d) list (Section 5 of the integrated report).

## Listed Waters

Table 5 shows the pollutants listed and the basis for listing for each §303(d) listed AU in the lower Salmon River and Hells Canyon Subbasins. Not all of the water bodies will require a TMDL, as will be discussed later. However, a thorough investigation, using the available data, was performed before any such conclusion was made. This investigation, along with a presentation of the evidence of non-compliance with standards for several other tributaries, is contained in the following sections.

**Table 5. §303(d)-Listed Segments in the Lower Salmon River and Hells Canyon Subbasins.**

| Stream Name* | Assessment Unit | Description | 2008 Integrated Report Listing |
|---|---|---|---|
| Wolf Creek* | ID17060101SL024_04 | Basin Creek to Mouth | Sediment, Temperature |
| Wolf Creek* | ID17060101SL025_02<br>ID17060101SL025_03<br>ID17060101SL025_04 | Source to Basin Creek | Sediment |
| Divide Creek* | ID17060101SL028_02 | Source to Mouth | Sediment |
| Divide Creek* | ID17060101SL028_03 | Source to Mouth | Sediment, Temperature |
| Cottonwood Creek | ID17060209SL003_02 | Source to unnamed tributary | Sediment |
| Billy Creek | ID17060209SL004_02 | Source to Mouth | Unknown |
| Rice Creek | ID17060209SL007_02 | Rice Creek Tributary | Sediment |
| Allison Creek | ID17060209SL028_03 | West Fork to Mouth | Sediment |
| John's Creek | ID17060209SL057_02 | Rock Cr. source to Graves Creek | Sediment |
| Rock Creek | ID17060209SL056_04 | Graves Creek to Mouth | Sediment |
| Rock Creek | ID17060209SL057_03 | Source to Graves Creek | Sediment |
| Graves Creek | ID17060209SL058_02<br>ID17060209SL058_03 | Headwaters to unnamed tributary, unnamed tributary to Rock Creek | Sediment |
| Deep Creek | ID17060209SL060_02 | Deep Cr. source to unnamed tributary | Nutrients Temperature, Bacteria, Sediment |
| Deer Creek | ID17060209SL062_02<br>ID17060209SL062_02a | Deer Creek tributaries, Source to West Fork Deer Creek | Sediment |

*Water body is in Hells Canyon Subbasin

## 2.2 Applicable Water Quality Standards

### Beneficial Uses

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

#### *Existing Uses*

Existing uses under the CWA are "those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards." The existing in-stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.050.02, .02.051.01, and .02.053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water body that could support salmonid spawning, but salmonid spawning is not occurring due to other factors, such as dams blocking migration.

#### *Designated Uses*

Designated uses under the 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 uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.27 and 58.01.02.109-.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 later. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters. If, in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel

dissolved oxygen, temperature). However, if for example, cold water aquatic life is not found to be an existing use, a 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).

Table 6 displays the designated/existing uses for water bodies addressed in this assessment.

**Table 6. Lower Salmon River and Hells Canyon Subbasins beneficial uses of §303(d) listed streams.**

| Water Body | Uses[a] | Type of Use |
|---|---|---|
| Cottonwood Creek | CW, SS, SCR | Existing |
| Billy Creek | CW, SCR | Existing |
| Rice Creek | CW, SS, SCR | Existing |
| Allison Creek | CW, SS, SCR | Existing |
| John's Creek | CW, SCR | Existing |
| Rock Creek | CW, SS, PCR | Designated |
| Graves Creek | CW, SS, SCR | Existing |
| Deep Creek | CW, SS, SCR | Existing |
| Deer Creek | CW, SS, SCR | Existing |
| Wolf Creek[1] | CW, SS, SCR | Existing |
| Divide Creek[1] | CW, SS, SCR | Existing |

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

## Criteria to Support Beneficial Uses

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

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

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

Narrative criteria for floating, suspended, or submerged matter are described in IDAPA 58.01.02.200.05, which states: "Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or

objectionable conditions or that may impair designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities."

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

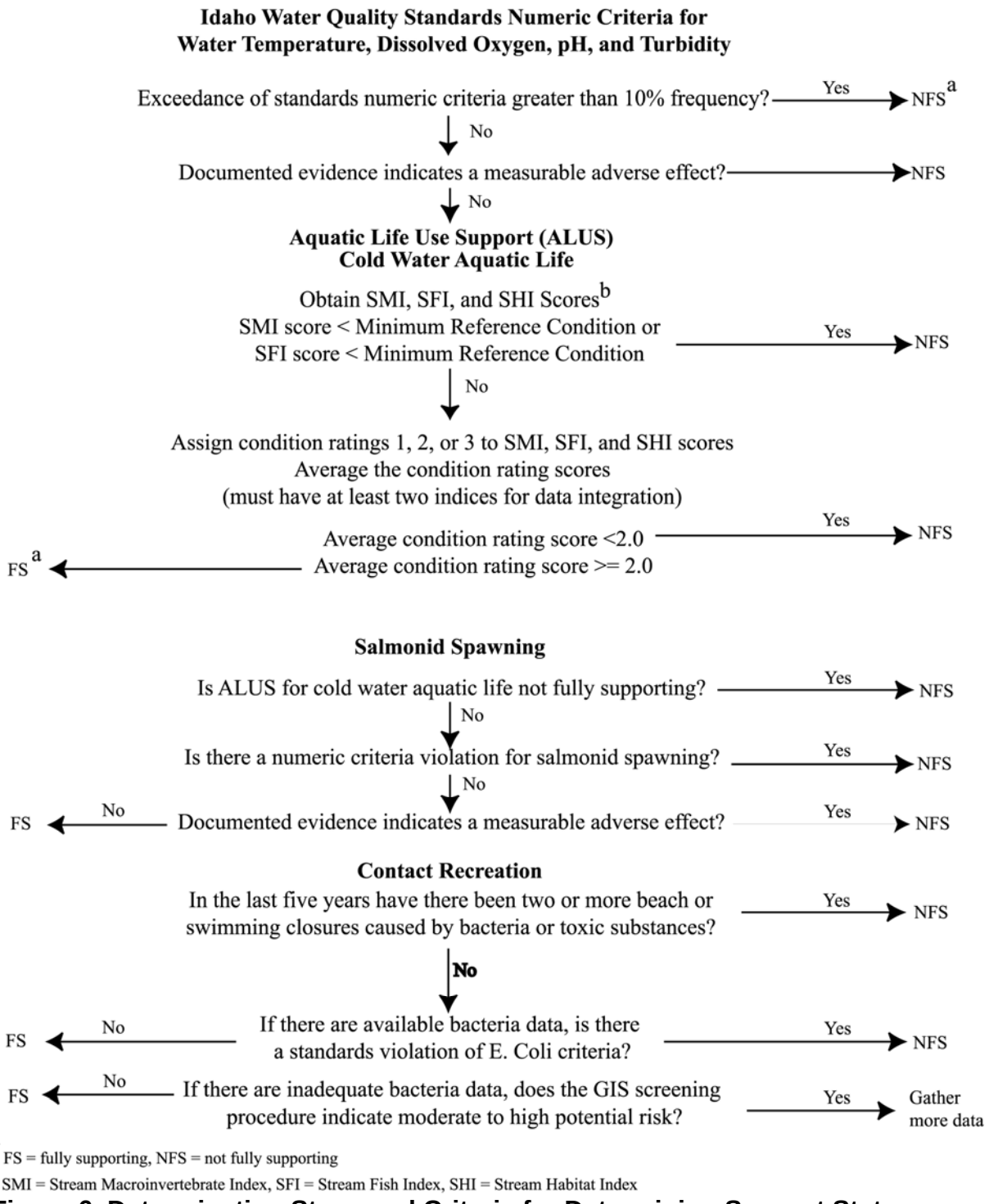
Table 7 includes the most common numeric criteria used in TMDLs.

Figure 6 provides an outline of the stream assessment process for determining support status of the beneficial uses of cold water aquatic life, salmonid spawning, and contact recreation.

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

| Designated and Existing Beneficial Uses | | | | |
|---|---|---|---|---|
| **Water Quality Parameter** | **Primary Contact Recreation** | **Secondary Contact Recreation** | **Cold Water Aquatic Life** | **Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)** |
| **Water Quality Standards: IDAPA 58.01.02.250** | | | | |
| **Bacteria, ph, and Dissolved Oxygen** | Less than 126 *E. coli*/100 ml[a] as a geometric mean of five samples over 30 days; no sample greater than 406 *E. coli* organisms/100ml | Less than 126 *E. coli*/100 ml as a geometric mean of five samples over 30 days; no sample greater than 576 *E. coli*/100 ml | pH between 6.5 and 9.0<br><br>DO[b] exceeds 6.0 mg/L[c] | pH between 6.5 and 9.5<br><br>Water Column DO: DO exceeds 6.0 mg/L in water column or 90% saturation, whichever is greater<br><br>Intergravel DO: DO exceeds 5.0 mg/L for a one day minimum and exceeds 6.0 mg/L for a seven day average |
| **Temperature[d]** | | | 22 °C or less daily maximum; 19 °C or less daily average | 13 °C or less daily maximum; 9 °C or less daily average<br><br>Bull trout: not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June – August; not to exceed 9 °C daily average in September and October |
| | | | Seasonal Cold Water: Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °C or less daily average | |
| **Turbidity** | | | Turbidity shall not exceed background by more than 50 NTU[e] instantaneously or more than 25 NTU for more than 10 consecutive days. | |
| **Ammonia** | | | Ammonia not to exceed calculated concentration based on pH and temperature. | |
| **EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR Part 131** | | | | |
| **Temperature** | | | | 7 day moving average of 10 °C or less maximum daily temperature for June - September |

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




[a] FS = fully supporting, NFS = not fully supporting

[b] SMI = Stream Macroinvertebrate Index, SFI = Stream Fish Index, SHI = Stream Habitat Index

**Figure 6. Determination Steps and Criteria for Determining Support Status of Beneficial Uses in Wadeable Streams: Water Body Assessment Guidance, Second Addition (Grafe et al. 2002)**

## 2.3 Pollutant/Beneficial Use Support Status Relationships

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

### Temperature

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

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

### Dissolved Oxygen

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

Dissolved oxygen levels of 6 mg/L and above are considered optimal for aquatic life. When DO levels fall below 6 mg/L, organisms are stressed, and if levels fall below 3 mg/L for a prolonged period, these organisms may die; oxygen levels that remain below 1-2 mg/L for a few hours can result in large fish kills. Dissolved oxygen levels below 1 mg/L are often referred to as hypoxic; anoxic conditions refer to those situations where there is no measurable DO.

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

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

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

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

## Sediment

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

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

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

In addition to these direct effects on the habitat and spawning success of fish, detrimental changes to food sources may also occur. Aquatic insects, which serve as a primary food source for fish, are affected by excess sedimentation. Increased sedimentation leads to a

macroinvertebrate community that is adapted to burrowing, thereby making the macroinvertebrates less available to fish. Community structure, specifically diversity, of the aquatic macroinvertebrate community is diminished due to the reduction of coarse substrate habitat.

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

## Bacteria

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

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

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

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

## Nutrients

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

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

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

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

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

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

## Sediment – Nutrient Relationship

The linkage between sediment and sediment-bound nutrients is important when dealing with nutrient enrichment problems in aquatic systems. Phosphorus is typically bound to particulate matter in aquatic systems and, thus, sediment can be a major source of phosphorus to rooted macrophytes and the water column. While most aquatic plants are able to absorb nutrients over the entire plant surface due to a thin cuticle (Denny 1980),

bottom sediments serve as the primary nutrient source for most sub-stratum attached macrophytes. The USDA (1999) determined that other than harvesting and chemical treatment, the best and most efficient method of controlling growth is by reducing surface erosion and sedimentation.

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

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

## Floating, Suspended, or Submerged Matter (Nuisance Algae)

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

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

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

When algae die in low flow velocity areas, they sink slowly through the water column, eventually collecting on the bottom sediments. The biochemical processes that occur as the algae decompose remove oxygen from the surrounding water. Because most of the

decomposition occurs within the lower levels of the water column, a large algal bloom can substantially deplete DO concentrations near the bottom. Low DO in these areas can lead to decreased fish habitat as fish will not frequent areas with low DO. Both living and dead (decomposing) algae can also affect the pH of the water due to the release of various acid and base compounds during respiration and photosynthesis. Additionally, low DO levels caused by decomposing organic matter can lead to changes in water chemistry and to the release of sorbed phosphorus into the water column at the water/sediment interface.

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

## 2.4 Summary and Analysis of Existing Water Quality Data

This section summarizes and analyzes the available biological, chemical, and physical data as it relates to determining beneficial use support status and compliance with Idaho water quality standards (WQS). Data used for the development of the TMDL was gathered by DEQ personnel (Appendix B).

A water quality sampling project was conducted by DEQ personnel beginning in March 2007 and continued on a bi-weekly basis for approximately one year. Specific parameters that were sampled for included total phosphorus (TP), nitrite+nitrate-nitrogen ($NO_2$+$NO_3$-N), ammonia ($NH_3$-N), *E. coli* bacteria, total suspended solids (TSS), stream temperature, flow, and dissolved oxygen. Instantaneous sampling occurred approximately every two weeks at 11 sites throughout the Lower Salmon River and Hells Canyon Subbasins. The established monitoring sites are shown in Figures 7 and 8.

Various environmental conditions prohibited data collection at times during the monitoring year—snow accumulation on Craig Mountain caused road closures and therefore access to Deer Creek during winter and early spring wasn't possible; Salmon River road to Allison Creek was under construction and closed a majority of the time, making access to the site difficult; two perennial streams (Cottonwood Creek and John's Creek) and one intermittent stream (Deep Creek) went dry in 2007; Rice Creek at the established monitoring site near the mouth gets backed up every year when runoff occurs in the main stem Salmon River—which is reflected in the data set (Appendix B). Additionally, it is important to note that event-based data (i.e., during peak flows) is very limited because of sampling frequency and duration. The assessments below are based on the available water quality data.

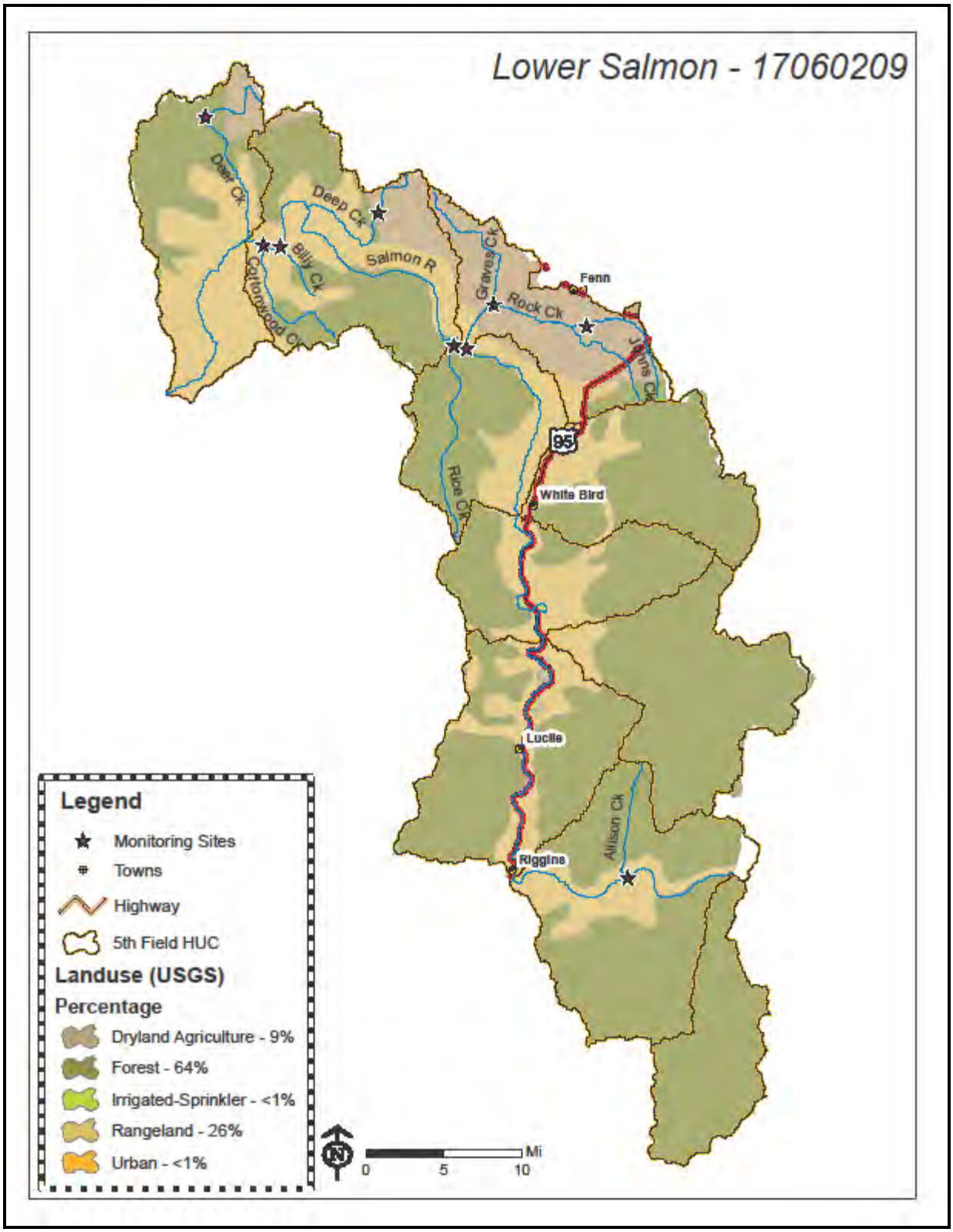



**Figure 7. Established Monitoring Sites in the Lower Salmon River Subbasin.**

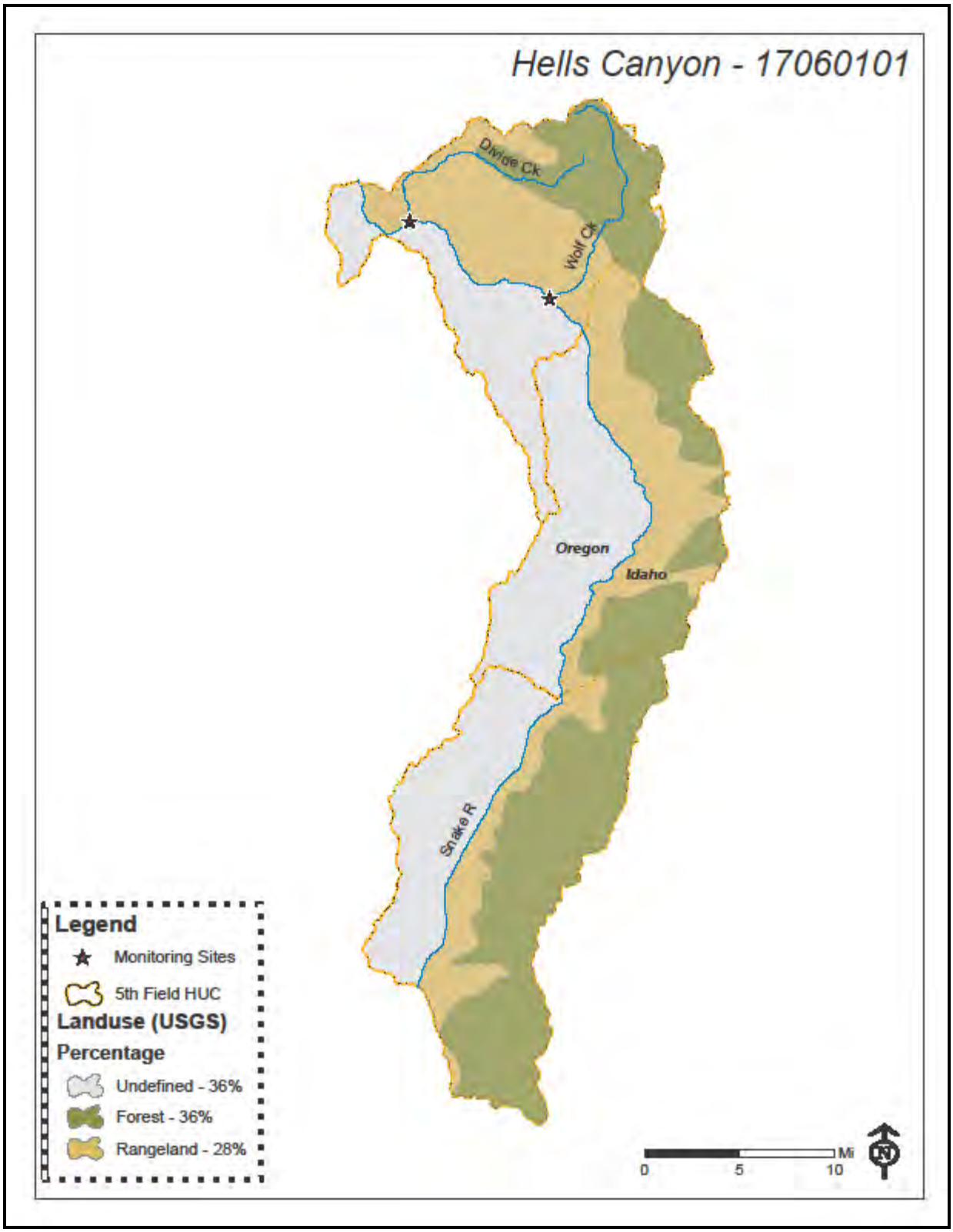



**Figure 8. Established Monitoring Sites in the Hells Canyon Subbasin.**

## Flow Characteristics

No permanent gage stations that measure discharge exist within the sub-watersheds where routine monitoring occurred. Flow measurements were collected on a bi-weekly basis at each monitoring site unless conditions prohibited such efforts (Appendix B). Table 8 summarizes the measured discharges for each monitoring site.

**Table 8. Summary of measured discharge for each monitoring site.**

| Water Body | Maximum Discharge (cfs) | Minimum Discharge (cfs) | Mean Discharge (cfs) |
|---|---|---|---|
| Cottonwood Creek | 13.7 | Dry | 5.2 |
| Billy Creek | 3.2 | 0.1 | 1.0 |
| Rice Creek | 66.3 | 1.8 | 12.3 |
| Allison Creek | 37.8 | 5.7 | 13.0 |
| John's Creek | 21.1 | Dry | 4.9 |
| Rock Creek | 84.9 | 2.2 | 16.6 |
| Graves Creek | 30.4 | 0.9 | 5.9 |
| Deep Creek | 20.0 | Dry | 5.8 |
| Deer Creek | 9.5 | 0.3 | 1.8 |
| Wolf Creek* | 36.7 | 0.9 | 11.1 |
| Divide Creek* | 15.1 | 0.2 | 4.3 |

*Tributary to Hells Canyon Subbasin (17060101).

Three water bodies went dry for at least one month during 2007 (Table 8). The decline in overland runoff and ground water recharge, and the lack of adequate ground water upwelling that sustains perennial flow during the critical flow period, resulted in categorized perennial water bodies—John's Creek and Cottonwood Creek—drying up (Appendix B).

During the majority of the period monitored (2007), the North Central Prairie as well as the North Central Canyon locations received significantly less precipitation (negative 5.41 inches and 4.84 inches departure from normal, respectively). Additionally, total annual precipitation for 2006 was less than normal throughout the subbasin. The significant deficit in precipitation during 2007 and below normal precipitation in 2006, coupled with higher than normal ambient air temperatures (+1.1- +1.6 $^{o}$F, respectively) resulted in lower than normal in-stream flows as is illustrated in Figure 9. Figure 9 displays the average monthly discharge during the summer months (June-September) of 2007 in relation to the long term monthly average (1910-1917, 1919-present) in the main stem Salmon River at White Bird, Idaho.

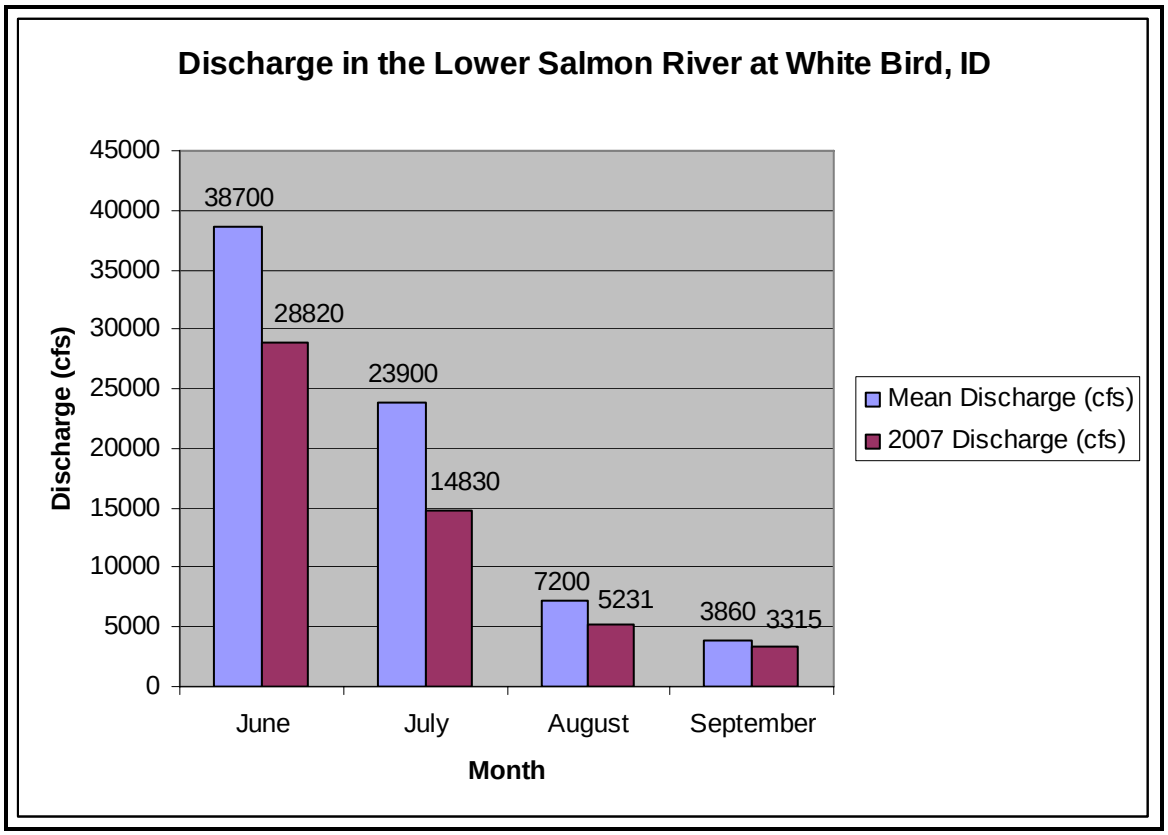



**Figure 9. Average Monthly Discharge in the Salmon River, June through September 2007, compared to the Long Term Average Discharge**

## Water Column Data

### *Pathogens*

The Idaho WQS address frequency for bacteria criteria exceedances in the primary and secondary contact recreation criteria by using triggers or instantaneous criteria for additional sampling (IDAPA 58.01.02251.01 & 02). If further sampling is required, then a geometric mean is calculated and interpreted to determine whether there is a violation. The state of Idaho criteria for the protection of contact recreation uses are:

1)Primary Contact Recreation (Rock Creek)
*E. coli* bacteria is not to exceed 126 colony forming units per 100 milliliters of solution (cfu/100 ml) as a 30-day geometric mean. The instantaneous trigger to require obtaining additional samples is 406 cfu/100 ml.

2) Secondary Contact Recreation (All other monitored water bodies)
*E. coli* bacteria is not to exceed 126 cfu/100 ml as a 30-day geometric mean. The instantaneous trigger to require gathering of additional samples is 576 cfu/100 ml.

Instantaneous sampling for *E. coli* bacteria occurred bi-weekly (Appendix B). Additional monitoring was conducted to assess compliance with Idaho's geometric mean criterion from late May through early June in 2008, at the sites accessible by land, with the

exception of Rice Creek; the other four sites were sampled from 7/6/2008 through 7/20/2008. Additional sampling took place in Allison Creek in January 2009. Rice Creek was not assessed because the monitoring site was backed up from the Salmon River as runoff was occurring (Appendix B). Table 9 shows the 5 sample 30-day geometric mean concentrations from the sampling events.

**Table 9. Existing geometric mean concentrations of E. coli bacteria.**

| Water Body | 5 Sample 30-day E. coli Bacteria Concentration (cfu/100 ml) | 30 day E.Coli Bacteria Concentration (cfu/100 ml) |
|---|---|---|
| Cottonwood Creek | 30 | 502 |
| Billy Creek | 150 | 2087 |
| Rice Creek | Not Assessed | 201 |
| Allison Creek | 162 | |
| John's Creek | 723 | |
| Rock Creek | 468 | |
| Graves Creek | 205 | |
| Deep Creek | 82 | 804 |
| Deer Creek | 22 | |
| Wolf Creek | 32 | |
| Divide Creek | 37 | 148 |

In comparison with the data presented in Appendix B, the 5 sample 30-day geometric mean results listed in Table 9 are considered representative of the critical time period concentrations found in Rock Creek, Graves Creek, John's Creek, Deep Creek, Allison Creek, and Wolf Creek. The 5 sample 30-day geometric mean concentrations in Table 9 do not reflect the most critical time period concentrations found in Cottonwood Creek, Billy Creek, Rice Creek, Deep Creek or, Divide Creek since these creeks either appear to have multiple critical time periods, inconsistent critical time periods, or lacked the appropriate data to identify the most critical time period. For these creeks, a more conservative 30-day geometric mean, typically with 3 samples, is presented in Table 9 to better represent concentrations during their most critical time periods.

### *Stream Temperature*

The temperature of a water body usually varies by geographic location because of climate, elevation, coverage of streamside vegetation, and ground water input. Stream temperatures also vary on a daily, seasonal, and annual basis. Air temperature, solar radiation, cloud cover, evaporation, wind, influence of tributaries, and channel width and depth are additional factors that affect stream temperature.

Water bodies in the state of Idaho designated for a cold water aquatic life beneficial use are not to exceed water temperatures of 22 °C (71.6 $^{o}$F), and/or a daily average of 19 °C

(66.2 $^{o}$F) (IDAPA 58.01.02.250.02.b). The cold water aquatic life criteria apply to all waters in the two subbasins when salmonid spawning isn't occurring.

Salmonid spawning criteria of 9 $^{o}$C (48.2 $^{o}$F) as a daily average and 13 $^{o}$C (55.4 $^{o}$F) as a daily maximum apply to the water bodies shown in Table 10. The salmonid species present in each sub-watershed, and the time frame during which the salmonid spawning temperature criteria applies, is also shown in Table 10 (Johnson, Personal Communication 2008).

**Table 10. Time periods of salmonid spawning and incubation in the Lower Salmon River and Snake River tributaries.**

| Stream(s) | Salmonid Species | Dates Criteria are Applicable |
|---|---|---|
| Allison, Cottonwood, Rice, Rock, Graves, Deep, Deer, Wolf, and Divide | Steelhead Trout | March 15- May 15 |
| Deer Creek above the Falls | Brook Trout | September 1 - October 15 |

Analysis of the existing continuous temperature data, displayed in Table 11 and Figures 10 through 14, shows that Idaho's temperature criteria for the cold water aquatic life beneficial use was violated in five of the water bodies. In the section on Data Gaps, it is noted that continuous temperature data should be gathered for the remaining water bodies when possible. The instantaneous temperature data collected from the monitoring season is displayed in Appendix B.

**Table 11. Summary of continuous stream temperature data.**

| Water Body | Assessment Period | MDMT ($^{o}$C) | MWMT ($^{o}$C) | MDAT ($^{o}$C) | MWAT ($^{o}$C) |
|---|---|---|---|---|---|
| John's Creek | 6/30/2005-9/30/2005 | 31.87 | 22.80 | 23.25 | 21.25 |
| Rice Creek | 7/4/2000-10/16/2000 | 24.10 | 23.50 | 21.50 | 20.90 |
| Rock Creek | 6/13/2000-8/12/2000 | 24.00 | 23.00 | 20.80 | 20.00 |
| Divide Creek | 5/10/2001-10/17/2001 | 26.20 | 24.60 | 25.50 | 23.90 |
| Wolf Creek | 6/3/2001-10/31/2001 | 28.00 | 27.00 | 23.60 | 22.80 |

MDMT=Maximum Daily Maximum Temperature, MWMT=Maximum Weekly Maximum Temperature, MDAT=Maximum Daily Average Temperature, MWAT=Maximum Weekly Average Temperature

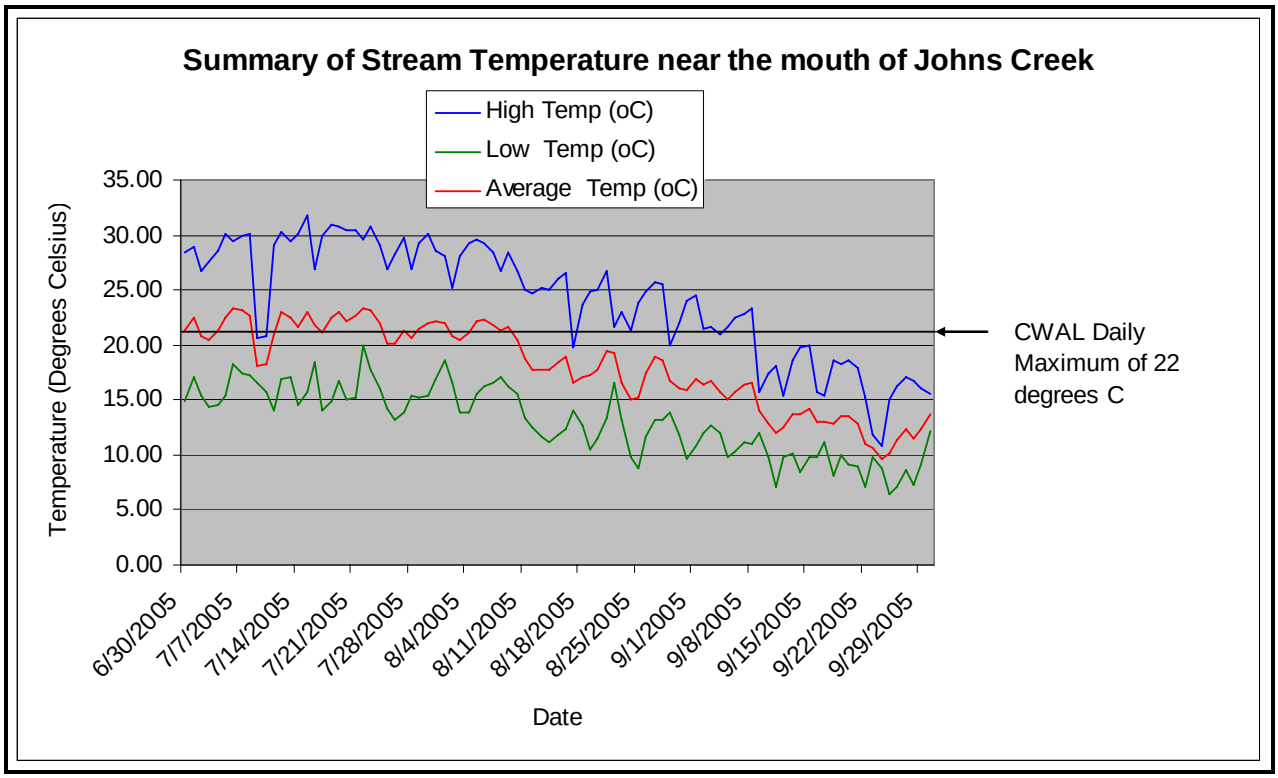



**Figure 10. Continuous Temperature Data collected near the mouth of John's Creek (2005).**

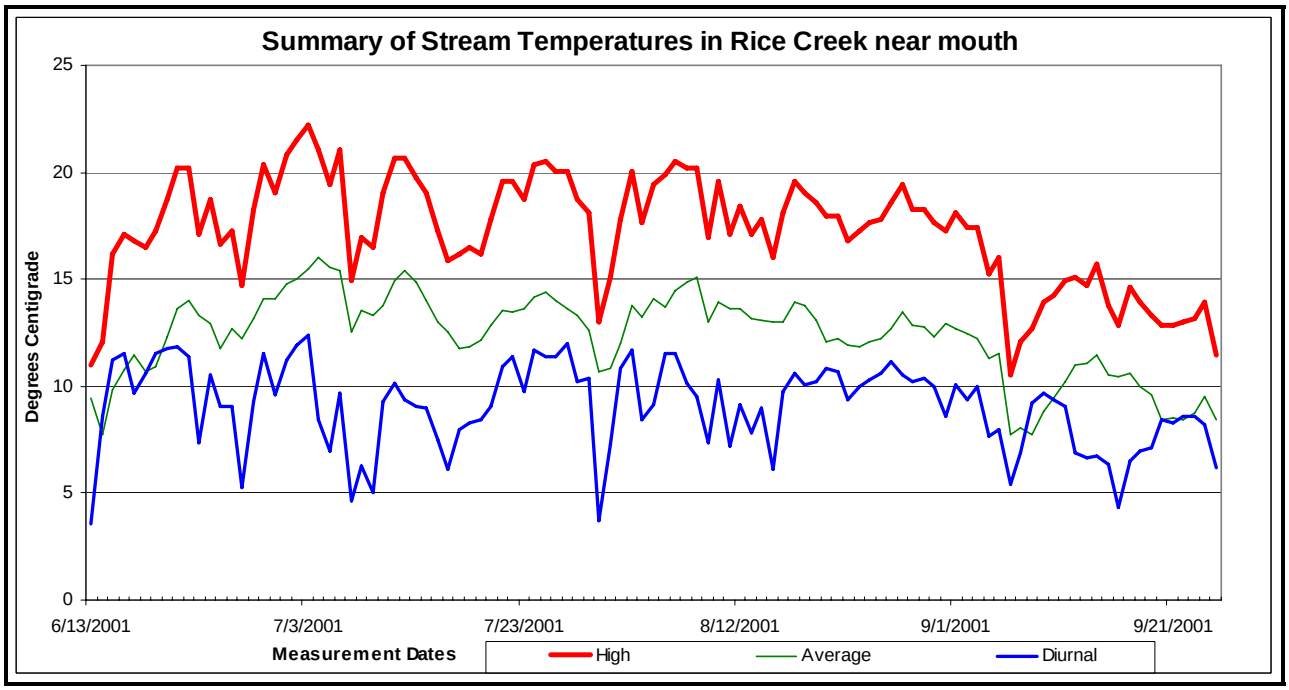



**Figure 11. Continuous Temperature Data collected near the mouth of Rice Creek (2001).**

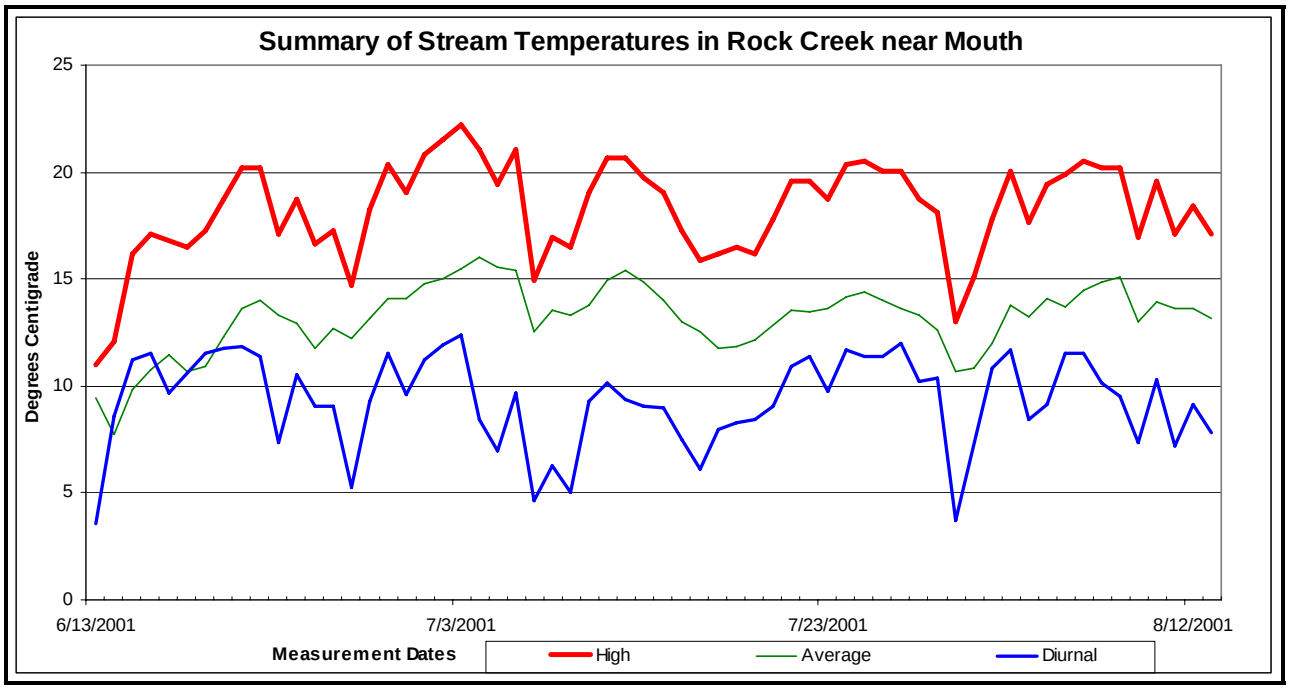



**Figure 12. Continuous Temperature Data collected near the mouth of Rock Creek (2001).**

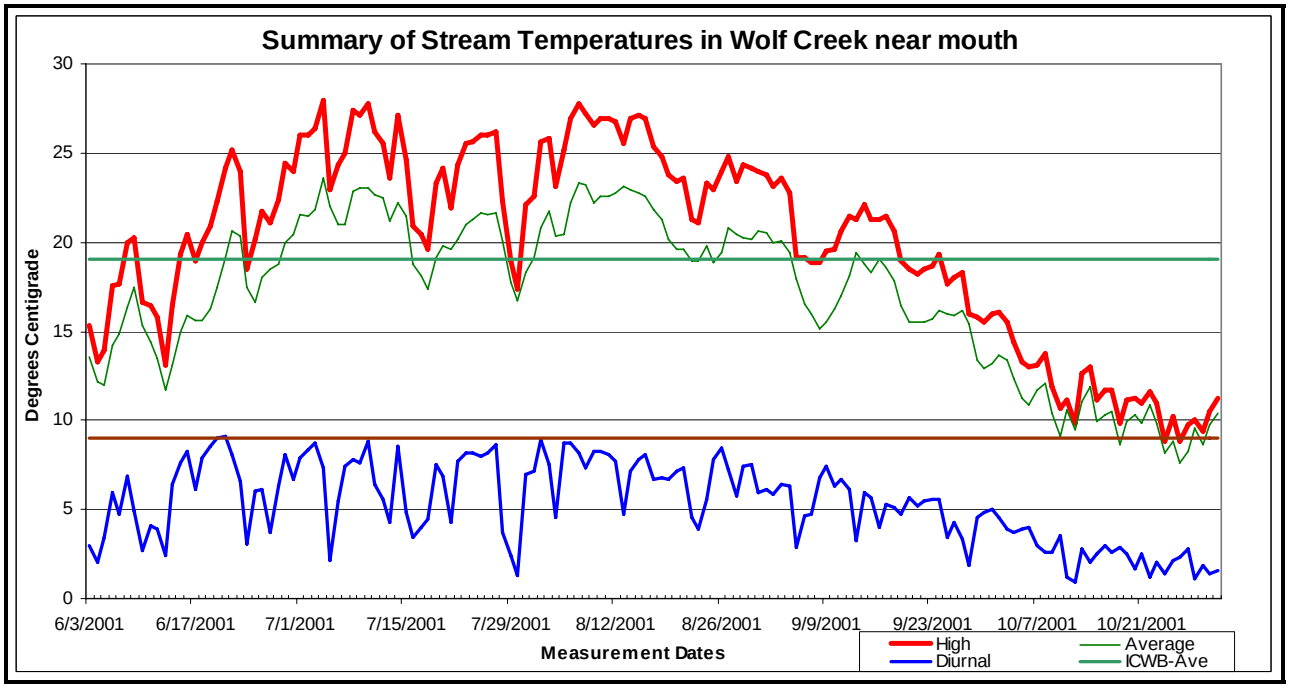



**Figure 13. Continuous Temperature Data collected near the mouth of Wolf Creek (2001).**

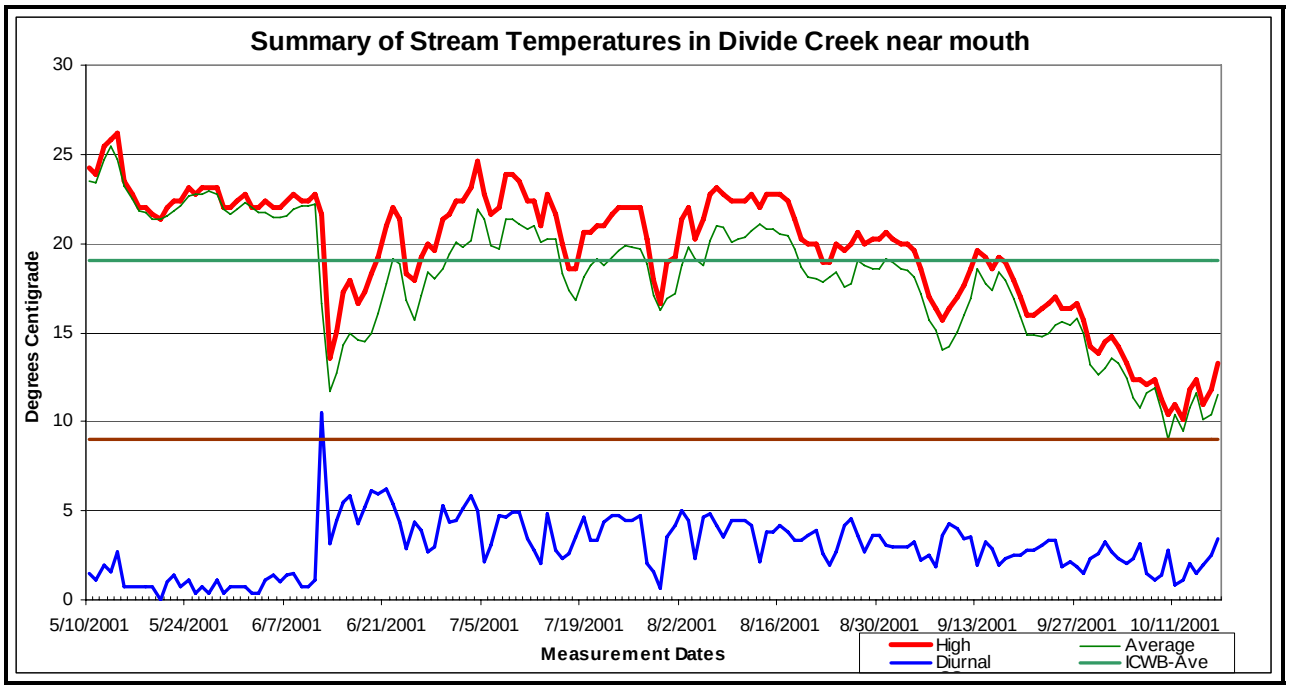



**Figure 14. Continuous Temperature Data collected near the mouth of Divide Creek (2001).**

### *Dissolved Oxygen*

Waters designated for cold water aquatic life must sustain DO concentrations of 6.0 mg/l or greater at all times (IDAPA 58.01.02250.02.a). The Idaho state criterion for DO in a water column for the salmonid spawning beneficial use is a one-day minimum of not less than 6.0 mg/L (IDAPA 58.01.02.250.02.f.2.a).

No violations of the DO criterion of 6.0 mg/L were observed during routine, instantaneous sampling (Appendix B). An analysis of the benthic macroinvertebrate community (5 dominant taxa) in John's Creek identified pollutant-tolerant macroinvertebrates able to occupy habitats with low dissolved oxygen and high nutrient concentrations.

### *Nutrients*

Nutrient criteria found in Idaho Water Quality Standards (58.01.02) is narrative, meaning there is not a numeric value to assess whether a water body is in compliance with standards; instead Idaho's narrative standard for nutrients states, "surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses" (IDAPA 58.01.02. 200.06).

Excessive nutrient loading affects water column DO concentrations and can thereby impair aquatic life beneficial uses due to the increased biological oxygen demand for the growth and decomposition cycle of algae and aquatic vegetation during "critical time periods" when in-stream flows decrease significantly and water temperatures increase. An in-stream DO concentration of 6.0 mg/L is required by Idaho's water quality

standards for protection of aquatic life beneficial uses, and is a component of assessing whether nutrients are impairing the aquatic life beneficial use.

### *Nutrient Data*

The second order segment of Deep Creek (17060209060_02) is the only water body in the lower Salmon River Subbasin listed for nutrients in Section 5 of the integrated report (impaired waters needing TMDLs). Deep Creek, at the established monitoring site, is classified as intermittent (i.e., dry part of year), according to the National Hydrography Dataset, and site observations in July 2007 validated this classification.

Application of Idaho's numeric water quality standards (i.e. DO) for the protection of aquatic life applies to intermittent waters only during optimum flow periods sufficient to support the use. For aquatic life uses, optimum flow is equal to or greater than one (1) cfs (IDAPA 58.01.02.070.06). Flow in Deep Creek dropped below 1.0 cfs in May 2007, prior to the summer months. No violations of the DO criterion of 6.0 mg/L were observed in Deep Creek. Additionally, no visible slime growths or excessive aquatic vegetation growth in-stream were documented during site visits.

Total phosphorus (TP) and nitrite+nitrate as nitrogen ($NO_2$+$NO_3$-N) samples were obtained from Deep Creek to assess the Section 5 listing status. Resultant TP concentrations ranged from 0.19 mg/L to 0.05 mg/L with an average of 0.09 mg/L, while $NO_2$+$NO_3$-N concentrations ranged from 0.73 mg/L to non-detectable (less than 0.05 mg/L) in five of 11 samples (Table 12).

**Table 12. Nutrient data summary for Deep Creek.**

| Sample Date | Flow (cfs) | D.O. (mg/L) | TP (mg/L) | $NO_2$+$NO_3$-N (mg/L) |
|---|---|---|---|---|
| 3/14/2007 | 20.01 | 12.8 | 0.11 | 0.40 |
| 3/28/2007 | 10.07 | 12.7 | 0.05 | 0.14 |
| 4/10/2007 | 3.94 | 12.4 | 0.08 | *ND |
| 4/25/2007 | 3.01 | 10.4 | 0.10 | ND |
| 5/7/2007 | 1.05 | 8.9 | 0.07 | ND |
| 5/22/2007 | 0.87 | 10.7 | 0.11 | ND |
| 6/5/2007 | 0.33 | 8.3 | 0.19 | 0.05 |
| 6/19/2007 | 0.15 | 9.4 | 0.05 | ND |
| 7/1/2007 | Dry | | | |
| 7/17/2007 | Dry | | | |
| 11/6/2007 | Dry | | | |
| 11/19/2007 | 0.50 | 13.4 | 0.08 | 0.17 |
| 1/15/2008 | Inaccessible | | | |
| 3/10/2008 | Frozen | | | |
| 4/9/2008 | 1.70 | 13.2 | | |

| Sample Date | Flow (cfs) | D.O. (mg/L) | TP (mg/L) | $NO_2$+$NO_3$-N (mg/L) |
|---|---|---|---|---|
| 4/21/2008 | 9.39 | 13.0 | 0.07 | 0.73 |
| 4/30/2008 | 16.73 | | | |
| 5/7/2008 | 12.65 | | 0.07 | 0.15 |

*ND = Not Detected

Recommended nutrient concentrations have been established for streams in different sub-ecoregions of Idaho. Sub-ecoregions are based on general similarities in geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. Deep Creek and John's Creek are positioned between the transition zones of two sub-ecoregions: Columbia Plateau (Nez Perce Prairie) and the Blue Mountains (Canyons and Dissected Uplands). The recommended criterion values for TP are 0.030 mg/L and 0.0325 mg/L, respectively; recommend criterion values for $NO_2$+$NO_3$-N are 0.072 mg/L and 0.01 mg/L, respectively.

Observed TP values in Deep Creek are above the recommended criterion values discussed above. However, no violations of the DO criterion were observed and it does not appear that the aquatic life beneficial use is being impaired by visible slime growths or nuisance aquatic growths. As well, the monitoring site goes dry during the typical critical time period (July-September) when violations of the DO criterion are likely to occur as a result of increased biological oxygen demand from nuisance aquatic growths. The TP concentrations predominantly reflect the winter and spring months when TP concentrations are normally higher in-stream as a result of overland runoff and increased sediment loading (Figure 15).

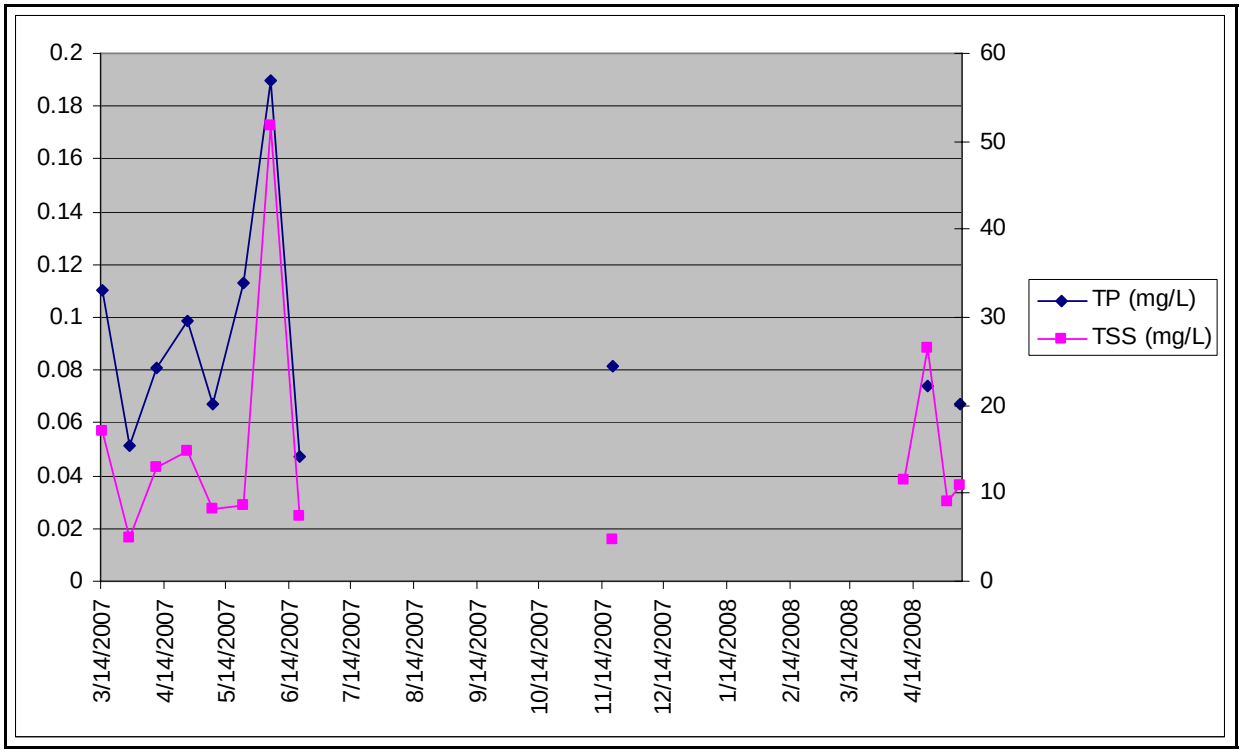



**Figure 15. TP and TSS Summary for Deep Creek.**

### *John's Creek*

Analysis of the dominant benthic macroinvertebrate community from a 2008 BURP survey (site 2008SLEWA021) within John's Creek identified pollutant-tolerant taxa that are able to occupy habitats with low DO and high nutrient concentrations. This implies that impairment to the cold water aquatic life beneficial use from excessive nutrient loading is occurring, and that nutrient loading needs to be reduced to achieve full support of the beneficial use.

Currently, the lack of nutrient data restricts the ability to adequately calculate loads and any necessary load reductions. Therefore, it is recommended that John's Creek be listed in Section 5 of Idaho's next integrated report for nutrients. It is assumed that reducing excessive nutrient loading will cause a shift in the composition of the benthic macroinvertebrate community structure toward those organisms that usually occupy habitats with reference conditions.

### *Sediment (Total Suspended Solids)*

Sediment criteria found in Idaho Water Quality Standards (IDAPA 58.01.02) is narrative, meaning there is not a numeric value to assess whether a water body is in compliance with standards; instead, Idaho has a requirement that states sediment shall be limited to a quantity that does not impair beneficial uses.

The most available water column sediment data for application in this TMDL are reported in terms of total suspended solids (TSS). A total suspended solids target for sediment has been taken from the *Guide to Selection of Sediment Targets for Use in Idaho TMDLs*, set at a level such that the lower Salmon River tributaries will not exceed the estimated load capacity supportive of a good fishery (DEQ 2003).

The effects of sediment on the most sensitive designated beneficial use, aquatic life, are dependent on concentration and duration of exposure (DEQ 2003). Guidance developed by DEQ for application of the narrative sediment criteria for protection of aquatic life beneficial uses suggests that a sediment target incorporate both concentration and duration of exposure, not only to properly protect aquatic life, but also to allow for episodic spikes that can occur naturally with spring runoff or heavy precipitation events.

The targets used to develop the loading calculations shown later (Section 5.3) are a monthly average of 25 mg/L total suspended solids (TSS) with a maximum daily limit of 50 mg/L to allow for natural variability. The average monthly target and the maximum daily limit are within the range identified by the European Inland Fisheries Advisory Commission and the Committee on Water Quality Criteria from the Environmental Studies Board of the National Academy of Science and National Academy of Engineers as supporting a moderate fishery (DEQ 2003). A summary of the collected TSS concentrations is show in Table 13; raw data is contained in Appendix B.

**Table 13. TSS data summary.**

| Water Body | High TSS Concentration (mg/L) | Low TSS Concentration (mg/L) |
|---|---|---|
| Wolf Creek | 16 | Non Detectable |
| Divide Creek | 31 | Non Detectable |
| Cottonwood Creek | 41 | Non Detectable |

| Water Body | High TSS Concentration (mg/L) | Low TSS Concentration (mg/L) |
|---|---|---|
| Billy Creek | 43 | 6 |
| Rice Creek | 22 | 2 |
| Allison Creek | 29 | Non Detectable |
| John's Creek | 162 | 14 |
| Rock Creek | 137 | Non Detectable |
| Graves Creek | 16 | 2 |
| Deep Creek | 52 | 5 |
| Deer Creek | 16 | Non Detectable |

## Other Data

### *Beneficial Use Support Status*

Table 14 displays the current beneficial use support status for the water bodies listed in section 5 of the 2008 Integrated Report (i.e., needing a TMDL); not all AUs have been assessed for cold water aquatic life (CWAL) and contact recreation. The contact recreation beneficial use full support determinations for Wolf Creek and Deep Creek are based on an assessment of E. coli bacteria data generated in 2008. The CWAL beneficial use has not been assessed for Wolf Creek, Deep Creek, and Cottonwood Creek in the listed AUs using the BURP protocol and WBAG.

**Table 14. Beneficial use support status of listed water bodies.**

| Stream Name | Assessment Unit | Recent BURP Year | CWAL Use | Recreation Use |
|---|---|---|---|---|
| Wolf Creek | ID17060101SL024_04 | NA* | NA | FS* |
| Wolf Creek | ID17060101SL025_02, ID17060101SL025 _03 ID17060101SL025 _04 | NA | NA | FS |
| Divide Creek | ID17060101SL028_02 | 2003 | NFS* | FS |
| Divide Creek | ID17060101SL028_03 | 2003 | NFS | FS |
| Cottonwood Creek | ID17060209SL003_02 | NA | NA | FS |
| Billy Creek | ID17060209SL004_02 | 2003 | NFS | NFS |
| Rice Creek | ID17060209SL007_02 | NA | NA | NA |
| Allison Creek | ID17060209SL028_03 | NA | NFS | NFS |
| John's Creek | ID17060209SL057_02 | 2008 | NFS | NFS |
| Rock Creek | ID17060209SL056_04 | 2003 | NFS | NFS |
| Rock Creek | ID17060209SL057_03 | 2003 | NFS | NFS |
| Graves Creek | ID17060209SL058_02 ID17060209SL058_03 | 2003 | NFS | NFS |
| Deep Creek | ID17060209SL060_02 | NA | NA | FS |
| Deer Creek | ID17060209SL062_02 ID17060209SL062_02a | 2003 | NFS | FS |

*NA=Not Assessed, FS=Full Support, NFS=Not Full Support

### *Bacteria DNA Analysis*

Water samples were analyzed for the presence/absence of human gene biomarkers by polymerase chain reaction (PCR) DNA analytical technology, to determine if fecal pollution from human sources was a source of bacteria loading to the monitored water bodies. The DNA analytical results are show in Table 15.

**Table 15. DNA analytical results.**

| Water Body | Sample Date | Human Bacteroidetes ID DNA Analytical Result | Human Enterococcus ID DNA Analytical Result |
|---|---|---|---|
| Wolf Creek | 7/17/2008 | Human Gene Biomarker Detected | Negative |
| Divide Creek | 7/17/2008 | Negative | Negative |
| Cottonwood Creek | 7/17/2008 | Negative | Negative |
| Billy Creek | 7/17/2008 | Human Gene Biomarker Detected | Negative |
| Rice Creek | Not Assessed | Not Assessed | Not Assessed |
| Allison Creek | 7/16/2008 | Human Gene Biomarker Detected | Negative |
| John's Creek | 7/16/2008 | Negative | Negative |
| Rock Creek | 7/16/2008 | Human Gene Biomarker Detected | Human Gene Biomarker Detected |
| Graves Creek | 7/16/2008 | Negative | Negative |
| Deep Creek | Not Assessed | Not Assessed | Not Assessed |
| Deer Creek | Not Assessed | Not Assessed | Not Assessed |

As shown in Table 15, human gene biomarkers were detected at four sites: Wolf Creek, Billy Creek, Allison Creek, and Rock Creek. The magnitude, or percent contribution, of bacteria loading to these water bodies from human sources is unknown since the analysis was strictly to determine presence/absence.

The DNA analytical results reported as negative means that the strain (Human Bacteroidetes or Enterococcus or both) used as an indicator of human fecal contamination was absent in the submitted sample. Further monitoring to assess other possible sources of bacteria, such as cattle or wildlife, could be conducted in the future within these sub-watersheds to help prioritize implementation efforts.

## Conclusions

In nine water bodies in the lower Salmon and Snake Rivers Subbasins, the geometric mean criterion of 126 cfu/100 ml was exceeded. The bacteria TMDLs have been developed to trigger the implementation of best management practices (BMPs) to ensure that the secondary contact recreation beneficial use is maintained for the protection of

human health. The bacteria TMDLs should guide the implementation of BMPs designed to limit bacteria loading, such as off site watering, exclusions, and waste management practices that address the sources of bacteria.

Analysis of the existing continuous temperature data documented five water bodies where Idaho's temperature criteria for the cold water aquatic life beneficial use were violated. The temperature TMDLs apply a potential natural vegetation (PNV) approach, which establishes specific shade targets for each water body based on riparian plant communities.

Analysis of the dominant benthic macroinvertebrate community from a 2008 BURP survey (site 2008SLEWA021) within John's Creek identified pollutant-tolerant taxa that are able to occupy habitats with low dissolved oxygen and high nutrient concentrations. This implies that impairment to the cold water aquatic life beneficial use from excessive nutrient loading is occurring, and that nutrient loading needs to be reduced to achieve full support of the beneficial use. It is assumed that reducing excessive nutrient loading will cause a shift in the composition of the benthic macroinvertebrate community structure toward those organisms that usually occupy habitats with reference conditions.

Currently, the lack of nutrient data restricts the ability to adequately calculate loads and any necessary load reductions. Therefore, it is recommended that John's Creek be listed for nutrients in Section 5 of Idaho's next integrated report.

Sediment TMDLs were developed for control points where target concentrations greater than the load capacity were measured. Each of the sediment TMDLs allocates a gross concentration to all sources of sediment upstream of the established control points. Sediment TMDLs have been developed for Rock Creek, ID17060209SL056_04 which also applies to ID17060209SL057_03; John's Creek, ID17060209SL057_02; Billy Creek, ID17060209SL004_02, and Deep Creek, ID17060209SL060_02. Reductions in sediment to John's Creek through the implementation of best management practices will also reduce nutrient loading, and will limit downstream impacts to Rock Creek.

## 2.5 Data Gaps

This TMDL addresses water quality concerns in the lower Salmon River and Hells Canyon Subbasins, based on available data. Additional nutrient data, as well as continuous DO data, needs to be generated within John's Creek.

All available data generated in the future, where applicable, will be used to review and reevaluate the subbasin assessment and TMDLs. Any new listings in Section 5 of the integrated report or carry-overs will also be addressed in the next review cycle.

# 3. Subbasin Assessment–Pollutant Source Inventory

This chapter briefly discusses the typical pollutant sources in a watershed that can directly or indirectly affect water quality. Sources may occur as point sources, regulated by National Pollutant Discharge Elimination System (NPDES) permits, and as nonpoint sources which are not subject to any permitting program. Point sources convey pollutants directly into waters through a pipe, ditch, or other identifiable point of discharge. Nonpoint sources have no exact point of discharge to receiving waters, conveying their associated pollutants over the landscape.

There are currently no point sources that discharge to the water bodies that have been assessed in this report.

## 3.1 Nonpoint Sources

### Bacteria

Nonpoint sources of bacteria to water bodies typically include livestock, wildlife, waterfowl, pets, and in rural or unincorporated areas, septic tank drain fields. Livestock manure from pastures, rangeland, and corrals are considered manageable sources of bacteria because manure can be collected and disposed of before it reaches surface water. Manure can be deposited directly into water bodies where access is available.

Septic system drain fields can also be a source of bacteria reaching surface waters if the drain field is placed too close to the stream. Bacteria typically do not travel as far underground as they do above ground, normally dying off before underground septic waste reaches the stream. However, if the drain field is not far enough away from the stream, bacteria can survive long enough to reach the stream.

Based on the human DNA analysis presented in Section 2.4, it appears that human waste and associated bacteria loading is a source that needs to be managed in these two subbasins, to ensure that water quality is maintained for the protection of human health.

### Nutrients

Potential nonpoint sources of nutrients (nitrogen and phosphorus) include agricultural and urban fertilizer, septic system drain fields, and livestock. Ground water is also affected by fertilizer application and can then deliver this excess nutrient load back to surface waters in the form of upwelling, or springs. Increased soil erosion from tillage practices may add both phosphorus and nitrogen directly to streams. Bank destruction, as well as soil compaction, contributes to increased run-off by creating a “hard pan” that water cannot infiltrate properly. Transport of nutrients (nitrogen and phosphorus) to water bodies takes place through rain events, subsequent runoff, ground water, drainage networks, and industrial and waste effluents. Nutrients received by a water body can be taken up by aquatic vegetation (macrophytes), algae, and microorganisms; sorbed to organic and inorganic particles in the water and sediment; amassed or recycled in the sediment; or transformed into a gas and released from the water body (EPA 2000).

Excess nutrient inputs taken up by macrophytes can lead to excess algae growth, which in turn can lead to oxygen depletion. High ammonia concentrations can also lead to low oxygen levels, as bacteria oxidize the ammonia to nitrate, through nitrification.

### Sediment

In-stream erosion is a major source of sediment; ephemeral overland flow, road runoff, and landslides that result from natural events such as forest fires are others. Land uses such as silviculture and agriculture can expose soil, destabilize land formations, and increase and direct runoff, which in turn can contribute to higher erosion rates than those that would occur naturally in the watershed.

### Temperature

Heat from solar radiation is a source of temperature loading to streams in the two subbasins. Solar heat loads at levels greater than naturally-occurring solar heat loads usually result from shade reduction and disturbances of natural stream morphology. Removal of shade or canopy cover from the riparian zones of streams and watershed forests can allow heat loading to streams and may accelerate melting of watershed snow packs, causing summer and fall flows that are smaller in volume and warmer. Such disturbances also de-stabilize stream banks, leading to higher erosion rates and creating wider, shallower channels. The wider and more shallow the channel, the more solar heat load it can receive. The combination of low-volume summer flows and less shade can lead to temperature criteria exceedance.

Five streams, Wolf, Divide, Rock, Rice, and John's, have temperature TMDLs developed for them. The temperature TMDL (section 5.3) seeks to decrease the heat load each water body receives by increasing the riparian vegetation.

## 3.2 Data Gaps

The pollutant load data used in this assessment are in-stream pollutant loads and stream flows measured at selected sites. Sites selected for measurement of in-stream loads and flow rates are used for points of compliance for monitoring of allowable in-stream loads. Conclusive water quality evaluations to discern in-stream load contributions from and among the various nonpoint sources within the watersheds are not possible from this data. Instead, loads are attributed to nonpoint sources located within the watershed areas, as delineated by upstream and downstream monitoring sites, with loads represented by the difference in load between the two points. More specific identification of pollutant loads attributable to known non point sources located within the delineated watershed areas should be completed by the appropriate designated management agency to ensure effective and efficient load reductions are achieved if deemed necessary.

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

## Point Sources

There are currently no known point sources that discharge to the water bodies addressed in this document. The TMDL has provided waste load allocations for future growth based on water quality standards and associated TMDL targets. The state has responsibility under Sections 401 and 402 of the Clean Water Act to provide water quality certification that the NPDES permit complies with any applicable TMDL waste load allocation.

## Nonpoint Sources

Numerous private landowners and governmental agencies have implemented conservation projects that have resulted in water quality improvement within the Lower Salmon River Subbasin. These projects include fencing, riparian and stream bank restoration, grazing (animal feeding operation {AFO] and allotment) and nutrient management plans, septic system upgrades, road abandonment, and trail restoration improvements, and weed control. Prioritization of future pollution control efforts in watersheds with TMDLs will be recommended and completed by the watershed advisory group and other management agencies, and identified in a corresponding implementation plan.

Under Section 319 of the Clean Water Act, each state is required to develop and submit a Nonpoint Source Management Plan. Idaho's most recent Nonpoint Source Management Plan was finalized in December 1999. The plan was submitted to and approved by the EPA. Among other things, the plan identifies programs for achieving implementation of nonpoint source *Best Management Practices* (BMPs), includes a schedule of project milestones, outlines key agencies and agency roles, identifies available funding sources, and is certified by the state attorney general to ensure that adequate authorities exist to implement the plan.

Idaho's Nonpoint Source Management Plan describes many of the voluntary and regulatory approaches the state will take to abate nonpoint pollution sources. One of the prominent programs described in the plan is the provision for public involvement, such as the formation of Basin Advisory Groups (BAGs) and Watershed Advisory Groups (WAGs). The WAGs are to be established in watersheds to assist DEQ and other state agencies in formulating specific action needed to decrease pollutant loading from point and nonpoint sources that affect water quality limited water bodies. The Lower Salmon River WAG was established in 2008, and is the designated advisory group for the part of the subbasins affected by the TMDLs. The WAG provides guidance to DEQ on TMDL development and implementation.

The Idaho water quality standards refer to existing authorities to control nonpoint pollution sources in Idaho. Some of these authorities and the responsible state agencies are listed in Table 16.

**Table 16. State of Idaho's regulatory authority for nonpoint pollution sources.**

| Authority | IDAPA Citation | Responsible Agency |
|---|---|---|
| Rules Pertaining to the Idaho Forest Practices Act | 58.01.02.350.03(a) | Idaho Department of Lands (IDL) |
| Rules Governing Solid Waste Management | 58.01.02.350.03(b) | DEQ |
| Rules Governing Individual and Subsurface Sewage Disposal Systems | 58.01.02.350.03(c) | DEQ |
| Rules and Standards for Stream-channel Alteration | 58.01.02.350.03(d) | Idaho Department of Water Resources (IDWR) |
| Rules Governing Exploration and Surface Mining Operations in Idaho | 58.01.02.350.03(f) | IDL |
| Rules Governing Placer and Dredge Mining in Idaho | 58.01.02.350.03(g) | IDL |
| Rules Governing Dairy Waste | 58.01.02.350.03(h) | Idaho State Department of Agriculture (ISDA) |

The state of Idaho uses a voluntary approach to address agricultural nonpoint sources. IDAPA 58.01.02.054.07 refers to the Idaho Agricultural Pollution Abatement Plan (Ag Plan), which provides guidance to the agricultural community and includes a list of recommended BMPs.

A portion of the Agricultural Pollution Abatement Plan outlines responsible agencies or elected groups (Soil Conservation Districts-SCDs) that will take the lead if nonpoint source pollution problems need to be addressed. For agricultural activity, it assigns the local SCDs to assist the landowner/operator with developing and implementing BMPs to abate nonpoint pollution associated with the land use.

The Idaho Water Quality Standards and Wastewater Treatment Requirements specify that if water quality monitoring indicates that water quality standards are not being met, even with the use of BMPs or knowledgeable and reasonable practices, the state may request that the designated agency evaluate and/or modify the BMPs to protect beneficial uses (IDAPA 58.01.02.52).

# 5. Total Maximum Daily Load(s)

A total maximum daily load (TMDL) is the allowable amount of a pollutant that can be in a water body and still have the water body comply with water quality standards (WQS). The allowable amount of the pollutant is called the pollutant load capacity. Once the load capacity is calculated, it is distributed or allocated among the sources of the pollutant in the watershed.

There are two kinds of pollutant sources: point sources and nonpoint sources. Point sources receive a waste load allocation; nonpoint sources receive a load allocation. Waste load allocations have been provided in the TMDLs to account for future growth. Since there are currently no known point sources that discharge directly into water bodies addressed in this report, no waste load reductions are needed. The background amount is considered part of the load allocation, but it is not available for allocation. Except for storm water construction permits, future point sources will need to acquire a waste load allocation from the gross load allocation established by the TMDLs.

A margin of safety is required to account for uncertainties used in the measurement, analysis, or calculation of the load capacity. The margin of safety may consist of conservative assumptions, or may be added as a separate quantity in the TMDL calculation.

The TMDL can be written as an equation:

**Load Capacity = Margin of Safety + Load Allocation + Waste load Allocation**

A TMDL is usually only required for water bodies that do not meet state WQS. Once the allowable loads are calculated, existing loads also need to be calculated so that necessary load reductions can be recognized and achieved by the sources.

The load capacity must be based on critical conditions, the conditions when WQS are most likely to be violated. If protective under critical conditions, it is assumed that the load capacity will be protective under all conditions.

A load calculation is the product of pollutant concentration and flow, whether the allowable pollutant concentration as per state standards, or the existing pollutant concentration found in samples collected from the water body. Table 17 summarizes the water bodies and pollutant(s) for which TMDLs have been developed.

**Table 17. Water bodies and associated pollutants for which TMDLs have been developed.**

| Stream Name | Extent | WBID & AU#(s) | Monitoring Site | Pollutants |
|---|---|---|---|---|
| Wolf Creek | Basin Creek to Mouth | ID17060101SL024_04 and ID17060101SL025_02, _03, _04 | Snake R. #1 | Temperature |
| Divide Creek | Source to Mouth | ID17060101SL028_02 and 03 | Snake R. #2 | Temperature Bacteria |
| Billy Creek | Source to Mouth | ID17060209SL004_02 | Salmon R. #1 | Bacteria, Sediment |
| Cottonwood Creek | Source to unnamed trib. | ID17060209SL003_02 | Salmon R. #2 | Bacteria |
| Allison Creek | West Fork to Mouth | ID17060209SL028_03 | Salmon R. #3 | Bacteria |
| Rice Creek | Rice Creek Tributary | ID17060209SL007_02 and _03 | Salmon R. #4 | Temperature Bacteria |
| Rock Creek | Grave Creek to Mouth | ID17060209SL056_04 and ID17060209SL057_03 | Salmon R. #5 | Temperature, Sediment, Bacteria |
| Graves Creek | Unnamed tributary to Rock Creek | ID17060209SL058_02 and _03 | Salmon R. #6 | Bacteria |
| John's Creek | Rock Cr. source to Grave Creek | ID17060209SL057_02 | Salmon R. #7 | Temperature, Sediment, Bacteria |
| Deep Creek | Source to unnamed trib. | ID17060209SL060_02 | Salmon R. #8 | Sediment Bacteria |
| Telcher Creek | Rock Cr. source to Grave Creek | ID17060209SL057_02 | Within AU | Temperature |

## 5.1 *E. coli* Bacteria TMDL

*E. coli* bacteria in Allison Creek, Rock Creek, Graves Creek, and John's Creek are above the 5 sample 30-day geometric mean criterion allowed by the Idaho WQS. Cottonwood Creek, Billy Creek, Rice Creek, Deep Creek, and Divide Creek are above the 30-day geometric mean used to identify impairment during their most critical time periods (Section 2.4).

### Target

The Idaho water quality standard for *E. coli* bacteria, used as the target for the development of the TMDL, is a geometric mean of 126 cfu/100 ml (IDAPA 58.01.02. 251.02).

### Load Capacity

The *E. coli* bacteria load capacity is expressed as the geometric mean of 126 cfu/100 ml. The load capacity is expressed as a concentration (cfu/100 ml) because it is difficult to calculate a mass load due to several variables (i.e. temperature, moisture conditions, flow) that influence the die-off rate of *E. coli* bacteria in the environment.

## Estimates of Existing Pollutant Loads

Livestock and septic system drain fields are the most likely sources of *E. coli* bacteria found in the above listed water bodies. Potential for these sources to contribute to the bacteria load is greatest from livestock and septic systems based on the information collected from the DNA sampling as well as activities observed while in the field. The percentage of the load contribution coming from each nonpoint source cannot be determined from the limited data available at this time.

## Load Allocation and Waste Load Allocation for Future Growth

Bacteria are living organisms that have an associated die-off rate. The die-off rate fluctuates with varying water quality and environmental conditions. Flow and temperature dictate the actual mass of bacteria in the water and complicate the load allocation process because of the continuous fluctuation of flow and temperature that occurs during any given time period. To simplify this process, the daily allocation is expressed in terms of 126 cfu/100 ml, the target geometric mean concentration currently required by Idaho's WQS.

The in-stream load allocations listed in Table 18 have been assigned to each water body to ensure compliance with Idaho Water Quality Standards throughout the watershed. Table 18 includes the load capacity based on the allowable geometric mean for secondary contact recreation, the load allocation, and the reduction in E. coli bacteria concentration that must occur to meet the load allocation assigned to each water body. Wastes load allocation have been provided for future point sources of E. coli bacteria.

**Table 18. Load allocation[1] for E. coli bacteria.**

| Location (Control Point) | Existing Load (#/100 ml) | Load Capacity (#/100 ml) | Daily Load and Waste load Allocation (#/100 ml) | Non Point Source Load Reduction (%) |
|---|---|---|---|---|
| Cottonwood Creek | 502 | 126 | 126 | 75 |
| Billy Creek | 2087 | 126 | 126 | 94 |
| Rice Creek | 201 | 126 | 126 | 37 |
| Allison Creek | 162 | 126 | 126 | 22 |
| Rock Creek | 468 | 126 | 126 | 73 |
| Graves Creek | 205 | 126 | 126 | 39 |
| Deep Creek | 804 | 126 | 126 | 84 |
| John's Creek | 723 | 126 | 126 | 83 |
| Divide Creek | 148 | 126 | 126 | 15 |

[1] Expressed in terms of an allowable concentration (mass/volume).

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### Margin of Safety

The establishment of a TMDL requires that a margin of safety (MOS) be identified to account for uncertainty. An MOS is expressed as either an implicit or explicit portion of a water body's loading capacity that is reserved to account for the uncertainty about the relationship between the pollutant loads and the quality of the receiving water body. The MOS is not allocated to any sources of a pollutant.

The pollutant load capacity has been calculated for the most critical time periods identified and is applied year round. In certain cases a conservative 30-day geometric mean, typically with 3 samples, was used instead of the 5 sample 30-day geometric mean to identify impairment. Application of these conservative methods is considered an implicit margin of safety.

### Critical Time Period

The *E. coli* bacteria allocations apply to any 30-day time period since secondary contact recreation may occur at any time of year. This allocation ensures water quality standards are attained for the protection of public health. Table 19 shows the critical time period for bacteria.

**Table 19. Critical time period for the *E. coli* bacteria TMDL.**

| Pollutant | Critical Period |
|---|---|
| *E. coli* Bacteria | Year-round |

## 5.2 Sediment TMDL

### Target

Sediment criteria found in Idaho Water Quality Standards (IDAPA 58.01.02) is narrative, meaning there is not a numeric value used to assess whether a water body is in compliance with standards. Instead, the standard states sediment shall be limited to a quantity that does not impair beneficial uses.

The most available water column sediment data for application in this TMDL are reported in terms of total suspended solids (TSS). A total suspended solids target for sediment has been taken from the Guide to Selection of Sediment Targets for Use in Idaho TMDLs (DEQ 2003).

The effects of sediment on the most sensitive designated beneficial use, aquatic life, are dependent on concentration and duration of exposure (DEQ 2003). Guidance developed by DEQ for application of the narrative sediment criteria for protection of aquatic life beneficial uses suggests that a sediment target incorporate both concentration and duration of exposure, not only to properly protect aquatic life, but also to allow for episodic spikes that can occur naturally with spring runoff or heavy precipitation events. The TSS (sediment) target is set at a level such that these tributaries will not exceed the estimated load capacity supportive of a good fishery and the Special Resource Water beneficial use designation of the Lower Salmon River.

Sediment TMDLs were developed for control points where concentrations were measured at levels above the load capacity. The targets used to develop the load calculations are a monthly average of 25 mg/L TSS, with a maximum daily limit of 50 mg/L to allow for natural variability. The average monthly target and the maximum daily limit are within the range identified as supporting a good fishery by the European Inland Fisheries Advisory Commission and the Committee on Water Quality Criteria from the Environmental Studies Board of the National Academy of Science and National Academy of Engineers (DEQ 2003).

## Load Capacity

A TSS load capacity is the product of the target concentration and flow. The load capacity for TSS is based on the in-stream load that would be present when the target concentration is met. For example, the maximum daily target for Rock Creek is 50 mg/L TSS, not to exceed 25 mg/L as a monthly average. The load capacity is based on a maximum daily limit of 50 mg/L TSS throughout the stream multiplied by the daily flow, not to exceed a monthly average of 25 mg/L. Concentrations exceeding these target capacities require a load reduction.

## Estimates of Existing Pollutant Loads

Estimates of existing loads are based on amounts of sediment measured during monitoring and recorded flows or averages of recorded flows. Table 20 summarizes the existing TSS concentrations recorded at each monitoring site.

**Table 20. Summary of measured TSS concentrations.**

| Water Body | High TSS Concentration (mg/L) | Low TSS Concentration (mg/L) |
|---|---|---|
| Wolf Creek | 16 | Non Detectable |
| Divide Creek | 31 | Non Detectable |
| Cottonwood Creek | 41 | Non Detectable |
| Allison Creek | 29 | Non Detectable |
| Billy Creek | 43 | 6 |
| Rice Creek | 22 | 2 |
| John's Creek | 162 | 14 |
| Rock Creek | 137 | Non Detectable |
| Graves Creek | 16 | 2 |
| Deep Creek | 52 | 5 |
| Deer Creek | 16 | Non Detectable |

## Load Allocation

TSS load allocations have been developed for four control points: Billy Creek (Salmon R. #1), John's Creek (Salmon R. #7), Rock Creek (Salmon R. #5), and Deep Creek (Salmon R. #8). All sources upstream are required to make a certain percentage of reduction in the current TSS load to meet the load allocations at the control points. The load capacity,

load allocation, and load reduction in TSS concentrations on a daily basis are included in Tables 21 through 24. Tables 25 through 28 display the monthly load allocations.

**Table 21. Daily TSS load allocation for Billy Creek (Salmon R. #1)**

| Billy Creek | | | | | | |
|---|---|---|---|---|---|---|
| Sample Date | Flow (cfs) | TSS (mg/L) | Existing Load (tons/day) | Load Capacity (tons/day) | Load Allocation (tons/day) | Load Reduction Required (%) |
| 3/8/2007 | 3.18 | 28.7 | 0.246 | 0.429 | 0.386 | 0.00 |
| 3/22/2007 | 2.67 | 13.8 | 0.099 | 0.360 | 0.324 | 0.00 |
| 4/5/2007 | 2.34 | 15.8 | 0.100 | 0.315 | 0.284 | 0.00 |
| 4/19/2007 | 1.47 | 16.1 | 0.064 | 0.198 | 0.178 | 0.00 |
| 5/4/2007 | 1.18 | 16.5 | 0.052 | 0.159 | 0.143 | 0.00 |
| 5/17/2007 | 0.74 | 26.1 | 0.052 | 0.100 | 0.090 | 0.00 |
| 5/31/2007 | 0.86 | 22.6 | 0.053 | 0.116 | 0.105 | 0.00 |
| 6/14/2007 | 0.65 | 29.8 | 0.052 | 0.088 | 0.079 | 0.00 |
| 6/28/2007 | 0.26 | 27.4 | 0.019 | 0.035 | 0.032 | 0.00 |
| 7/12/2007 | 0.10 | 39.3 | 0.010 | 0.013 | 0.012 | 0.00 |
| 7/26/2007 | 0.12 | 30.4 | 0.010 | 0.016 | 0.015 | 0.00 |
| 8/10/2007 | 0.10 | 22.25 | 0.006 | 0.013 | 0.012 | 0.00 |
| 8/23/2007 | 0.10 | 17.9 | 0.005 | 0.013 | 0.012 | 0.00 |
| 9/6/2007 | 0.10 | 42.5 | 0.011 | 0.013 | 0.012 | 0.00 |
| 9/20/2007 | 0.10 | 21.1 | 0.006 | 0.013 | 0.012 | 0.00 |
| 10/4/2007 | 0.29 | 12.6 | 0.010 | 0.040 | 0.036 | 0.00 |
| 10/18/2007 | 0.40 | 15.8 | 0.017 | 0.053 | 0.048 | 0.00 |
| 11/1/2007 | 0.60 | 5.49 | 0.009 | 0.081 | 0.073 | 0.00 |
| 11/29/2007 | 0.43 | 6.79 | 0.008 | 0.058 | 0.052 | 0.00 |
| 12/13/2007 | 0.71 | 8.78 | 0.017 | 0.096 | 0.086 | 0.00 |
| 1/10/2008 | 0.71 | 14.4 | 0.028 | 0.096 | 0.086 | 0.00 |
| 2/7/2008 | 0.84 | 19.7 | 0.045 | 0.114 | 0.102 | 0.00 |
| 2/21/2008 | 2.71 | 14.8 | 0.108 | 0.365 | 0.329 | 0.00 |
| 3/6/2008 | 2.42 | 11.8 | 0.077 | 0.326 | 0.293 | 0.00 |
| 3/20/2008 | 2.20 | 19.1 | 0.113 | 0.296 | 0.267 | 0.00 |
| 4/3/2008 | 1.4 | 7.73 | 0.029 | 0.189 | 0.170 | 0.00 |

**Table 22. Daily TSS load allocation for John's Creek (Salmon R. #7).**

| John's Creek | | | | | | |
|---|---|---|---|---|---|---|
| Sample Date | Flow (cfs) | TSS (mg/L) | Existing Load (tons/day) | Load Capacity (tons/day) | Load Allocation (tons/day) | Load Reduction Required (%) |
| 3/14/2007 | 7.28 | 24 | 0.47 | 0.98 | 0.88 | 0.00 |
| 3/28/2007 | 21.11 | 162.4 | 9.24 | 2.84 | 2.56 | 72.3 |
| 4/10/2007 | 4.64 | 32 | 0.40 | 0.62 | 0.56 | 0.00 |
| 4/25/2007 | *NA | 29.3 | NA | NA | NA | 0.00 |
| 5/7/2007 | 5.19 | 31.7 | 0.44 | 0.70 | 0.63 | 0.00 |
| 5/21/2007 | 1.80 | 29.7 | 0.14 | 0.24 | 0.22 | 0.00 |
| 6/5/2007 | 0.67 | 28.4 | 0.05 | 0.09 | 0.08 | 0.00 |
| 6/19/2007 | 1.10 | 31.3 | 0.09 | 0.15 | 0.13 | 0.00 |
| 7/1/2007 | 0.41 | 42.2 | 0.05 | 0.06 | 0.05 | 0.00 |
| 7/17/2007 | 0.06 | 13.7 | 0.00 | 0.01 | 0.01 | 0.00 |
| 11/19/2007 | 1.19 | 130.2 | 0.42 | 0.16 | 0.14 | 65.4 |
| 12/4/2007 | 0.92 | 124.4 | 0.31 | 0.12 | 0.11 | 63.8 |
| 12/17/2007 | Ice | 1 | NA | NA | NA | NA |
| 1/15/2008 | Ice | 16.2 | NA | NA | NA | NA |
| 2/12/2008 | 2.20 | 22 | 0.13 | 0.30 | 0.27 | 0.00 |
| 2/28/2008 | 6.60 | 25.2 | 0.45 | 0.89 | 0.80 | 0.00 |
| 3/11/2008 | 5.53 | 24.2 | 0.36 | 0.74 | 0.67 | 0.00 |
| 3/25/2008 | 9.90 | 42.1 | 1.12 | 1.33 | 1.20 | 0.00 |
| 4/9/2008 | 5.63 | 32.7 | 0.50 | 0.76 | 0.68 | 0.00 |
| 4/21/2008 | 9.79 | 31.7 | 0.84 | 1.32 | 1.19 | 0.00 |
| 4/29/2008 | NA | 41.2 | NA | NA | NA | NA |
| 5/7/2008 | NA | 35.4 | NA | NA | NA | NA |

*NA = Not Available

**Table 23. Daily TSS load allocation for Rock Creek (Salmon R. #5).**

| Rock Creek | | | | | | |
|---|---|---|---|---|---|---|
| Sample Date | Flow (cfs) | TSS (mg/L) | Existing Load (tons/day) | Load Capacity (tons/day) | Load Allocation (tons/day) | Load Reduction Required (%) |
| 3/14/2007 | 28.07 | 8 | 0.61 | 3.78 | 3.40 | 0.00 |
| 3/28/2007 | 84.92 | 137.3 | 31.42 | 11.44 | 10.30 | 67.23 |
| 4/10/2007 | 28.29 | 15.1 | 1.15 | 3.81 | 3.43 | 0.00 |
| 4/25/2007 | 27.97 | 21.1 | 1.59 | 3.77 | 3.39 | 0.00 |
| 5/8/2007 | 17.46 | 17.8 | 0.84 | 2.35 | 2.12 | 0.00 |
| 5/22/2007 | 10.59 | 18 | 0.51 | 1.43 | 1.28 | 0.00 |
| 6/5/2007 | 3.54 | 12.7 | 0.12 | 0.48 | 0.43 | 0.00 |
| 6/19/2007 | 6.36 | 5.38 | 0.09 | 0.86 | 0.77 | 0.00 |
| 7/2/2007 | 2.54 | 6.11 | 0.04 | 0.34 | 0.31 | 0.00 |
| 7/17/2007 | 2.24 | 7.4 | 0.04 | 0.30 | 0.27 | 0.00 |
| 7/31/2007 | 2.20 | 6.95 | 0.04 | 0.30 | 0.27 | 0.00 |
| 8/14/2007 | 2.20 | 6.02 | 0.04 | 0.30 | 0.27 | 0.00 |
| 8/29/2007 | 2.20 | 4.08 | 0.02 | 0.30 | 0.27 | 0.00 |

| Rock Creek | | | | | | |
|---|---|---|---|---|---|---|
| Sample Date | Flow (cfs) | TSS (mg/L) | Existing Load (tons/day) | Load Capacity (tons/day) | Load Allocation (tons/day) | Load Reduction Required (%) |
| 9/11/2007 | 2.20 | 4.22 | 0.03 | 0.30 | 0.27 | 0.00 |
| 9/26/2007 | 2.20 | 4.5 | 0.03 | 0.30 | 0.27 | 0.00 |
| 10/10/2007 | 3.83 | 2.5 | 0.03 | 0.52 | 0.46 | 0.00 |
| 10/24/2007 | 5.23 | 2.13 | 0.03 | 0.70 | 0.63 | 0.00 |
| 11/7/2007 | 4.48 | 1.04 | 0.01 | 0.60 | 0.54 | 0.00 |
| 11/19/2007 | 10.92 | 13.5 | 0.40 | 1.47 | 1.32 | 0.00 |
| 12/4/2007 | 22.66 | 103 | 6.29 | 3.05 | 2.75 | 56.31 |
| 12/18/2007 | 10.00 | 1.19 | 0.03 | 1.35 | 1.21 | 0.00 |
| 1/2/2008 | 5.60 | 0.5 | 0.01 | 0.75 | 0.68 | 0.00 |
| 1/15/2008 | 7.63 | 2.03 | 0.04 | 1.03 | 0.93 | 0.00 |
| 1/29/2008 | 7.41 | 5.05 | 0.10 | 1.00 | 0.90 | 0.00 |
| 2/12/2008 | 36.40 | 19.9 | 1.95 | 4.90 | 4.41 | 0.00 |
| 2/27/2008 | 47.20 | 12.6 | 1.60 | 6.36 | 5.72 | 0.00 |
| 3/10/2008 | 27.62 | 5.08 | 0.38 | 3.72 | 3.35 | 0.00 |
| 3/24/2008 | 100 | 14.9 | 4.02 | 13.48 | 12.13 | 0.00 |
| 4/9/2008 | 51.52 | 13.4 | 1.86 | 6.94 | 6.25 | 0.00 |
| 4/22/2008 | 100 | 18.2 | 4.90 | 13.48 | 12.13 | 0.00 |

** A value of 0.5 mg/L TSS was used for 1/2/2008 to compute the loading analyses because the resultant value was below the detection limit (BDL).

## Table 24. Daily TSS load allocation for Deep Creek (Salmon R. #8)

| Deep Creek | | | | | | |
|---|---|---|---|---|---|---|
| Sample Date | Flow (cfs) | TSS (mg/L) | Existing Load (tons/day) | Load Capacity (tons/day) | Load Allocation (tons/day) | Load Reduction Required (%) |
| 3/14/2007 | 20.01 | 17 | 0.917 | 2.696 | 2.427 | 0.00 |
| 3/28/2007 | 10.07 | 4.92 | 0.134 | 1.357 | 1.221 | 0.00 |
| 4/10/2007 | 3.94 | 12.9 | 0.137 | 0.531 | 0.477 | 0.00 |
| 4/25/2007 | 3.01 | 14.7 | 0.119 | 0.405 | 0.365 | 0.00 |
| 5/7/2007 | 1.05 | 8.32 | 0.024 | 0.141 | 0.127 | 0.00 |
| 5/22/2007 | 0.87 | 8.63 | 0.020 | 0.117 | 0.106 | 0.00 |
| 6/5/2007 | 0.33 | 51.7 | 0.046 | 0.045 | 0.040 | 13.0 |
| 6/19/2007 | 0.15 | 7.49 | 0.003 | 0.020 | 0.018 | 0.00 |
| 11/19/2007 | 0.50 | 4.68 | 0.006 | 0.067 | 0.061 | 0.00 |
| 4/9/2008 | 1.70 | 11.5 | 0.053 | 0.229 | 0.206 | 0.00 |
| 4/21/2008 | 9.39 | 26.5 | 0.671 | 1.265 | 1.139 | 0.00 |
| 4/30/2008 | 16.73 | 9.05 | 0.408 | 2.254 | 2.029 | 0.00 |
| 5/7/2008 | 12.65 | 10.8 | 0.368 | 1.705 | 1.534 | 0.00 |

**Table 25. Monthly TSS load allocation for Billy Creek (Salmon R. #1).**

| Month | Average Flow (cfs) | Average TSS (mg/L) | Existing Load (tons/month) | Load Capacity (tons/month) | Load Allocation (tons/month) | Reduction Required (%) |
|---|---|---|---|---|---|---|
| Mar-07 | 2.93 | 21.25 | 5.03 | 5.91 | 5.32 | 0.00 |
| Apr-07 | 1.91 | 15.95 | 2.46 | 3.85 | 3.47 | 0.00 |
| May-07 | 0.93 | 21.73 | 1.63 | 1.88 | 1.69 | 0.00 |
| Jun-07 | 0.46 | 28.60 | 1.05 | 0.92 | 0.83 | 21.33 |
| Jul-07 | 0.11 | 34.85 | 0.30 | 0.22 | 0.20 | 35.44 |
| Aug-07 | 0.10 | 20.08 | 0.16 | 0.20 | 0.18 | 0.00 |
| Sep-07 | 0.10 | 31.80 | 0.26 | 0.20 | 0.18 | 29.25 |
| Oct-07 | 0.34 | 14.20 | 0.40 | 0.70 | 0.63 | 0.00 |
| Nov-07 | 0.52 | 6.14 | 0.26 | 1.04 | 0.94 | 0.00 |
| Dec-07 | 0.71 | 8.78 | 0.50 | 1.44 | 1.29 | 0.00 |
| Jan-08 | 0.71 | 14.40 | 0.83 | 1.44 | 1.29 | 0.00 |
| Feb-08 | 1.78 | 17.25 | 2.48 | 3.59 | 3.23 | 0.00 |
| Mar-08 | 2.31 | 15.45 | 2.88 | 4.67 | 4.20 | 0.00 |

**Table 26. Monthly TSS load allocation for John's Creek (Salmon R. #7).**

| Month | Average Flow (cfs) | Average TSS (mg/L) | Existing Load (tons/month) | Load Capacity (tons/month) | Load Allocation (tons/month) | Reduction Required (%) |
|---|---|---|---|---|---|---|
| Mar-07 | 14.20 | 93.2 | 106.96 | 28.69 | 25.82 | 75.86 |
| Apr-07 | 4.64 | 30.65 | 11.49 | 9.37 | 8.44 | 0.00 |
| May-07 | 3.50 | 30.7 | 8.68 | 7.07 | 6.36 | 0.00 |
| Jun-07 | 0.88 | 29.85 | 2.13 | 1.79 | 1.61 | 0.00 |
| Jul-07 | 0.24 | 27.95 | 0.53 | 0.48 | 0.43 | 0.00 |
| Aug-07 | NA | NA | NA | NA | NA | NA |
| Sep-07 | NA | NA | NA | NA | NA | NA |
| Oct-07 | NA | NA | NA | NA | NA | NA |
| Nov-07 | 1.19 | 130.2 | 12.54 | 2.41 | 2.17 | 82.72 |
| Dec-07 | 0.92 | 62.7 | 4.64 | 1.85 | 1.66 | 64.11 |
| Jan-08 | NA | NA | NA | NA | NA | NA |
| Feb-08 | 4.40 | 23.6 | 8.40 | 8.90 | 8.01 | 0.00 |
| Mar-08 | 7.71 | 33.15 | 20.67 | 15.59 | 14.03 | 0.00 |
| Apr-08 | 7.71 | 35.2 | 21.94 | 15.58 | 14.03 | 0.00 |

*NA=not available

**Table 27. Monthly TSS load allocation for Rock Creek (Salmon R. #5)**

| Month | Average Flow (cfs) | Average TSS (mg/L) | Existing Load (tons/month) | Load Capacity (tons/month) | Load Allocation (tons/month) | Reduction Required (%) |
|---|---|---|---|---|---|---|
| Mar-07 | 56.50 | 72.65 | 331.84 | 114.19 | 102.77 | 69.03 |
| Apr-07 | 28.13 | 18.10 | 41.17 | 56.86 | 51.17 | 0.00 |
| May-07 | 14.02 | 17.90 | 20.29 | 28.34 | 25.51 | 0.00 |
| Jun-07 | 4.95 | 9.04 | 3.62 | 10.01 | 9.00 | 0.00 |
| Jul-07 | 2.33 | 6.82 | 1.28 | 4.70 | 4.23 | 0.00 |
| Aug-07 | 2.20 | 5.05 | 0.90 | 4.45 | 4.00 | 0.00 |
| Sep-07 | 2.20 | 4.36 | 0.78 | 4.45 | 4.00 | 0.00 |
| Oct-07 | 4.53 | 2.32 | 0.85 | 9.16 | 8.24 | 0.00 |
| Nov-07 | 7.70 | 7.27 | 4.53 | 15.56 | 14.01 | 0.00 |
| Dec-07 | 16.33 | 52.10 | 68.78 | 33.01 | 29.71 | 56.81 |
| Jan-08 | 6.88 | 2.53 | 1.41 | 13.91 | 12.52 | 0.00 |
| Feb-08 | 41.80 | 16.25 | 54.92 | 84.49 | 76.04 | 0.00 |
| Mar-08 | 63.81 | 9.99 | 51.54 | 128.97 | 116.08 | 0.00 |
| Apr-08 | 75.76 | 15.80 | 96.78 | 153.13 | 137.82 | 0.00 |

**Table 28. Monthly TSS load allocation for Deep Creek (Salmon R. #8).**

| Month | Average Flow (cfs) | Average TSS (mg/L) | Existing Load (tons/month) | Load Capacity (tons/month) | Load Allocation (tons/month) | Reduction Required (%) |
|---|---|---|---|---|---|---|
| Mar-07 | 15.04 | 10.96 | 13.33 | 30.40 | 27.36 | 0 |
| Apr-07 | 3.47 | 13.80 | 3.87 | 7.02 | 6.32 | 0 |
| May-07 | 0.96 | 8.48 | 0.66 | 1.94 | 1.75 | 0 |
| Jun-07 | 0.24 | 29.60 | 0.58 | 0.49 | 0.44 | 23.97 |
| Apr-08 | 9.27 | 15.68 | 11.76 | 18.74 | 16.87 | 0 |

## Margin of Safety

An explicit margin of safety of 10% of the target load was deducted from the load allocations to account for uncertainties about the relationship between in-stream dynamics and TSS concentrations.

## Critical Time Period

The critical time period for TSS in the Rock Creek watershed occurs when TSS concentrations become elevated as the result of increasing stream flow and overland runoff. Increased sediment loading to Deep Creek occurred in June 2007 and in Billy Creek during June, July, and September 2007. Increased sediment loading can occur outside of this critical time period as the result of activities occurring within the watershed. Therefore, implementation of BMPs to address excess sediment loading should be applied year round to ensure compliance with the daily load allocations.

### Waste Load Allocation for Future Growth

No TSS waste load reduction is required by this TMDL since no waste load is currently discharged to these water bodies. A future TSS waste load allocation of 50 mg/L as a

daily maximum, not to exceed 25 mg/L as a monthly average, multiplied by the daily and monthly effluent discharge volumes is assigned to each new facility.

## 5.3 Temperature TMDL

### In-stream Water Quality Target

The potential natural vegetation (PNV) method has been used to create the temperature TMDL. Idaho Water Quality Standards, IDAPA 58.01.02.200.09, states: "When natural background conditions exceed any applicable water quality criteria set forth …., the applicable water quality criteria shall not apply; instead, pollutant levels shall not exceed the natural background conditions, except that temperature levels may be increased above natural background conditions when allowed under Section 401." In these situations, natural conditions are the water quality standard, and the natural level of shade (as would be provided by natural vegetation) and channel width are the TMDL target. The in-stream temperature which results from these conditions is consistent with the water quality standard, even though it may exceed numeric temperature criteria.

### Potential Natural Vegetation for Temperature TMDLs

Ground water temperature, air temperature, and direct solar radiation are important contributors to stream temperature (Poole and Berman 2001). Shade and stream morphology affect or control the amount of solar radiation reaching a stream. They are the natural stream conditions most likely to be impaired by human activities, and the two that can be readily corrected. The amount of solar radiation reaching the stream may be reduced by restoring the stream bank, vegetation, and channel to more natural conditions.

Vegetation outside the riparian corridor can provide shade if there is enough relief in the surrounding watershed; however, riparian vegetation provides the most substantial amount of shade. Effective shade is shade that exists as the sun makes its way across the sky. Effective shade is measured using optical equipment, similar to a fish eye lens on a camera, called a Solar Pathfinder. Effective shade can be modeled using detailed information about riparian plant communities, topography, and the stream's aspect. Riparian canopy cover is the vegetation that hangs over a stream and is measured using a densiometer or is estimated on site or from aerial photographs.

Potential natural vegetation (PNV) along a stream is the mature riparian plant community that would exist if it had not been disturbed or reduced—in some cases, it still does exist; in other cases, estimates must be made of what would have existed. The PNV is used as a temperature TMDL target because it provides a natural level of solar loading to the stream. A riparian plant community composed of less than PNV results in the stream heating up from excess solar radiation.

Existing shade was estimated from aerial photos. PNV targets were determined from an analysis of probable vegetation in the watersheds, and comparison with shade curves developed for similar vegetation communities in the Nez Perce National Forest, as well as for the Black Hawthorn species found on the Camas Prairie. A shade curve shows the relationship between effective shade and stream width. Shade decreases with increasing width, as the vegetation is less able to shade the center of a wide stream. Taller riparian vegetation allows shade to reach further across a stream channel.

## Shade Estimate Methodology

### *Pathfinder Methodology*

The solar pathfinder is a device used, at some point in a stream, to trace an outline of objects producing shade on the stream onto a specialized chart called the solar path chart. The percentage of the sun's path covered by these objects is the effective shade on the stream at the point where the tracing is made. In order to adequately characterize the effective shade on a reach of stream, 10 traces are taken at systematic or random intervals along the length of the stream in question.

### *Aerial Photo Interpretation*

Shade estimates are based on observations about the kind of vegetation present, its density, and the width of the stream. These observations can be made on site or from aerial photographs. The typical vegetation type shows the kind of landscape a typically found for a reach of stream that has that amount of shade and is 5 meters wide or less.

| Shade class | Typical vegetation type on 5m-wide stream |
|---|---|
| **0** (0 – 9% cover) | agricultural land, denuded areas |
| **10** (10 –19%) | agricultural land, meadows, open areas, clearcuts |
| **20** (20 – 29%) | agricultural land, meadows, open areas, clearcuts |
| **30** (30 – 39%) | agricultural land, meadows, open areas, clearcuts |
| **40** (40 – 49%) | shrublands/meadows |
| **50** (50 – 59%) | shrublands/meadows, open forests |
| **60** (60 – 69%) | shrublands/meadows, open forests |
| **70** (70 – 79%) | forested |
| **80** (80 – 89%) | forested |
| **90** (90 –100%) | forested |

Visual estimates of shade used in this TMDL were field-verified with a solar pathfinder. The pathfinder measures effective shade and takes into consideration physical features other than vegetation that block the sun from hitting the stream surface (e.g., hillsides and canyon walls). The estimate of shade made visually from an aerial photo does not always take into account topography or any shading that may occur from physical features other than vegetation.

## Stream Morphology

Measures of current bankfull width or near-stream disturbance zone width may not reflect widths present under PNV. Width-to-depth ratios tend to increase (streams become wider and shallower) as streams and riparian areas are disturbed. Estimated channel widths used in this TMDL were not developed from aerial photo work as described above. Bankfull widths were estimated based on drainage area, according to the Clearwater River and Salmon curves shown in Figure 16. Existing widths were determined from evaluating available data. If the stream's existing width was greater than that predicted by the Clearwater River and Salmon curves (Figure 16), then the curve-

based estimate of bankfull width was used in the load analysis. If existing width is smaller, then existing width was used in the load analysis. On most of the smaller tributaries, existing widths were used. The larger, third and fourth order tributaries show the effects of upstream disturbances, with width-to-depth ratios that have increased and existing widths that are wider than those estimated from the curves; in these cases, the curve-based estimates were used.

## Vegetation Description

The creeks are found within the Blue Mountains Level III Ecoregion of McGrath et al. (2001), a series of mountain ranges that are lower and more open than the Cascades or Northern Rockies. This ecoregion is largely in eastern Oregon but extends slightly into southeast Washington and western Idaho. The majority of the streams examined are in the Canyons and Dissected Uplands Level IV Ecoregion, although the higher elevations may extend into the Canyons and Dissected Highlands Level IV Ecoregion. The Canyons and Dissected Uplands Ecoregion includes that portion of the Snake and Salmon Rivers that have cut deeply (to 3000' or greater) into the Columbia Plateau. The exposed basalt and metamorphic rock holds little moisture and only supports a dry grassland of bluebunch wheatgrass and Sanberg's bluegrass. The Canyons and Dissected Highlands are higher elevation (4000' to 6400') portions of the Seven Devils Mountains or uplifted Columbia Plateau. Here, drier forests of Douglas fir and Ponderosa pine occur.

Tisdale (1979) indicated that the vegetation of the Snake River canyon from Brownlee to Lewiston was mainly grassland at lower and mid elevations with coniferous forest above, and that a narrow band of riparian vegetation along the river and its tributaries was dominated by white alder (*Alnus rhombifolia*).

For much of the forested sections of streams examined, we utilized the Breaklands setting vegetation type, which is typical of the nearby Nez Perce National Forest (NF), for shade targets (Figure D-2). The Nez Perce NF Breaklands setting includes vegetation response unit (VRU) groups 3, 8, 12, and 16, which include a variety of forest breakland and bunchgrass/shrubland vegetation types. One shade curve was developed to reflect the conglomeration of these VRUs (Shumar and de Varona, *in prep*.).

The more interior streams examined (John's Creek and Telcher Creek) occur in these breaklands, but they also extend into a Black Hawthorn vegetation type in non-forested regions (Figure D-1). Rock Creek, which forms from the confluence of John's Creek and Telcher Creek, extends out of a narrower Nez Perce Breakland type to a broader canyon that is dominated by black cottonwood (Figure D-3). The Black Hawthorn shade curve was produced from field measurements of a hawthorn dominated stream in the Palouse region, with an average canopy cover of 84% and an average height of 6.1m. The black cottonwood shade curve is from the southern Idaho non-forest vegetation types produced by us (Shumar and de Varona, *in prep*.), and includes a plant community of black cottonwood, dogwood, and hawthorn with an average canopy cover of 72.8% and an overall average height of 16.4m.

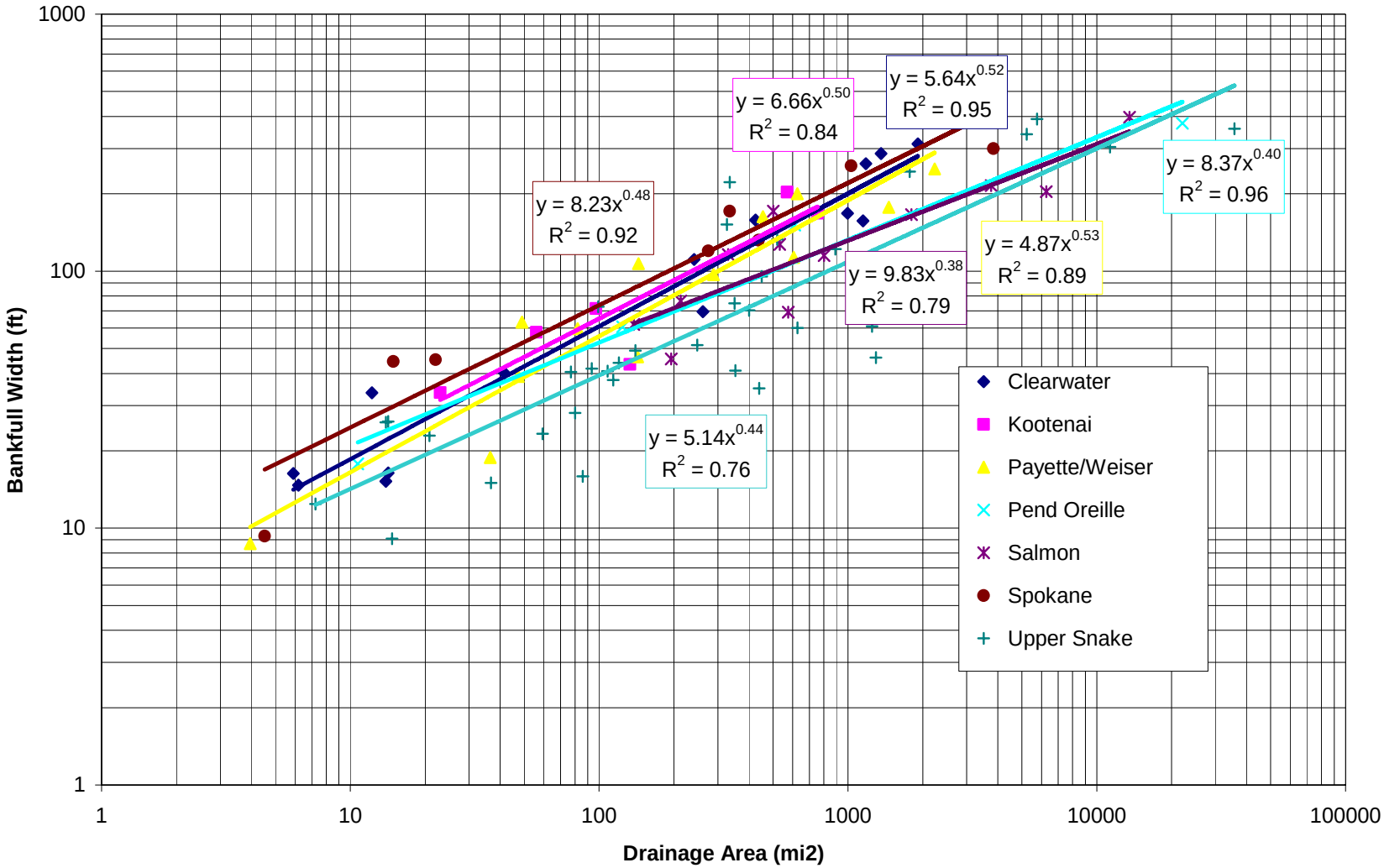



**Figure 16. Bankfull Width as a Function of Drainage Area**

The Snake River tributaries (Divide Creek and Wolf Creek) and Rice Creek on the western side of the lower Salmon River have white alder vegetation in the lower elevations and Nez Perce breakland type vegetation in the upper elevations. Thus, shade curves used for target determination include the Nez Perce NF breakland curve and a surrogate for white alder. Because we have not developed a specific shade curve for a white alder dominated riparian community, we have borrowed a shade curve based on narrowleaf cottonwood (Figure D-4), which is a similarly sized tree (15-20m). The narrowleaf cottonwood curve was developed from a riparian plant community consisting of cottonwoods, willows, and dogwood that had an average overall canopy cover of 81.2% and an overall average height of 11m. The principal species in this community were narrowleaf cottonwood (18m height) and dogwood (4m height). It is our hope that this plant community will adequately represent a typical white alder plant community until such time as field data can be acquired to produce a new shade curve.

### *Shade Curve Use in Development of TMDLs*

The four shade curves used to develop the temperature TMDLs described in the vegetation description section above are displayed in Appendix D. A shade curve shows the relationship between the effective shade of a mature riparian plant community as a function of stream width. The x-axis of the shade curve shows the "calculated shade conditions" at the specific channel width. The y-axis shows the effective shade of the plant community in relation to channel width. For example, the average calculated shade using the Black Hawthorn shade curve for a stream with a width of one meter is 98%; two meters is 95%; and three meters is 88%.

Shade curves (see Appendix D) were used to develop the shade targets listed as the potential shade fraction in the tables in Appendix C (see Table C-1, column 4). Values from the Nez Perce NF Breaklands shade curve (Table D-2) were applied to the higher elevations of Wolf Creek, Divide Creek, Rice Creek, upper segment of Rock Creek, John's Creek, and Telcher Creek. The breaklands shade curve was also applied to the canyon section (break) of John's Creek and Telcher Creek. The Black Hawthorn shade curve (Table D-1) was applied to the non-forested prairie sections of John's Creek and Telcher Creek. The Narrowleaf Cottonwood shade curve (Table D-4) was applied to the lower elevations of Wolf Creek, Divide Creek, and Rice Creek. The Black Cottonwood shade curve (Table D-3) was applied to the lower elevations of Rock Creek.

Existing shade increases and decreases as a result of the natural variation in plant community characteristics such as height, age and leaf size (Table C-1, Column 2). Lack of shade is the difference between the existing shade and the target shade. The lack of shade, as shown in the second to last column in the tables in Appendix C, illustrates the variation in shade between stream segments. The lack of shade is the estimated amount of increased shade needed to meet the shade target.

## Target Selection

Effective shade curves described above were used to determine potential natural vegetation (PNV) shade targets for the analyzed water bodies. These TMDLs used vegetation community modeling to produce these shade curves. Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis (Appendix D).

The effective shade calculations are based on a six month period from April through September. This time period coincides with the critical time period when temperatures affect beneficial uses such as spring and fall salmonids spawning, and when cold water aquatic life criteria may be exceeded (usually during summer months). Late July and early August typically represent the period of highest stream temperatures. Solar gains can begin early in the spring and affect not only the highest temperatures reached later on in the summer, but also affect salmonid spawning temperatures in spring and fall. Thus, solar loading in these streams is evaluated from spring (April) to early fall (September).

## Load Capacity

A stream's load capacity based on PNV is the solar load allowed by the shade targets specified for the stream. The load is the solar load measured by a flat plate collector under full sun conditions for a given period of time multiplied by the fraction of the solar radiation that is not blocked by shade in a particular location during that same period of time. In other words, the solar load hitting the collector under full sun is considered to be 100%, so if a shade target is 60%, then the solar load hitting the stream under conditions meeting that target would be 40%.

Solar load data from a flat plate collector at the National Renewable Energy Laboratory weather station in Pendleton, Oregon were used for this TMDL. The solar loads used to calculate the shade target are spring and summer averages occurring between April and September. This period coincides with the time of year when stream temperatures are increasing and vegetation is growing. Tables in Appendix C show the PNV shade targets (Target or Potential Shade, as percentages) and their corresponding potential summer loads (in kilowatt hours per square meter per day [$kWh/m^2/day$] and kilowatt hours per day [kWh/day]) that serve as the load capacities for a specific segment and as a total for the stream, respectively. Target shade is also visually illustrated, indicating the potential (target) percent shade for each stream segment, on an aerial photo in Figure 17.

## Estimates of Existing Pollutant Loads

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

Existing loads in this temperature TMDL are estimates, derived from estimates of existing shade determined through aerial photo interpretations (Figure 18). Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat plate collector at the Pendleton weather station. Existing shade estimates are presented in Appendix C. Like load capacities (potential loads), existing loads in Appendix C are presented both on an area basis ($kWh/m^2/day$) and as total loads (kWh/day).

Total load amounts are highly variable depending on the size of the stream. Large rivers that are wide have less shade than smaller, narrow streams. Thus, total potential loads on rivers are expected to be quite large. A large river may have a very large existing load, but require

only a small increase in shade because its total load is expected to be much greater. Conversely, a small stream may have a small existing load in relation to larger streams, but its necessary increase in shade could be high because it has a small potential load to begin with.

Existing and potential/target total loads in kWh/day can be summed for the entire stream or portion of stream examined in a single load analysis table. These total loads are shown at the bottom of their respective columns in each table in Appendix C. The difference between potential load and existing load is also summed for the entire table. If existing load exceeds potential load, this difference becomes the excess load to be discussed next in the load allocation section.

The excess load can also be expressed as the lack of shade. To calculate the lack of shade, the potential shade fraction is subtracted from the existing shade fraction for the individual stream segments or reaches. (Percentages can instead be considered as fractions, so for the example given earlier, the total would be expressed as 1.0 (100%), and when 0.6 (60%) is subtracted, the lack of shade would be expressed as 4.0.) The lack of shade for individual reaches (Figure 19) is summed and then divided by the number of segments to determine the average lack of shade for the entire stream (Table 29). If the average lack of shade shown is a negative number, this means that the shade averaged over the entire water body is less than the target. If the number is positive, this means that the shade averaged over the entire water body meets or exceeds the target. It is important to note that even if the average lack of shade calculated for a given water body is a positive number, it is still likely that individual reaches in that water body do not meet their individual shade targets and should still receive restoration treatment during the implementation phase of this TMDL.

In the load analysis tables, each vegetation type is highlighted in its own color to distinguish when and where the dominant vegetation type changes. Each of the vegetation types have their own specific shade targets for each specific stream width; therefore, the changes in highlighted color also help visually explain the changes in potential shade.

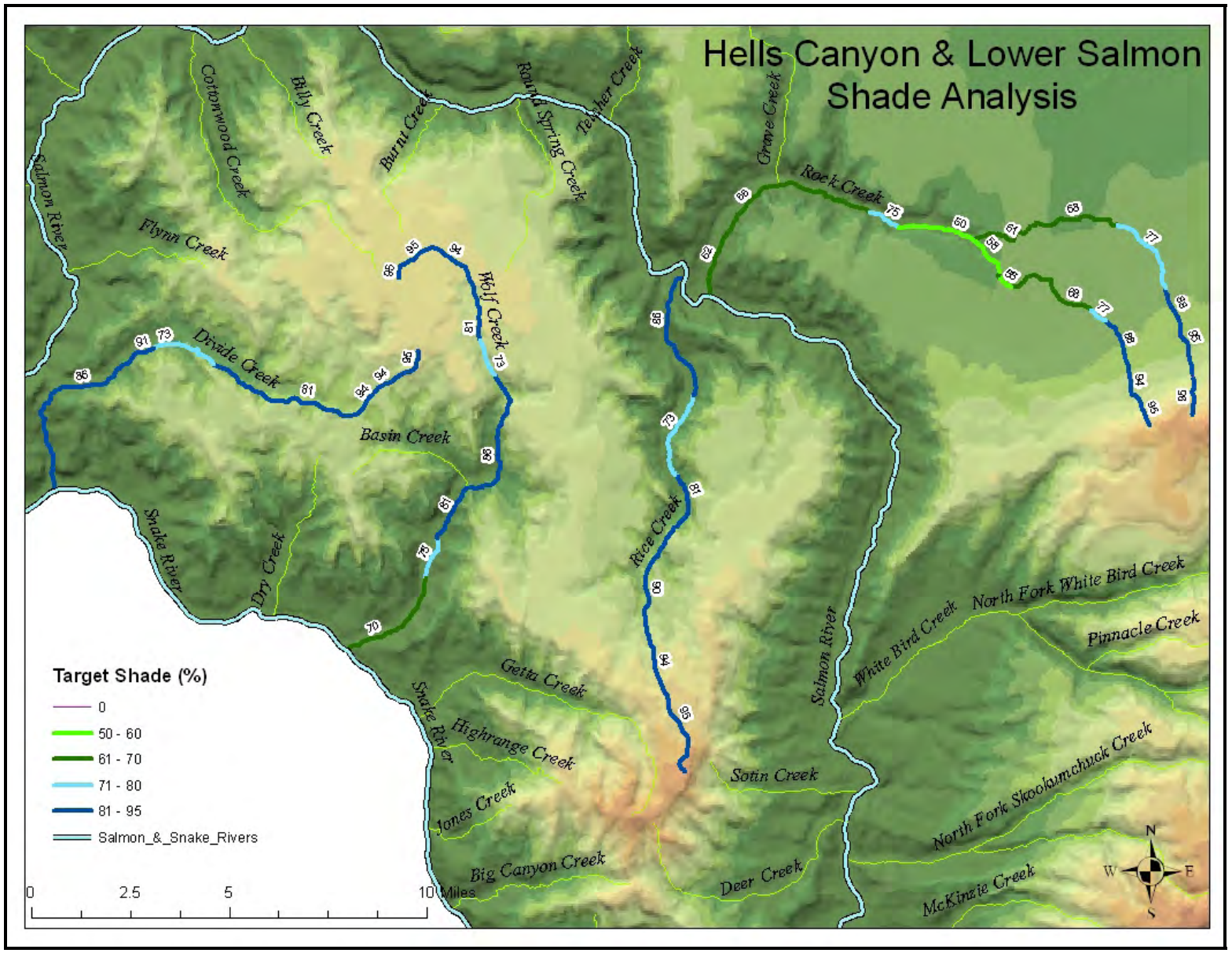



**Figure 17. Percent Target Shade for Stream Segments in the Lower Salmon River and Hells Canyon Subbasins**

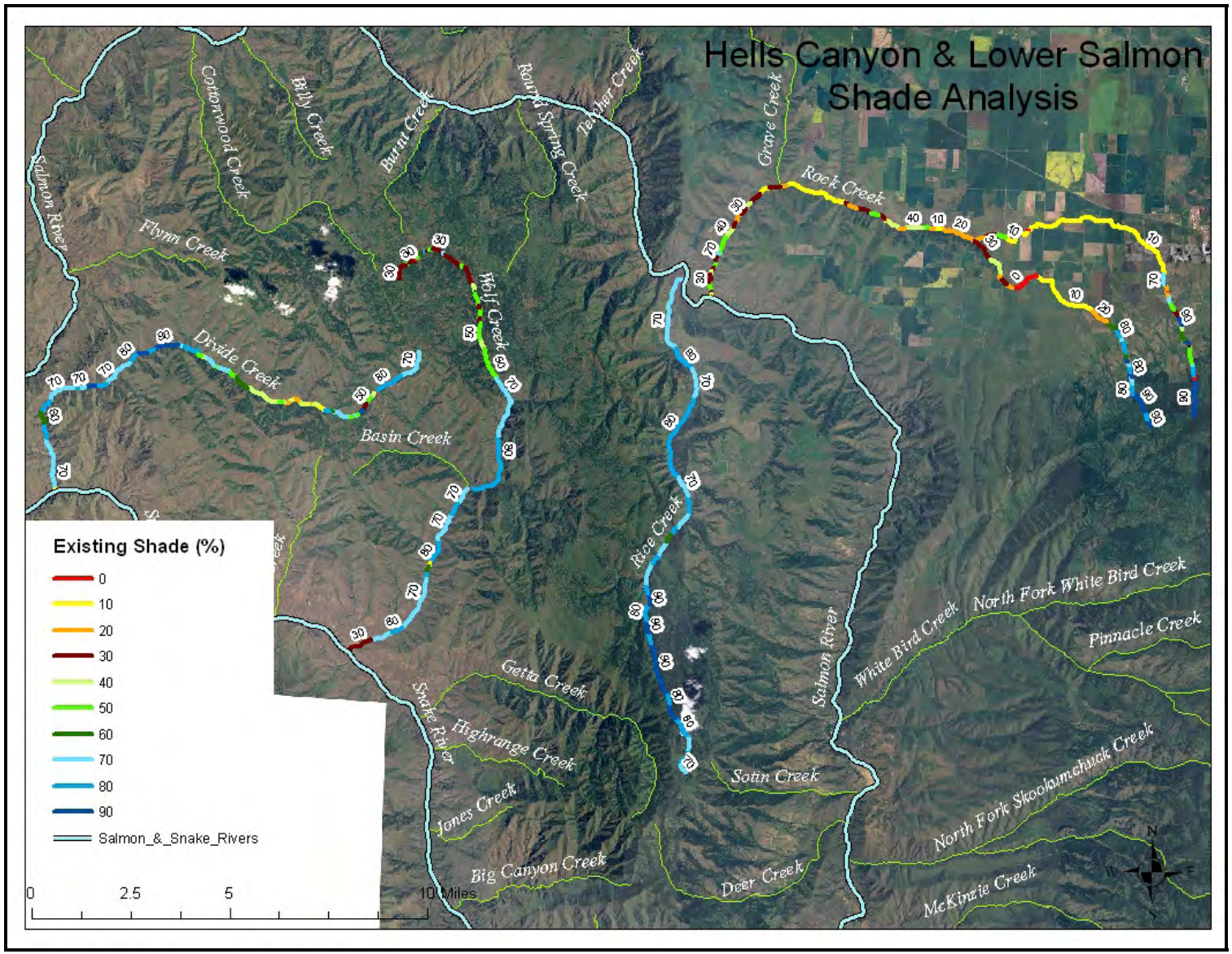



**Figure 18. Percent Existing Shade for Assessed Stream Segments in the Lower Salmon River and Hells Canyon Subbasins based on Aerial Photo Interpretation**

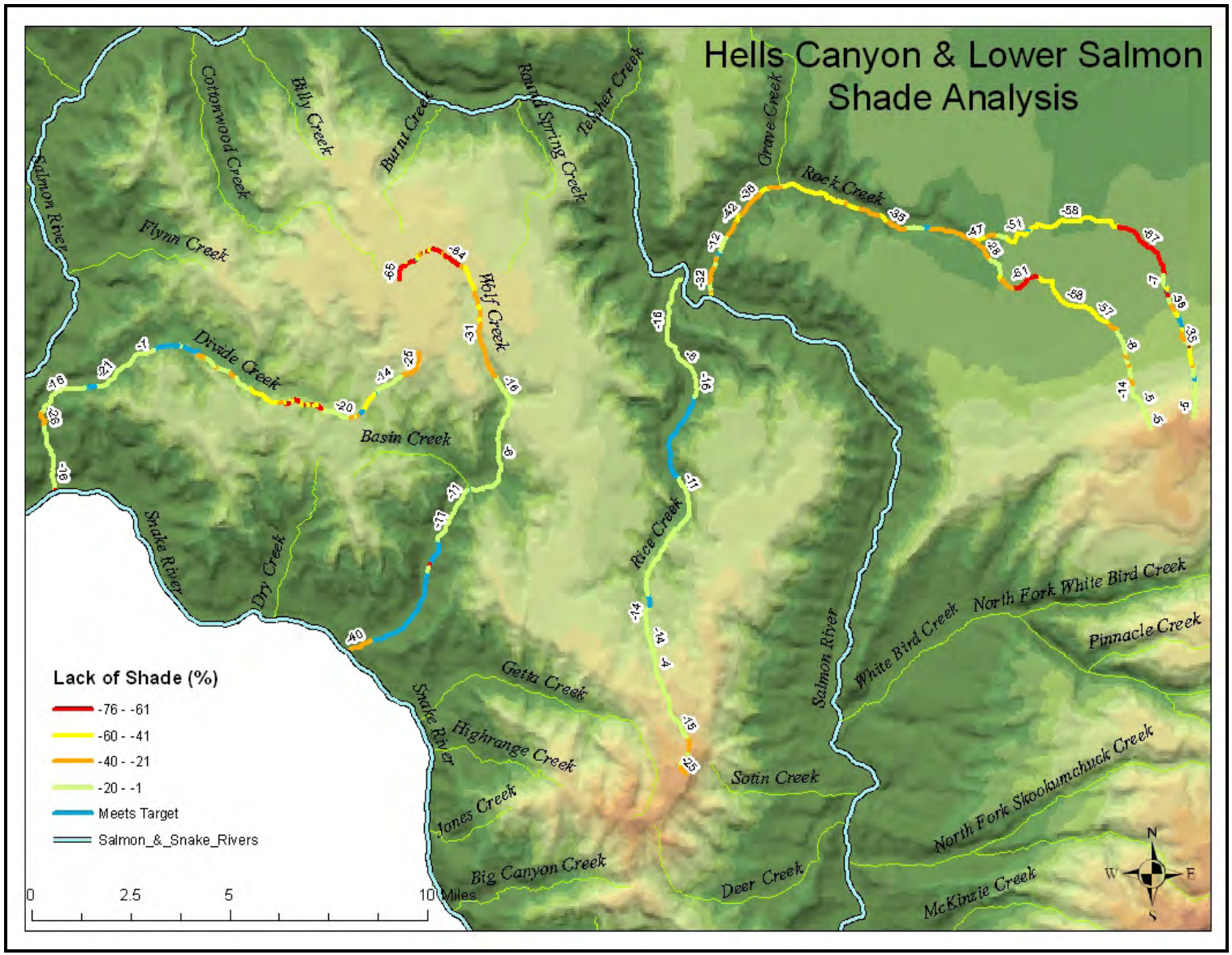



**Figure 19. Percent Shade Change Required (Lack of Shade) to meet Target for Stream Segments based on Target Shade minus Existing Shade**

## Load Allocation

This TMDL is based on potential natural vegetation, which is equivalent to natural background loading. Although water bodies not listed for temperature in Idaho' integrated report are not included in this analysis, it is necessary for all water bodies in the watersheds to achieve PNV in order for natural background loading to occur. Compliance with the load allocation is achieved when natural background conditions are established. Load allocations are assigned to nonpoint source activities that have affected or may affect riparian vegetation and shade. Load allocations are therefore stream reach specific and are dependent upon the target load for a given reach.

The difference between existing shade and target shade (the delta) is visually illustrated for each reach in Figure 19. For any percentage in Figure 19 is expressed as a negative, this indicates the lack of shade, or the deviation from the target, for that reach. Similarly, where the percentage is expressed as a positive this indicates that the reach meets or exceeds the target.

The load analysis tables in Appendix C show the potential shade and load capacity of the stream that is necessary to achieve natural background conditions, in addition to the load reduction needed for each stream segment, listed in descending order. The potential shade has been converted to a summer load by multiplying the inverse fraction (1.0 minus the shade fraction) by the average load recorded on a flat plate collector for the months of April through September.

Table 29 shows the total excess heat load (kWh/day) experienced by each water body examined, and the average lack of shade (percentage) for all segments in that water body. The lack of shade percentage shown in Table 29 represents the average deviation from the target for all the reaches in that water body. It is important to note that even if the average lack of shade calculated for a given water body is a positive number, it is still likely that individual reaches in that water body do not meet their individual shade targets and should still receive restoration treatment during the implementation phase of this TMDL. Entities wishing to estimate load reductions for specific implementation projects should use the reach-specific values shown in the load analysis tables in Appendix C, which represent the load reductions necessary over the length of each specific reach.

### Table 29. Excess solar loads and average lack of shade for the assessed water bodies.

| Water Body | Excess Load (kWh/day) | Average Lack of Shade (%) |
|---|---|---|
| Wolf Creek | -127,245 | -32 |
| Divide Creek | -110,649 | -27 |
| Rice Creek | -42,507 | -12 |
| Rock Creek | -363,083 | -32 |
| John's Creek | -265,326 | -29 |
| Telcher Creek | -134,167 | -26 |

### Waste Load Allocation for Future Growth

No temperature waste load reductions are required by this TMDL. Temperature waste load allocations for future growth is the allowable effluent temperature that will not increase the

receiving water by more than 0.3 $^{o}$C with a mixing zone of 25% volume of stream flow (IDAPA 58.01.02.060). Future waste load allocations will be determined through application of the following equation.

*Eq.* $T_E = \{[Q_E + (0.25 \times Q_S)] \times [Tc + 0.3C] - [(0.25 \times Q_S) \times Tc]\} \div Q_E$

Where: $T_E$ = Effluent temperature ($^{o}$C)
$Q_E$ = Effluent flow (cfs)
$Q_S$ = stream flow (cfs)
$T_c$ = criteria temperature ($^{o}$C)
0.25= 25% by volume mixing zone (unit-less)

### Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially background conditions, there are no loads allocated to specific sources or activities. The loading analysis used in this TMDL involves estimations that are likely to have some variance. Stream width and existing shade were not measured for every segment analyzed. Measurements of stream width and existing shade took place at the monitoring sites, and used other data such as the bankfull width models and BURP data to estimate the loadings. As a result, there is variability associated with estimating, as well as the variability that exists naturally (fires, wind falls, debris torrents, etc) from now to the time it takes to implement the TMDL. Therefore, a review or verification of existing conditions in relation to the target should take place prior to any large scale implementation projects to ensure that expenditures are effective and warranted.

### Seasonal Variation

This TMDL is based on average summer loads, calculated to be inclusive of the 6-month period from April through September. This time period was chosen because it represents the time period when the combination of increasing air and water temperatures coincides with increasing solar inputs and increasing vegetative shade. The critical time periods are June when spring salmonid spawning is occurring, July and August when maximum temperatures exceed cold water aquatic life criteria, and September during fall salmonid spawning. Water temperature is not likely to be a problem for beneficial uses outside of this time period because of cooler weather and lower sun angle.

## 5.4 Construction Storm Water and TMDL Waste Load Allocations

### Construction Storm Water

The Clean Water Act requires operators of construction sites to obtain permit coverage to discharge storm water to a water body or to a municipal storm sewer. In Idaho, EPA has issued a general permit for storm water discharges from construction sites. In the past storm water was treated as a non-point source of pollutants. However, because storm water can be managed on site through management practices or when discharged through a discrete conveyance such as a

storm sewer, it now requires a National Pollution Discharge Elimination System (NPDES) Permit.

### The Construction General Permit (CGP)

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

### Storm Water Pollution Prevention Plan (SWPPP)

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

### Construction Storm Water Requirements

When a stream is on Idaho's § 303(d) list and has a TMDL developed DEQ now incorporates a gross waste load allocation (WLA) for anticipated construction storm water activities. TMDLs developed in the past that did not have a WLA for construction storm water activities will also be considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement the appropriate Best Management Practices.

Typically there are specific requirements you must follow to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for post-construction storm water management. Sediment is usually the main pollutant of concern in storm water from construction sites. The application of specific best management practices from *Idaho's Catalog of Storm Water Best Management Practices for Idaho Cities and Counties* is generally sufficient to meet the standards and requirements of the General Construction Permit, unless local ordinances have more stringent and site specific standards that are applicable.

## 5.5 Implementation Strategies

Idaho Code, in 39-3611 and 39-3612, provides guidance on the development and implementation of TMDLs in Idaho. The guidance contained in code relies on participation and assistance of watershed advisory groups (WAGs) and designated management agencies (DMAs).

### Reasonable Assurance

Nonpoint sources will be managed by applying the combination of authorities the state has included in the Idaho Nonpoint Source Management Plan (DEQ 1999). Section 319 of the federal Clean Water Act requires each state to submit to EPA a management plan for controlling pollution from nonpoint sources within the state. Idaho's authority for implementing the Idaho Nonpoint Source Management Plan has been certified by the Idaho Attorney General. The plan has been submitted to and approved by EPA as complying with Section 319 of the Clean Water Act.

Nonpoint source pollutant controls or best management practices determined to be ineffective in achieving the desired load reductions are subject to the feedback loop process, or adaptive management, to ensure load reductions are achieved (IDAPA 58.01.02.350). The feedback loop

provides for water quality improvements and maintenance through installation, evaluation, and modification of best management practices. Implementing the feedback loop to modify best management practices until water quality standards are met results in compliance with the water quality standards.

## Time Frame

A schedule for implementation of best management practices, pollution control strategies, assessment reporting dates, and evaluation of progress will be developed with appropriate designated management agencies and the Lower Salmon River Watershed Advisory Group, and included in the Lower Salmon River and Hells Canyon Subbasins Assessment and TMDLs Implementation Plan. Based on such assessments and evaluations, implementation strategies for TMDLs may need to be modified if monitoring shows that the water quality standards are not being met.

## Approach

This TMDL focuses on implementation of load allocations for *E. coli* bacteria, nutrients, sediment, and stream temperature. Both the biological and numeric water quality data analyzed for this project suggests that poor habitat conditions and exceedances of numeric standards are impairing the designated beneficial uses in some of the assessed water bodies.

Nonpoint source best management practices for activities with the potential to contribute bacteria, nutrients, and sediment will be evaluated for application within the watershed by the DMAs responsible for such activities.

## Responsible Parties

Idaho Code 39-3612 states designated management agencies are to use TMDL processes for achieving water quality standards. The Department of Environmental Quality will rely on the designated management agencies to implement pollution control measures or best management practices for pollutant sources they identify as priority.

The Department of Environmental Quality also recognizes the authorities and responsibilities of local city and county governments as well as applicable state and federal agencies, and will enlist their involvement and authorities for protecting water quality through implementation of Idaho Administrative Procedures Act 58.01.02 and Clean Water Act Section 401.

The designated state agencies listed below are responsible for assisting and providing technical support for the development of specific implementation plans and other appropriate support to water quality projects. General responsibilities for Idaho designated management agencies are:

- Idaho Soil Conservation Commission: grazing and agriculture.
- Idaho State Department of Agriculture: aquaculture and animal feeding operations.
- Idaho Transportation Department: public roads.
- Idaho Department of Lands: timber harvest, oil and gas exploration, and mining.
- Idaho Department of Water Resources: stream channel alteration activities.
- Department of Environmental Quality: all other activities.

## Monitoring Strategy

Idaho Code 39-3611 requires the Department of Environmental Quality to review and evaluate each Idaho TMDL, supporting assessment, implementation plan, and all available data periodically, at intervals no greater than five years. Such reviews are to be conducted using the Beneficial Use Reconnaissance Program protocol and the Water Body Assessment Guidance methodology to determine beneficial use attainability and status, and whether state water quality standards are being achieved.

Permanent control points for water quality monitoring should be established at the mouths of the tributaries and at the assessment unit boundaries. These would be used for long term monitoring to assess trends in cumulative pollutant loading identified by this TMDL. Beneficial use support status monitoring and assessment will be conducted within each assessment unit of the watershed and evaluated using the Water Body Assessment Guidance for compliance with Idaho state water quality standards.

Idaho Code 39-3621 requires designated agencies, in cooperation with the appropriate land management agency, to ensure best management practices are monitored for their effect on water quality. The monitoring results should be presented to the Department of Environmental Quality on a schedule agreed to between the designated agency and the Department. The designated management agency should report the effectiveness of the measures or practices implemented to the Department in the form of load reductions applicable to the TMDL.

Pollutant load reductions gained by the application of pollutant controls and best management practices will be monitored by the Department of Environmental Quality through reports provided by designated management agencies. Information reported will be compiled and tracked over time to determine measurable pollutant load reductions relative to the total maximum daily load allocations.

## 5.6 Conclusions

Bacteria, sediment, and temperature TMDLs have been developed for some of the listed tributaries to the lower Salmon River Subbasin and Hells Canyon Subbasin (Table 30). With the exception of storm water construction permits, loads have been allocated to the existing sources currently in the watershed. A growth reserve is not included in the TMDLs. Future sources will need to acquire a load allocation from existing allocations unless the load capacity is increased.

**Table 30. Summary of assessment outcomes**

| Water Body Segment(s)/ Assessment Unit(s) | Pollutant | TMDL(s) Completed | Recommended Changes to §303(d) List/2008 Integrated Report | Justification |
|---|---|---|---|---|
| Wolf Creek, Basin Creek to Mouth ID17060101SL024_04 and ID17060101SL025_02, _03, _04 | Temperature | Yes | Place in section 4a* | TMDL completed |
| Wolf Creek, Basin Creek to Mouth ID17060101SL024_04 and ID 17060101SL025_02, _03, _04 | Sediment | No | Remove pollutant from list of impairments | SBA completed |

| Water Body Segment(s)/ Assessment Unit(s) | Pollutant | TMDL(s) Completed | Recommended Changes to §303(d) List/2008 Integrated Report | Justification |
|---|---|---|---|---|
| Divide Creek, Source to Mouth ID17060101SL028_02 and _03 | Temperature Bacteria | Yes | Place in section 4a* | TMDL completed |
| Divide Creek, Source to Mouth ID17060101SL028_02 and _03 | Sediment | No | Remove pollutant from list of impairments | SBA completed |
| Cottonwood Creek, Source to unnamed tributary 17060209SL003_02 | Sediment | No | Remove pollutant from list of impairments | SBA completed |
| Cottonwood Creek, Source to unnamed tributary 17060209SL003_02 | Bacteria | Yes | Place in section 4a* | TMDL completed |
| Billy Creek, Source to Mouth ID17060209SL004_02 | Unknown | Bacteria, Sediment | Place in section 4a* | TMDL completed |
| Rice Creek, Rice Creek tributary ID17060209SL007_02 ID17060209SL007_03 | Temperature Bacteria | Yes | Place in section 4a* | TMDL completed |
| Rice Creek, Rice Creek tributary ID17060209SL007_02 | Sediment | No | Remove pollutant from list of impairments | SBA completed |
| Allison Creek, West Fork to Mouth ID17060209SL028_03 | Bacteria | Yes | Place in section 4a* | TMDL completed |
| Allison Creek, West Fork to Mouth ID17060209SL028_03 | Sediment | No | Remove pollutant from list of impairments | SBA completed |
| John's Creek, Rock Creek source to Graves Creek ID17060209SL057_02 | Sediment, Temperature, Bacteria | Yes | Place in section 4a* | TMDL completed |
| John's Creek, Rock Creek source to Graves Creek ID17060209SL057_02 | Nutrients | No | Move to section 5** | SBA |
| Rock Creek, Source to Grave Creek and Grave Creek to Mouth ID17060209SL057_03 ID17060209SL056_04 | Sediment, Bacteria, Temperature | Yes | Place in section 4a* | TMDL completed |
| Graves Creek, Headwaters to unnamed tributary, unnamed tributary to Rock Creek ID17060209SL058_02 ID17060209SL058_03 | Sediment | No | Remove pollutant from list of impairments | SBA completed |
| Graves Creek, Headwaters to unnamed tributary, unnamed tributary to Rock Creek ID17060209SL058_02 ID17060209SL058_03 | Bacteria | Yes | Place in section 4a* | TMDL completed |

| Water Body Segment(s)/ Assessment Unit(s) | Pollutant | TMDL(s) Completed | Recommended Changes to §303(d) List/2008 Integrated Report | Justification |
|---|---|---|---|---|
| Deep Creek, source to unnamed tributary ID17060209SL060_02 | Sediment Bacteria | Yes | Place in section 4a* | TMDL Completed |
| Deep Creek, source to unnamed tributary ID17060209SL060_02 | Nutrients, Temperature, | No | Remove pollutants from list of impairments | SBA completed |
| Deer Creek, Deer Creek tributary ID17060209SL062_02 and _02a | Sediment | No | Remove pollutant from list of impairments | SBA completed |

* Refers to section 4a of the integrated report (DEQ 2005), which is the section of the report for waters with completed TMDLS.

** Refers to section 5 of the integrated report (DEQ 2005), which is the section of the report for waters that are impaired (their water quality is limited) and need TMDLs.

In nine water bodies in the lower Salmon and Snake Rivers Subbasins, the *E. coli* bacteria geometric mean criterion of 126 cfu/100 ml was exceeded. The bacteria TMDLs have been developed to trigger the implementation of best management practices (BMPs) to ensure that the secondary contact recreation beneficial use is maintained for the protection of human health. The bacteria TMDLs should guide the implementation of BMPs designed to limit bacteria loading, such as off site watering, exclusions, and waste management practices that address the sources of bacteria.

Analysis of the existing continuous temperature data documented five water bodies that violated Idaho's temperature criteria for the cold water aquatic life beneficial use. The temperature TMDLs apply a potential natural vegetation (PNV) approach, which establishes specific shade targets for each water body based on riparian plant communities.

No violations of the DO criterion of 6.0 mg/L were observed during routine sampling within John's Creek. Analysis of the dominant benthic macroinvertebrate community as well as other factors suggest nutrient loading needs to be reduced to ensure in-stream DO concentrations above the criterion are maintained, and excessive growth of aquatic vegetation and visible slime growths aren't impairing beneficial uses. It is recommended that John's Creek be listed for nutrients in Section 5 of Idaho's next integrated report.

Sediment TMDLs were developed for control points where target concentrations greater than the load capacity were measured. Each of the sediment TMDLs allocates a gross concentration to all sources of sediment upstream of the established control points. Sediment TMDLs have been developed for Billy Creek, ID17060209SL004_02; John's Creek, ID17060209SL057_02; Rock Creek, ID17060209SL056_04 and ID17060209SL057_03; and Deep Creek, ID17060209SL060_02.

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### *GIS Coverages*

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# Glossary

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| **305(b)** | Refers to section 305 subsection "b" of the Clean Water Act. The term "305(b)" generally describes a report of each state's water quality and is the principle means by which the U.S. Environmental Protection Agency, Congress, and the public evaluate whether U.S. waters meet water quality standards, the progress made in maintaining and restoring water quality, and the extent of the remaining problems. |
| **§303(d)** | Refers to section 303 subsection "d" of the Clean Water Act. 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval. |
| **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. |
| **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 water body, living off stored yolk. |
| **Algae** | Non-vascular (without water-conducting tissue) aquatic plants that occur as single cells, colonies, or filaments. |

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| **Alluvium** | Unconsolidated recent stream deposition. |
| **Ambient** | General conditions in the environment (Armantrout 1998). In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations or specific disturbances such as a wastewater outfall (EPA 1996). |
| **Anadromous** | Fish, such as salmon and sea-run trout, that live part or the majority of their lives in the saltwater 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 58.01.02.003.61). |
| **Aquatic** | Occurring, growing, or living in water. |
| **Aquifer** | An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding of water to wells or springs. |
| **Assemblage (aquatic)** | An association of interacting populations of organisms in a given water body; for example, a fish assemblage or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996). |
| **Assessment Database (ADB)** | The ADB is a relational database application designed for the U.S. Environmental Protection Agency for tracking water quality assessment data, such as use attainment and causes and sources of impairment. States need to track this information and many other types of assessment data for thousands of water bodies and integrate it into meaningful reports. The ADB is designed to make this process accurate, |

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| | straightforward, and user-friendly for participating states, territories, tribes, and basin commissions. |
| **Assessment Unit (AU)** | A segment of a water body that is treated as a homogenous unit, meaning that any designated uses, the rating of these uses, and any associated causes and sources must be applied to the entirety of the unit. |
| **Assimilative Capacity** | The ability to process or dissipate pollutants without ill effect to beneficial uses. |
| **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 life, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards. |
| **Beneficial Use Reconnaissance Program (BURP)** | A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address lakes, reservoirs, and wadeable streams and rivers |
| **Benthic** | Pertaining to or living on or in the bottom sediments of a water body |
| **Benthic Organic Matter.** | The organic matter on the bottom of a water body. |
| **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. |

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| **Biochemical Oxygen Demand (BOD)** | The amount of dissolved oxygen used by organisms during the decomposition (respiration) of organic matter, expressed as mass of oxygen per volume of water, over some specified period of time. |
| **Biological Integrity** | 1) The condition of an aquatic community inhabiting unimpaired water bodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991). |
| **Biomass** | The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often expressed as grams per square meter. |
| **Biota** | The animal and plant life of a given region. |
| **Biotic** | A term applied to the living components of an area. |
| **Clean Water Act (CWA)** | The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources. |
| **Coliform Bacteria** | A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria, *E. Coli,* and Pathogens). |
| **Colluvium** | 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/centimeter 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. |

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| **Criteria** | In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. The U.S. Environmental Protection Agency develops criteria guidance; states establish criteria. |
| **Cubic Feet per Second** | A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day. |
| **Cultural Eutrophication** | The process of eutrophication that has been accelerated by human-caused influences. Usually seen as an increase in nutrient loading (also see Eutrophication). |
| **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 millimeters depending on the observer and methodology used. The depth sampled varies but is typically about one foot (30 centimeters). |
| **Designated Uses** | Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act. |
| **Discharge** | The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs). |
| **Dissolved Oxygen (DO)** | The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life. |

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| **Disturbance** | Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment. |
| ***E. coli*** | Short for *Escherichia coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans, but their presence in water is often indicative of fecal contamination. *E. coli* are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms. |
| **Ecology** | The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature. |
| **Ecological Indicator** | A characteristic of an ecosystem that is related to, or derived from, a measure of a biotic or abiotic variable that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability. Ecological indicators are often used within the multimetric index framework. |
| **Ecological Integrity** | The condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes (EPA 1996). |
| **Ecosystem** | The interacting system of a biological community and its non-living (abiotic) environmental surroundings. |
| **Effluent** | A discharge of untreated, partially treated, or treated wastewater into a receiving water body. |
| **Endangered Species** | Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act. |
| **Environment** | The complete range of external conditions, physical and biological, that affect a particular organism or community. |
| **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. |

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| **Ephemeral Stream** | A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table (American Geological Institute 1962). |
| **Erosion** | The wearing away of areas of the earth's surface by water, wind, ice, and other forces. |
| **Eutrophic** | From Greek for "well nourished," this describes a highly productive body of water in which nutrients do not limit algal growth. It is typified by high algal densities and low clarity. |
| **Eutrophication** | 1) Natural process of maturing (aging) in a body of water. 2) The natural and human-influenced process of enrichment with nutrients, especially nitrogen and phosphorus, leading to an increased production of organic matter. |
| **Exceedance** | A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria. |
| **Existing Beneficial Use or Existing Use** | A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02). |
| **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, *E. coli*, and Pathogens). |
| **Fecal Streptococci** | A species of spherical bacteria including pathogenic strains found in the intestines of warm-blooded animals. |

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| **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. |
| **Fully Supporting but Threatened** | An intermediate assessment category describing water bodies that fully support beneficial uses, but have a declining trend in water quality conditions, which if not addressed, will lead to a “not fully supporting” status. |
| **Geographical Information Systems (GIS)** | A georeferenced database. |
| **Geometric Mean** | A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data. |
| **Grab Sample** | A single sample collected at a particular time and place. It may represent the composition of the water in that water column. |
| **Gradient** | The slope of the land, water, or streambed surface. |

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| **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. |

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| **Instantaneous** | A condition or measurement at a moment (instant) in time. |
| **Intergravel Dissolved Oxygen** | The concentration of dissolved oxygen within spawning gravel. Consideration for determining spawning gravel includes species, water depth, velocity, and substrate. |
| **Intermittent Stream** | 1) A stream that flows only part of the year, such as when the ground water table is high or when the stream receives water from springs or from surface sources such as melting snow in mountainous areas. The stream ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. 2) A stream that has a period of zero flow for at least one week during most years. |
| **Interstate Waters** | Waters that flow across or form part of state or international boundaries, including boundaries with Native American nations. |
| **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 water body's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area). |
| **Load(ing)** | The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration. |

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| **Load(ing) Capacity (LC)** | A determination of how much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, and a margin of safety, it becomes a total maximum daily load. |
| **Loam** | Refers to a soil with a texture resulting from a relative balance of sand, silt, and clay. This balance imparts many desirable characteristics for agricultural use. |
| **Loess** | A uniform wind-blown deposit of silty material. Silty soils are among the most highly erodible. |
| **Lotic** | An aquatic system with flowing water such as a brook, stream, or river where the net flow of water is from the headwaters to the mouth. |
| **Luxury Consumption** | A phenomenon in which sufficient nutrients are available in either the sediments or the water column of a water body, such that aquatic plants take up and store an abundance in excess of the plants' current needs. |
| **Macroinvertebrate** | An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500µm mesh (U.S. #30) screen. |
| **Macrophytes** | Rooted and floating vascular aquatic plants, commonly referred to as water weeds. These plants usually flower and bear seeds. Some forms, such as duckweed and coontail (*Ceratophyllum sp.*), are free-floating forms not rooted in sediment. |
| **Margin of Safety (MOS)** | An implicit or explicit portion of a water body's loading capacity set aside to allow the uncertainly about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution. |
| **Mass Wasting** | A general term for the down slope movement of soil and rock material under the direct influence of gravity. |
| **Mean** | Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people. |
| **Median** | The middle number in a sequence of numbers. If there are an even number of numbers, the median is the average of the two middle |

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| | numbers. For example, 4 is the median of 1, 2, 4, 14, 16; 6 is the median of 1, 2, 5, 7, 9, 11. |
| **Metric** | 1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement. |
| **Milligrams per Liter (mg/L)** | A unit of measure for concentration. In water, it is essentially equivalent to parts per million (ppm). |
| **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 water body. |
| **Mouth** | The location where flowing water enters into a larger water body. |
| **National Pollution Discharge Elimination System (NPDES)** | A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit. |
| **Natural Condition** | The condition that exists with little or no anthropogenic influence. |
| **Nitrogen** | An element essential to plant growth, and thus is considered a nutrient. |
| **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 water bodies that have been studied, but are missing critical information needed to complete an assessment. |

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| **Not Attainable** | A concept and an assessment category describing water bodies that demonstrate characteristics that make it unlikely that a beneficial use can be attained (e.g., a stream that is dry but designated for salmonid spawning). |
| **Not Fully Supporting** | Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002). |
| **Not Fully Supporting Cold Water** | At least one biological assemblage has been significantly modified beyond the natural range of its reference condition. |
| **Nuisance** | Anything that is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state. |
| **Nutrient** | Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth. |
| **Nutrient Cycling** | The flow of nutrients from one component of an ecosystem to another, as when macrophytes die and release nutrients that become available to algae (organic to inorganic phase and return). |
| **Oligotrophic** | The Greek term for "poorly nourished." This describes a body of water in which productivity is low and nutrients are limiting to algal growth, as typified by low algal density and high clarity. |
| **Organic Matter** | Compounds manufactured by plants and animals that contain principally carbon. |
| **Orthophosphate** | A form of soluble inorganic phosphorus most readily used for algal growth. |
| **Oxygen-Demanding Materials** | Those materials, mainly organic matter, in a water body that consume oxygen during decomposition. |
| **Parameter** | A variable, measurable property whose value is a determinant of the characteristics of a system, such as temperature, dissolved oxygen, and fish populations are parameters of a stream or lake. |
| **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 |

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| | the separation of a chemical into two or more phases, such as partitioning of phosphorus between the water column and sediment. |
| **Pathogens** | A small subset of microorganisms (e.g., certain bacteria, viruses, and protozoa) that can cause sickness or death. Direct measurement of pathogen levels in surface water is difficult. Consequently, indicator bacteria that are often associated with pathogens are assessed. *E. coli*, a type of fecal coliform bacteria, are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms. |
| **Perennial Stream** | A stream that flows year-around in most years. |
| **Periphyton** | Attached microflora (algae and diatoms) growing on the bottom of a water body or on submerged substrates, including larger plants. |
| **Pesticide** | Substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant. |
| **pH** | The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9. |
| **Phased TMDL** | A total maximum daily load (TMDL) that identifies interim load allocations and details further monitoring to gauge the success of management actions in achieving load reduction goals and the effect of actual load reductions on the water quality of a water body. Under a phased TMDL, a refinement of load allocations, wasteload allocations, and the margin of safety is planned at the outset. |
| **Phosphorus** | An element essential to plant growth, often in limited supply, and thus considered a nutrient. |
| **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 term “physical/chemical.” |
| **Plankton** | Microscopic algae (phytoplankton) and animals (zooplankton) that float freely in open water of lakes and oceans. |

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| **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 (Rand 1995). The goal of QA is to assure the data provided are of the quality needed and claimed (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 (Rand 1995). QC is implemented at the field or bench level (EPA 1996). |
| **Quantitative** | Descriptive of size, magnitude, or degree. |

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|---|---|
| **Reach** | A stream section with fairly homogenous physical characteristics. |
| **Reconnaissance** | An exploratory or preliminary survey of an area. |
| **Reference** | A physical or chemical quantity whose value is known and thus is used to calibrate or standardize instruments. |
| **Reference Condition** | 1) A condition that fully supports applicable beneficial uses with little affect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995). |
| **Reference Site** | A specific locality on a water body that is minimally impaired and is representative of reference conditions for similar water bodies. |
| **Representative Sample** | A portion of material or water that is as similar in content and consistency as possible to that in the larger body of material or water being sampled. |
| **Resident** | A term that describes fish that do not migrate. |
| **Respiration** | A process by which organic matter is oxidized by organisms, including plants, animals, and bacteria. The process converts organic matter to energy, carbon dioxide, water, and lesser constituents. |
| **Riffle** | A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness. |
| **Riparian** | Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body. |
| **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:<br>▪ 300 feet from perennial fish-bearing streams<br>▪ 150 feet from perennial non-fish-bearing streams<br>▪ 100 feet from intermittent streams, wetlands, and ponds in priority watersheds. |

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| **River** | A large, natural, or human-modified stream that flows in a defined course or channel or in 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 water body. |
| **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. |

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| **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 millimeters depending on the observer and methodology used. Results are typically expressed as a percentage of observation points with fine sediment. |
| **Surface Runoff** | Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow. |
| **Surface Water** | All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water. |
| **Suspended Sediments** | Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins. |
| **Taxon** | Any formal taxonomic unit or category of organisms (e.g., species, genus, family, order). The plural of taxon is taxa (Armantrout 1998). |
| **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. |

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| **Threatened Species** | Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range. |
| **Total Maximum Daily Load (TMDL)** | A TMDL is a water body's load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed. |
| **Total Dissolved Solids** | Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate. |
| **Total Suspended Solids (TSS)** | The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Franson et al. 1998) call for using a filter of 2.0 microns or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C. |
| **Toxic Pollutants** | Materials that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely. |
| **Tributary** | A stream feeding into a larger stream or lake. |
| **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. |
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| **Total Suspended Solids (TSS)** | The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Franson et al. 1998) call for using a filter of 2.0 micron or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C. |

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| **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 water body. |
| **Water Body** | A stream, river, lake, estuary, coastline, or other water feature, or portion thereof. |
| **Water Column** | Water between the interface with the air at the surface and the interface with the sediment layer at the bottom. The idea derives from a vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water. |
| **Water Pollution** | Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state, which will or is likely to create a nuisance or to render such waters harmful, detrimental, or injurious to public health, safety, or welfare; to fish and wildlife; or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses. |
| **Water Quality** | A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use. |
| **Water Quality Criteria** | Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes. |

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| **Water Quality Limited** | A label that describes water bodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a §303(d) list. |
| **Water Quality Limited Segment (WQLS)** | Any segment placed on a state's §303(d) list for failure to meet applicable water quality standards, and/or is not expected to meet applicable water quality standards in the period prior to the next list. These segments are also referred to as "§303(d) listed." |
| **Water Quality Management Plan** | A state or area-wide waste treatment management plan developed and updated in accordance with the provisions of the Clean Water Act. |
| **Water Quality Modeling** | The prediction of the response of some characteristics of lake or stream water based on mathematical relations of input variables such as climate, stream flow, and inflow water quality. |
| **Water Quality Standards** | State-adopted and U.S. Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses. |
| | **Water Table** |
| | The upper surface of ground water; below this point, the soil is saturated with water. |
| **Watershed** | 1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller "subwatersheds." 2) The whole geographic region which contributes water to a point of interest in a water body. |
| **Water Body Identification Number (WBID)** | A number that uniquely identifies a water body in Idaho and ties in to the Idaho water quality standards and GIS information. |
| **Wetland** | An area that is at least some of the time saturated by surface or ground water so as to support with vegetation adapted to saturated soil conditions. Examples include swamps, bogs, fens, and marshes. |
| **Young of the Year** | Young fish born the year captured, evidence of spawning activity. |

# Appendix A. Unit Conversion Chart

## Table A-1. Metric - English unit conversions.

| | English Units | Metric Units | To Convert | Example |
|---|---|---|---|---|
| **Distance** | Miles (mi) | Kilometers (km) | 1 mi = 1.61 km<br>1 km = 0.62 mi | 3 mi = 4.83 km<br>3 km = 1.86 mi |
| **Length** | Inches (in)<br>Feet (ft) | Centimeters (cm)<br>Meters (m) | 1 in = 2.54 cm<br>1 cm = 0.39 in<br>1 ft = 0.30 m<br>1 m = 3.28 ft | 3 in = 7.62 cm<br>3 cm = 1.18 in<br>3 ft = 0.91 m<br>3 m = 9.84 ft |
| **Area** | Acres (ac)<br>Square Feet ($ft^2$)<br>Square Miles ($mi^2$) | Hectares (ha)<br>Square Meters ($m^2$)<br>Square Kilometers ($km^2$) | 1 ac = 0.40 ha<br>1 ha = 2.47 ac<br>1 $ft^2$ = 0.09 $m^2$<br>1 $m^2$ = 10.76 $ft^2$<br>1 $mi^2$ = 2.59 $km^2$<br>1 $km^2$ = 0.39 $mi^2$ | 3 ac = 1.20 ha<br>3 ha = 7.41 ac<br>3 $ft^2$ = 0.28 $m^2$<br>3 $m^2$ = 32.29 $ft^2$<br>3 $mi^2$ = 7.77 $km^2$<br>3 $km^2$ = 1.16 $mi^2$ |
| **Volume** | Gallons (gal)<br>Cubic Feet ($ft^3$) | Liters (L)<br>Cubic Meters ($m^3$) | 1 gal = 3.78 L<br>1 L= 0.26 gal<br>1 $ft^3$ = 0.03 $m^3$<br>1 $m^3$ = 35.32 $ft^3$ | 3 gal = 11.35 L<br>3 L = 0.79 gal<br>3 $ft^3$ = 0.09 $m^3$<br>3 $m^3$ = 105.94 $ft^3$ |
| **Flow Rate** | Cubic Feet per Second (cfs)[a] | Cubic Meters per Second ($m^3$/sec) | 1 cfs = 0.03 $m^3$/sec<br>1 $m^3$/sec = 35.31cfs | 3 $ft^3$/sec = 0.09 $m^3$/sec<br>3 $m^3$/sec = 105.94 $ft^3$/sec |
| **Concentration** | Parts per Million (ppm) | Milligrams per Liter (mg/L) | 1 ppm = 1 mg/L[b] | 3 ppm = 3 mg/L |
| **Weight** | Pounds (lbs) | Kilograms (kg) | 1 lb = 0.45 kg<br>1 kg = 2.20 lbs | 3 lb = 1.36 kg<br>3 kg = 6.61 lb |
| **Temperature** | Fahrenheit (°F) | Celsius (°C) | °C = 0.55 (F - 32)<br>°F = (C x 1.8) + 32 | 3 °F = -15.95 °C<br>3 °C = 37.4 °F |

[a] 1 cfs = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 cfs.
[b] The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water

# Appendix B. Lower Salmon River and Hells Canyon Subbasins Monitoring Data

## Table B-1. Data sources for Billy Creek; Lower Salmon River Subbasin Assessment.

| Sample Date | Time | Temp °C | D.O. (mg/L) | Flow (cfs) | E. coli (cfu/100ml) | E.coli 30 day Geomean | E.coli 5 Sample 30 day Geomean | TSS (mg/L) |
|---|---|---|---|---|---|---|---|---|
| 03/08/2007 | 1:05 | 8.5 | 11.9 | 3.18 | 980.4 | | | 28.7 |
| 03/22/2007 | 11:55 | 7.1 | 12.1 | 2.67 | 344.8 | | | 13.8 |
| 04/05/2007 | 11:25 | 9.1 | 11.4 | 2.34 | 113.7 | 337.5 | | 15.8 |
| 04/19/2007 | 11:30 | 7.7 | 11.6 | 1.47 | 54.6 | 128.9 | | 16.1 |
| 05/04/2007 | 11:00 | 8.5 | 11.4 | 1.18 | 137.4 | 94.8 | | 16.5 |
| 05/17/2007 | 9:30 | 13.2 | 10.1 | 0.74 | 63.1 | 77.9 | | 26.1 |
| 05/31/2007 | 1:00 | 14.8 | 9.2 | 0.86 | 21.1 | 56.8 | | 22.6 |
| 06/14/2007 | 1:00 | 14.6 | 11.0 | 0.65 | 60.9 | 43.3 | | 29.8 |
| 06/28/2007 | 10:00 | 16.3 | 10.5 | 0.26 | 148.3 | 57.5 | | 27.4 |
| 07/12/2007 | 9:45 | 19.9 | 9.4 | 0.10 | 1732.9 | 250.1 | | 39.3 |
| 07/26/2007 | 11:20 | 19.5 | 9.5 | 0.12 | 686.7 | 560.9 | | 30.4 |
| 08/10/2007 | 11:00 | 17.7 | 9.7 | 0.10 | 686.7 | 934.9 | | 22.25 |
| 08/23/2007 | 10:40 | 15 | 10.4 | 0.10 | 517.2 | 624.8 | | 17.9 |
| 09/06/2007 | 11:25 | 16.5 | 9.2 | 0.10 | 770.1 | 649.1 | | 42.5 |
| 09/20/2007 | 12:00 | 12.2 | 10.2 | 0.10 | 290.9 | 487.5 | | 21.1 |
| 10/04/2007 | 12:30 | 9.8 | 10.8 | 0.29 | 37.9 | 204.0 | | 12.6 |
| 10/18/2007 | 11:10 | 7.7 | 11.5 | 0.40 | 50.4 | 82.2 | | 15.8 |
| 11/01/2007 | 12:00 | 5.2 | 13.3 | 0.60 | 5.2 | 21.5 | | 5.49 |
| 11/29/2007 | 12:30 | 4.1 | 13.6 | 0.43 | 63.8 | 25.6 | | 6.79 |
| 12/13/2007 | 11:30 | 2.7 | 14.4 | 0.71 | 3.1 | 10.1 | | 8.78 |
| 01/10/2008 | 12:00 | 2.7 | 13.9 | 0.71 | >2419.2 | 78.2 | | 14.4 |
| 02/07/2008 | 12:00 | 4.1 | 13.3 | 0.84 | >2419.2 | 262.8 | | 19.7 |
| 02/21/2008 | 1:00 | 4.5 | 13.1 | 2.71 | 1553.1 | 2087.0 | | 14.8 |
| 03/06/2008 | 12:30 | 4.4 | 13.7 | 2.42 | 866.4 | 1482.1 | | 11.8 |
| 03/20/2008 | 10:00 | 6.3 | 13.0 | 2.20 | 613.1 | 937.9 | | 19.1 |
| 04/03/2008 | 12:00 | 4.4 | 13.9 | 1.4 | 17.1 | 208.6 | | 7.73 |
| 07/06/2008 | 1:00 | | | | 161.6 | | | |
| 07/10/2008 | 12:15 | 18.1 | 9.6 | | 135.4 | | | |
| 07/13/2008 | | | | | 101.9 | | | |
| 07/17/2008 | 11:15 | | | | 228.2 | | | |
| 07/20/2008 | 11:15 | | | | 151.5 | | 150.5 | |

## Table B-2. Data sources for Cottonwood Creek; Lower Salmon River Subbasin Assessment.

| Sample Date | Time | Temp °C | D.O. (mg/L) | Flow (cfs) | E. coli (cfu/100ml) | E.coli 30 day Geomean | E.coli 5 Sample 30 day Geomean | TSS (mg/L) |
|---|---|---|---|---|---|---|---|---|
| 03/08/2007 | 11:00 | 6 | 12.7 | 10.60 | 12 | | | 7.3 |
| 03/22/2007 | 11:05 | 5.4 | 12.6 | 13.49 | 11 | | | 9.9 |
| 04/05/2007 | 11:00 | 7.6 | 11.8 | 13.65 | 3.1 | 7.4 | | 5.89 |
| 04/19/2007 | 10:45 | 6.7 | 11.9 | 9.61 | 7.4 | 6.3 | | 14.4 |
| 05/04/2007 | 10:10 | 7.6 | 11.9 | 4.32 | 66.9 | 11.5 | | 40.9 |
| 05/17/2007 | 10:00 | 13.3 | 10.1 | 2.42 | 16.1 | 20.0 | | 7.95 |
| 05/31/2007 | 12:20 | 16.8 | 8.8 | 1.23 | 6.3 | 18.9 | | 4.81 |
| 06/14/2007 | 12:00 | 15.7 | 10.9 | 1.30 | 28.4 | 14.2 | | 5.89 |
| 06/28/2007 | 10:20 | 15.95 | 10.5 | 0.29 | 37.3 | 18.8 | | 4.19 |
| 07/12/2007 | 10:25 | | | Dry | 95.9 | 46.7 | | 8.62 |
| 07/26/2007 | | | | Dry | | | | |
| 08/10/2007 | | | | Dry | | | | |
| 08/23/2007 | | | | Dry | | | | |
| 09/06/2007 | | | | Dry | | | | |
| 09/20/2007 | | | | Dry | | | | |
| 10/04/2007 | | | | Dry | | | | |
| 10/18/2007 | | | | Dry | | | | |
| 11/01/2007 | 11:15 | 9.5 | 11.8 | 0.48 | 866.4 | | | ND |
| 11/29/2007 | 11:30 | 7.1 | 12.9 | 0.82 | 290.9 | 502.0 | | 1.16 |
| 12/13/2007 | 10:30 | 6.2 | 13.5 | 1.53 | 187.2 | 233.4 | | 1.34 |
| 01/10/2008 | 11:00 | 5 | 13.2 | 2.18 | 185 | 186.1 | | 4.45 |
| 02/07/2008 | 11:00 | 4.8 | 13.3 | 2.10 | 13.2 | 49.4 | | 1.35 |
| 02/21/2008 | 12:00 | 4.2 | 13.3 | 3.97 | 21.1 | 16.7 | | 2.8 |
| 03/06/2008 | 11:30 | 4.1 | 13.7 | 8.51 | 13.2 | 15.4 | | 2.77 |
| 03/20/2008 | 11:00 | 5 | 13.5 | 8.37 | 5.2 | 11.3 | | 4.1 |
| 04/03/2008 | 11:00 | 3.5 | 14.0 | 7.99 | 26.2 | 12.2 | | 2.55 |
| 07/06/2008 | 12:30 | | | | 54.5 | | | |
| 07/10/2008 | 11:45 | 18 | 9.7 | | 62 | | | |
| 07/13/2008 | | | | | 29.4 | | | |
| 07/17/2008 | 10:45 | | | | 15.8 | | | |
| 07/20/2008 | 10:45 | | | | 15.8 | | 30.1 | |

## Table B-3. Data sources for Allison Creek; Lower Salmon River Subbasin Assessment.

| Sample Date | Time | Temp °C | D.O. (mg/L) | Flow (cfs) | E. coli (cfu/100 ml) | E.coli 5 Sample 30 day Geomean | TSS (mg/L) |
|---|---|---|---|---|---|---|---|
| 03/13/2007 | 9:50 | 5 | 12.6 | 18.32 | 172.3 | | 18.0 |
| 03/27/2007 | 11:35 | 5.2 | 12.4 | 28.30 | 517.2 | | 5.6 |
| 04/09/2007 | 10:35 | 7.6 | 11.5 | 19.53 | >2419.2 | | 7.1 |
| 04/24/2007 | 11:30 | 7.2 | 11.5 | 14.02 | 135.4 | | 9.1 |
| 05/08/2007 | 10:00 | 7.8 | 11.6 | 23.15 | 38.4 | | 24.2 |
| 05/21/2007 | 10:00 | 6.8 | 11.7 | 37.75 | 101.7 | | 21.4 |
| 06/04/2007 | 10:40 | 12.6 | 8.1 | 11.48 | 1986.3 | | 29.1 |
| 06/18/2007 | 11:20 | 10.9 | 12.0 | 11.49 | 93.2 | | 6.9 |
| 07/01/2007 | 11:20 | 14.2 | 10.8 | 11.84 | 228.2 | | 6.6 |
| 07/16/2007 | 11:00 | 18.2 | 9.7 | 9.95 | 224.7 | | 7.8 |
| 07/30/2007 | 10:40 | | | | 135.4 | | 6.4 |
| 08/13/2007 | 10:40 | 14.4 | 10.4 | 8.27 | 111.9 | | 5.8 |
| 08/29/2007 | 8:00 | 12.5 | 10.7 | 5.74 | 68.3 | | 6.2 |
| 09/10/2007 | 11:00 | 13 | 10.5 | 8.05 | 110.6 | | 4.9 |
| 09/25/2007 | 10:25 | 9.1 | 10.8 | 7.10 | 410.6 | | 4.2 |
| 10/09/2007 | 10:45 | 8.7 | 11.0 | 9.17 | 29.5 | | 3.4 |
| 10/23/2007 | 10:45 | 7.7 | 12.3 | ND | 51.2 | | 2.3 |
| 11/05/2007 | 11:00 | 4.9 | 13.3 | 9.29 | 41.3 | | 1.6 |
| 11/19/2007 | 9:30 | 7.6 | 11.3 | 12.59 | 121.1 | | 13.6 |
| 12/03/2007 | 10:45 | 3 | 14.2 | 14.22 | 93.3 | | 13.5 |
| 12/17/2007 | 10:30 | 1.9 | 14.1 | 10.38 | 18.5 | | ND |
| 01/02/2008 | 10:30 | 0.1 | 15.3 | 7.24 | 32.7 | | 4.5 |
| 01/27/2008 | 1:30 | 5.2 | 9.9 | 12.03 | 98.8 | | 13.0 |
| 02/10/2008 | 2:00 | 3.5 | 12.9 | 6.56 | 770.1 | | 5.0 |
| 02/26/2008 | 2:00 | 4.4 | 12.7 | 9.8 | 1553.1 | | 4.0 |
| 03/09/2008 | 1:00 | 4.2 | 13.0 | 9.15 | 72.8 | | 2.5 |
| 04/06/2008 | 1:00 | 4.2 | 12.9 | 8.79 | 43.5 | | 3.5 |
| 05/28/2008 | 8:50 | | | | 10 | | |
| 06/01/2008 | 9:30 | | | | 7 | | |
| 06/04/2008 | 8:55 | | | | 12 | | |
| 06/08/2008 | 9:40 | | | | 15 | | |
| 06/11/2008 | 9:00 | | | | 228 | 20 | |
| 01/06/2009 | | | | | 72 | | |
| 01/09/2009 | | | | | 62 | | |
| 01/13/2009 | | | | | 12 | | |
| 01/20/2009 | | | | | 326 | | |
| 01/25/2009 | | | | | 1203 | | |
| 01/29/2009 | | | | | 461 | | |
| 02/03/2009 | | | | | 299 | 162 | |

## Table B-4. Data sources for Rice Creek; Lower Salmon River Subbasin Assessment.

| Sample Date | Time | Temp °C | D.O. (mg/L) | Flow (cfs) | E.Coli (cfu/100 ml) | E.coli 30 day Geomean | TSS (mg/L) |
|---|---|---|---|---|---|---|---|
| 03/28/2007 | 2:40 | 7.3 | 12.3 | 39.81 | 79.4 | | 5.08 |
| 04/10/2007 | 10:15 | 5.8 | 12.4 | 25.23 | 33.6 | | 8 |
| 04/25/2007 | 1:45 | 9.1 | 11.2 | 26.05 | 21.8 | 38.7 | 7.34 |
| 06/05/2007 | 10:00 | 17.2 | 8.8 | 3.56 | 980.4 | | 12.6 |
| 06/19/2007 | 10:20 | 13.4 | 12.0 | 7.92 | 90.9 | | 8.03 |
| 07/02/2207 | 9:00 | 17 | 10.9 | 3.60 | 90.7 | 200.7 | 8 |
| 07/17/2007 | 11:30 | 22.8 | 10.1 | 1.81 | 126.6 | 101.4 | 7.35 |
| 07/31/2007 | 10:00 | | | 1.80 | 118.7 | 110.9 | 4.93 |
| 08/14/2007 | 11:30 | 19.1 | 10.4 | 1.80 | 158.5 | 133.5 | 4.53 |
| 08/29/2007 | 11:30 | 16 | 10.1 | 1.80 | 261.3 | 170.0 | 3.15 |
| 09/11/2007 | 10:45 | 13.3 | 10.5 | 1.80 | 185 | 197.1 | 2.58 |
| 09/26/2007 | 10:30 | 9.3 | 11.3 | 1.80 | 69.7 | 149.9 | 1.58 |
| 10/10/2007 | 11:00 | 11 | 10.6 | 1.93 | 11 | 52.2 | 1.8 |
| 10/24/2007 | 11:15 | 8.4 | 12.0 | 2.13 | 4.1 | 14.6 | 1.51 |
| 11/07/2007 | 12:30 | 5.6 | 13.2 | 2.82 | 2 | 4.5 | 7.44 |
| 11/19/2007 | 12:30 | 5.9 | 13.0 | 4.99 | 30.5 | 6.3 | 5.19 |
| 12/04/2007 | 12:00 | 7.4 | 13.0 | 6.40 | 55.6 | 15.0 | 3.33 |
| 12/18/2007 | 11:00 | 2.9 | 14.4 | 6.30 | <1 | 11.9 | 2.02 |
| 01/02/2008 | 3:00 | 1.6 | 14.7 | 6.26 | 7.4 | 7.4 | 2.67 |
| 01/15/2008 | 11:30 | 2.8 | 14.7 | 6.84 | 9.7 | 4.2 | 2.89 |
| 01/29/2008 | 1:30 | 2.4 | 13.7 | 6.92 | 45 | 14.8 | 22.2 |
| 02/12/2008 | 9:00 | 5 | 13.4 | 16.40 | 32.7 | 24.3 | 8.67 |
| 02/27/2008 | 12:00 | 5.3 | 13.3 | 29.95 | 206.3 | 67.2 | 16.3 |
| 03/10/2008 | 3:30 | 7.2 | 12.8 | 26.56 | 214.2 | 113.1 | 6.4 |
| 03/24/2008 | 1:30 | 6.3 | 13.1 | 66.25 | 46.4 | 127.0 | 8.5 |
| 04/09/2008 | 12:30 | 5.7 | 13.17 | 46.6 | 365.4 | 153.7 | 7.56 |
| 04/22/2008 | 8:00 | 3.9 | 13.61 | 100 | 34.1 | 83.3 | 7.62 |

## Table B-5. Data sources for Rock Creek; Lower Salmon River Subbasin Assessment.

| Sample Date | Time | Temp °C | D.O. (mg/L) | Flow (cfs) | E. coli (cfu/100 ml) | E.coli 5 Sample 30 day Geomean | TSS (mg/L) |
|---|---|---|---|---|---|---|---|
| 03/14/2007 | 12:35 | 8.4 | 12.2 | 28.07 | 6.3 | | 8 |
| 03/28/2007 | 12:40 | 7.1 | 12.1 | 84.92 | 613.1 | | 137.3 |
| 04/10/2007 | 9:45 | 7.2 | 12.3 | 28.29 | 29.2 | | 15.1 |
| 04/25/2007 | 1:00 | 11.2 | 11.0 | 27.97 | 48.7 | | 21.1 |
| 05/08/2007 | 1:15 | 17.7 | 10.2 | 17.46 | 24.6 | | 17.8 |
| 05/22/2007 | 11:30 | 12.6 | 11.7 | 10.59 | 170.6 | | 18 |
| 06/05/2007 | 10:30 | 19 | 8.9 | 3.54 | 9.7 | | 12.7 |
| 06/19/2007 | 10:45 | 16.9 | 12.0 | 6.36 | 9.7 | | 5.38 |
| 07/02/2007 | 10:00 | 19.7 | 10.6 | 2.54 | 31.8 | | 6.11 |
| 07/17/2007 | 10:30 | 23.8 | 10.7 | 2.24 | 69.1 | | 7.4 |
| 07/31/2007 | 9:30 | | | 2.20 | 48.7 | | 6.95 |
| 08/14/2007 | 10:30 | 18.7 | 11.6 | 2.20 | 44.1 | | 6.02 |
| 08/29/2007 | 11:15 | 17.5 | 11.4 | 2.20 | 20.3 | | 4.08 |
| 09/11/2007 | 10:00 | 13.9 | 11.1 | 2.20 | 14.5 | | 4.22 |
| 09/26/2007 | 9:45 | 11.8 | 10.6 | 2.20 | 16 | | 4.5 |
| 10/10/2007 | 10:00 | 11.7 | 11.5 | 3.83 | 2 | | 2.5 |
| 10/24/2007 | 10:30 | 9.6 | 12.6 | 5.23 | 2 | | 2.13 |
| 11/07/2007 | 11:30 | 7.1 | 14.8 | 4.48 | 1 | | 1.04 |
| 11/19/2007 | 11:45 | 6.6 | 13.3 | 10.92 | 45.7 | | 13.5 |
| 12/04/2007 | 11:00 | 7.6 | 12.9 | 22.66 | <1 | | 103 |
| 12/18/2007 | 10:00 | 3.4 | 14.7 | 10.00 | 9.7 | | 1.19 |
| 01/02/2008 | 2:45 | 1.6 | 15.5 | 5.60 | 2 | | ND |
| 01/15/2008 | 10:50 | 2.7 | 14.8 | 7.63 | 2 | | 2.03 |
| 01/29/2008 | 12:30 | 3.1 | 14.1 | 7.41 | 22.8 | | 5.05 |
| 02/12/2008 | 9:30 | 4 | 13.9 | 36.40 | 79.8 | | 19.9 |
| 02/27/2008 | 1:00 | 4.7 | 13.6 | 47.20 | 12.2 | | 12.6 |
| 03/10/2008 | 2:30 | 7.8 | 13.1 | 27.62 | 1 | | 5.08 |
| 03/24/2008 | 2:30 | 7.3 | 13.0 | 100 | 18.1 | | 14.9 |
| 04/09/2008 | 11:30 | 7.5 | 13.1 | 51.52 | 4.1 | | 13.4 |
| 04/22/2008 | 9:00 | 4.8 | 13.3 | 100 | 39.3 | | 18.2 |
| 05/07/2008 | 11:00 | | | | | | 24.7 |
| 05/28/2008 | 10:40 | | | | 172.3 | | |
| 06/01/2008 | 11:30 | | | | 1986.3 | | |
| 06/04/2008 | 10:20 | | | | 1046.2 | | |
| 06/08/2008 | 11:25 | | | | 172.2 | | |
| 06/11/2008 | 10:50 | | | | 365.4 | 468 | |

## Table B-6. Data sources for Graves Creek; Lower Salmon River Subbasin Assessment.

| Sample Date | Time | Temp °C | D.O. (mg/L) | Flow (cfs) | E. coli (cfu/100 ml) | E.coli 5 Sample 30 day Geomean | TSS (mg/L) |
|---|---|---|---|---|---|---|---|
| 03/14/2007 | 12:00 | 6.2 | 12.4 | 11.82 | 9.8 | | 7 |
| 03/28/2007 | 11:45 | 5.8 | 12.6 | 12.27 | 48.7 | | 9.51 |
| 04/10/2007 | 9:00 | 5.5 | 12.1 | 4.42 | 7.4 | | 11.6 |
| 04/25/2007 | 12:20 | 9.9 | 10.9 | 4.21 | 4.1 | | 11.7 |
| 05/08/2007 | 12:40 | 15 | 10.1 | 2.46 | 79.4 | | 9.48 |
| 05/22/2007 | 11:00 | 10.1 | 11.0 | 1.79 | 74.8 | | 8.23 |
| 06/05/2007 | 9:20 | 15.6 | 8.3 | | 24.6 | | 15.7 |
| 06/19/2007 | 11:45 | 13.6 | 11.3 | 1.32 | 13.4 | | 8.18 |
| 07/02/2007 | 10:45 | 16 | 10.3 | 0.88 | 56.5 | | 9.36 |
| 07/17/2007 | 10:00 | 19.2 | 9.5 | 1.22 | 39.3 | | 11.4 |
| 07/31/2007 | 9:00 | | | 1.20 | 88.2 | | 7.74 |
| 08/14/2007 | 10:00 | 15.9 | 10.1 | 1.20 | 118.7 | | 7.16 |
| 08/29/2007 | 10:45 | 14.4 | 10.2 | 1.20 | 47.2 | | 7.53 |
| 09/11/2007 | 9:00 | 12.9 | 9.9 | 1.20 | 29.5 | | 6.1 |
| 09/26/2007 | 8:50 | 10.5 | 10.5 | 1.20 | 8.5 | | 4.26 |
| 10/10/2007 | 9:00 | 11.4 | 10.1 | 1.46 | 1 | | 3.2 |
| 10/24/2007 | 9:00 | 10 | 11.2 | 1.63 | 2 | | 1.91 |
| 11/07/2007 | 10:45 | 7.6 | 12.6 | 1.53 | <1 | | 2.11 |
| 11/19/2007 | 11:00 | 6.8 | 12.4 | 3.26 | 14.6 | | 3.6 |
| 12/04/2007 | 10:00 | 7.1 | 12.7 | 2.32 | 60.9 | | 2.37 |
| 12/18/2007 | 9:00 | 3.5 | 13.8 | 2.00 | 5.2 | | 1.68 |
| 01/02/2008 | 2:00 | 2.5 | 14.3 | 2.00 | 2 | | 2.15 |
| 01/15/2008 | 10:20 | 2.9 | 14.4 | 1.77 | 1 | | 2.54 |
| 01/29/2008 | | 4.1 | 12.9 | 2.17 | 1 | | 3.51 |
| 02/12/2008 | 11:00 | 5.7 | 13.0 | 5.34 | 1 | | 8.3 |
| 02/27/2008 | 11:15 | 5.8 | 13.0 | 10.72 | <1 | | 9.84 |
| 03/10/2008 | 1:30 | 7.2 | 12.6 | 8.47 | <1 | | 8.3 |
| 03/24/2008 | 4:00 | 5.8 | 12.9 | 20.14 | 25.9 | | 13.5 |
| 04/09/2008 | 11:00 | 5.2 | 13.2 | 17.28 | 2 | | 7.7 |
| 04/22/2008 | 10:15 | 4.2 | 13.2 | 19.13 | 35.9 | | 7.98 |
| 04/30/2008 | 10:30 | | | 30.43 | | | 11.2 |
| 05/28/2008 | 10:30 | | | | 20.1 | | |
| 06/01/2008 | 11:25 | | | | 727 | | |
| 06/04/2008 | 10:15 | | | | 435.2 | | |
| 06/08/2008 | 11:20 | | | | 129.6 | | |
| 06/11/2008 | 10:45 | | | | 436 | 205 | |

## Table B-7. Data sources for John's Creek; Lower Salmon River Subbasin Assessment.

| Sample Date | Time | Temp °C | D.O. (mg/L) | Flow (cfs) | E. coli (cfu/100 ml) | E.coli 5 Sample 30 day Geomean | TSS (mg/L) | $NO_2$+$NO_3$-N (mg/L) | TP (mg/L) | $NH_3$-N (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 03/14/2007 | 8:30 | 4.7 | 12.4 | 7.28 | 21.8 | | 24 | | | |
| 03/28/2007 | 8:55 | 3.1 | 12.3 | 21.11 | 344.1 | | 162.4 | | | |
| 04/10/2007 | 11:45 | 6.3 | 11.9 | 4.64 | 44.1 | | 32 | | | |
| 04/25/2007 | 9:30 | 10.1 | 10.2 | | 47.9 | | 29.3 | | | |
| 05/07/2007 | 4:00 | 20.4 | 9.6 | 5.19 | 51.2 | | 31.7 | | | |
| 05/21/2007 | 12:10 | 11.5 | 10.8 | 1.80 | 206.3 | | 29.7 | | | |
| 06/05/2007 | 8:30 | 18.4 | 7.7 | 0.67 | 2419.2 | | 28.4 | | | |
| 06/19/2007 | 9:00 | 15.9 | 10.2 | 1.10 | 2419.2 | | 31.3 | | | |
| 07/01/2007 | 1:50 | 29.6 | 7.1 | 0.41 | 2419.2 | | 42.2 | | | |
| 07/17/2007 | 9:00 | 22 | 7.1 | 0.06 | 2419.2 | | 13.7 | | | |
| 11/06/2007 | 14:00 | | | <0.05 | | | | | | |
| 11/19/2007 | 1:00 | 3.1 | 13.5 | 1.19 | 129.6 | | 130.2 | 0.188 | 0.202 | ND |
| 12/04/2007 | 9:00 | 3.3 | 13.7 | 0.92 | 727 | | 124.4 | | | |
| 12/17/2007 | 12:00 | 1 | 13.8 | Ice | 49.5 | | 1 | | | |
| 01/15/2008 | 2:30 | 0.9 | 13.9 | Ice | 47.1 | | 16.2 | | | |
| 02/12/2008 | 7:30 | 0.1 | 13.0 | 2.20 | 129.6 | | 22 | | | |
| 02/28/2008 | 10:00 | 1.9 | 13.5 | 6.60 | 30.5 | | 25.2 | | | |
| 03/11/2008 | 9:00 | 4.1 | 12.5 | 5.53 | 32.3 | | 24.2 | | | |
| 03/25/2008 | 8:30 | 1.7 | 13.8 | 9.90 | 55.6 | | 42.1 | | | |
| 04/09/2008 | 9:15 | 4.2 | 12.9 | 5.63 | 18.9 | | 32.7 | | | |
| 04/21/2008 | 12:00 | 5.6 | 12.9 | 9.79 | 30.9 | | 31.7 | | | |
| 04/29/2008 | 11:00 | | | | | | 41.2 | | | |
| 05/07/2008 | 9:00 | | | | | | 35.4 | | | |
| 05/28/2008 | 10:00 | | | | 160.7 | | | | | |
| 06/01/2008 | 10:40 | | | | 770.1 | | | | | |
| 06/04/2008 | 9:40 | | | | 1553.1 | | | | | |
| 06/08/2008 | 10:55 | | | | 517.2 | | | | | |
| 06/11/2008 | 7:30 | | | | 1986.3 | 723 | | | | |
| 08/28/2008 | 10:00 | 18 | 8.4 | 0.3 | | | | ND | 0.113 | 0.071 |
| 09/02/2008 | 1:15 | | | 0.28 | | | | ND | 0.104 | 0.069 |

## Table B-8. Data sources for Deep Creek; Lower Salmon River Subbasin Assessment.

| Sample Date | Time | Temp °C | D.O. (mg/L) | Flow (cfs) | E. coli cfu/100ml | E.coli 30 day Geomean | E.coli 5 Sample 30 day Geomean | TSS (mg/L) | $NH_3$-N | TP mg/L | $NO_2$+$NO_3$-N (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 03/14/2007 | 10:25 | 0.5 | 12.8 | 20.01 | 32.3 | | | 17 | ND | 0.11 | 0.4 |
| 03/28/2007 | 9:55 | 1.4 | 12.7 | 10.07 | 19.5 | | | 4.92 | ND | 0.05 | 0.14 |
| 04/10/2007 | 8:00 | 1.7 | 12.4 | 3.94 | 50.4 | 31.7 | | 12.9 | ND | 0.08 | ND |
| 04/25/2007 | 10:45 | 7.3 | 10.4 | 3.01 | 98.5 | 45.9 | | 14.7 | ND | 0.09 | ND |
| 05/07/2007 | 3:10 | 15.2 | 8.9 | 1.05 | 27.8 | 51.7 | | 8.32 | 0.11 | 0.061 | ND |
| 05/22/2007 | 10:00 | 7.7 | 10.7 | 0.87 | 1043.2 | 141.9 | | 8.63 | 0.08 | 0.11 | ND |
| 06/05/2007 | 2:00 | 12.9 | 8.3 | 0.33 | 2419.2 | 412.4 | | 51.7 | 0.12 | 0.19 | 0.05 |
| 06/19/2007 | | 19.3 | 9.4 | 0.15 | 206.3 | 804.5 | | 7.49 | 0.11 | 0.04 | ND |
| 07/01/2007 | | | | Dry | | | | | | | |
| 07/17/2007 | | | | Dry | | | | | | | |
| 11/06/2007 | 14:45 | | | Dry | | | | | | | |
| 11/19/2007 | 10:15 | 0.7 | 13.4 | 0.50 | 770.1 | | | 4.68 | 0.07 | 0.08 | 0.17 |
| 04/09/2008 | 10:00 | 1.2 | 13.2 | 1.70 | 74.4 | | | 11.5 | | | |
| 04/21/2008 | 10:30 | 0.5 | 13.0 | 9.39 | 16 | 34.5 | | 26.5 | ND | 0.07 | 0.7 |
| 04/30/2008 | 9:00 | | | 16.73 | | | | 9.05 | | | |
| 05/07/2008 | 12:30 | | | 12.65 | | | | 10.8 | | 0.06 | 0.15 |
| 05/28/2008 | 12:00 | | | | 29.9 | | | | | | |
| 06/01/2008 | 1:00 | | | | 44.1 | | | | | | |
| 06/04/2008 | 11:45 | | | | 60.1 | | | | | | |
| 06/08/2008 | 12:15 | | | | 137.4 | | | | | | |
| 06/11/2008 | 11:45 | | | | 343.6 | | 82 | | | | |

## Table B-9. Data sources for Deer Creek; Lower Salmon River Subbasin Assessment.

| Sample Date | Time | Temp °C | D.O. (mg/L) | Flow (cfs) | E. coli (cfu/100 ml) | E.coli 5 Sample 30 day Geomean | TSS (mg/L) |
|---|---|---|---|---|---|---|---|
| 04/25/2007 | 4:20 | 8.4 | 10.0 | 9.46 | 2 | | 3.46 |
| 05/07/2007 | 1:30 | 13.5 | 10.4 | 4.15 | 1 | | 16 |
| 05/22/2007 | 2:10 | 8.9 | 10.8 | 4.64 | 88.2 | | ND |
| 06/05/2007 | 12:45 | 13.5 | 8.8 | 1.26 | 32.8 | | 2.06 |
| 06/19/2007 | 2:05 | 15.3 | 10.9 | 0.39 | 23.1 | | 2.53 |
| 07/01/2007 | 1:40 | 19.9 | 10.8 | 1.28 | 10.9 | | 1.93 |
| 07/17/2007 | 1:30 | 20.6 | 10.5 | 0.79 | 42.5 | | 7.95 |
| 08/14/2007 | 12:50 | 17.3 | 10.2 | 0.50 | 48.7 | | 2.86 |
| 08/29/2007 | 1:00 | 16.5 | 9.7 | 0.25 | 24 | | 2.22 |
| 09/11/2007 | 1:00 | 12.1 | 10.6 | 0.25 | 31.7 | | 1.86 |
| 09/26/2007 | 12:30 | 5.9 | 11.6 | 0.25 | 33.1 | | 2.62 |
| 10/10/2007 | 1:30 | 7.9 | 11.6 | 0.74 | 1 | | 1.1 |
| 10/24/2007 | 1:30 | 8.2 | 12.5 | 0.45 | 2 | | 1.93 |
| 11/07/2007 | 9:00 | 1.4 | 13.8 | 0.62 | 5.2 | | 1.64 |
| 11/19/2007 | 8:00 | 0.9 | 13.2 | 1.21 | 37.3 | | 3.87 |
| 01/15/2008 | | | | | | | |
| 05/28/2008 | 1:00 | | | | 2 | | |
| 06/01/2008 | 2:10 | | | | 12.1 | | |
| 06/04/2008 | 12:45 | | | | 21.3 | | |
| 06/08/2008 | 1:00 | | | | 148.3 | | |
| 06/11/2008 | 12:45 | | | | 60.9 | 22 | |

## Table B-10. Data sources for Wolf Creek; Snake River Subbasin Assessment.

| Sample Date | Time | Temp. $C^0$ | D.O | *Cond.* | pH | Flow (cfs) | E. Coli | E.coli 5 Sample 30 day Geomean | TSS |
|---|---|---|---|---|---|---|---|---|---|
| 03/08/2007 | 8:06 | 5.3 | 13.3 | 75.1 | 8.3 | 33.17 | 1553.1 | | 11.5 |
| 03/22/2007 | 8:16 | 4.2 | 13.3 | 67.4 | 8.47 | 34.00 | 235.9 | | 5.8 |
| 04/05/2007 | 8:25 | 7.1 | 12.2 | 75.1 | 8.47 | 28.38 | 6.3 | | 5.35 |
| 04/19/2007 | 8:30 | 6.1 | 12.3 | 80.4 | 8.67 | 16.15 | 8.5 | | 8.67 |
| 05/03/2007 | | 9.2 | 11.6 | 87.4 | | 11.68 | 113 | | 14.6 |
| 05/18/2007 | 8:30 | 15.2 | 9.8 | 109 | | 4.93 | 41.3 | | 10.4 |
| 05/31/2007 | 8:45 | 14.6 | 9.2 | 119.3 | | 2.49 | 41.3 | | 6.37 |
| 06/14/2007 | 8:45 | 14.5 | 11.4 | | | 5.24 | 25.6 | | 7.07 |
| 06/28/2007 | 9:00 | 16.7 | 10.6 | 128.7 | | 3.66 | 14.8 | | 7.54 |
| 07/12/2007 | 8:41 | 21.2 | 9.7 | 143.8 | | 1.56 | 139.6 | | 11.7 |
| 07/26/2007 | 8:30 | 21.1 | 9.4 | | | 0.86 | 22.3 | | 6.07 |
| 08/10/2007 | 8:30 | 19.4 | 9.6 | | | 1.20 | 24.3 | | 2.11 |
| 08/23/2007 | 8:15 | 16.5 | 10.1 | | | 1.12 | 38.9 | | 1.52 |
| 09/06/2007 | 9:00 | 17.6 | 9.1 | | | 1.32 | 14.6 | | 1.29 |
| 09/20/2007 | 9:10 | 12.1 | 10.5 | | | 1.75 | 7.4 | | ND |
| 10/04/2007 | 9:00 | 9.5 | 11.1 | | | 2.60 | 98.9 | | 16.4 |
| 10/18/2007 | 8:45 | 8 | 11.6 | | | 1.70 | 24.3 | | 5.41 |
| 11/01/2007 | 8:50 | 5.3 | 13.5 | | | 2.75 | 7.4 | | ND |
| 11/29/2007 | 9:00 | 3.8 | 14.2 | | | 5.41 | 5.2 | | ND |
| 12/13/2007 | 8:30 | 2.7 | 14.4 | | | 5.79 | 2 | | 1 |
| 01/10/2008 | 9:00 | 3 | 14.1 | | | 8.31 | 11.9 | | ND |
| 02/07/2008 | 9:00 | 3.6 | 13.7 | | | 9.19 | 7.4 | | 2.01 |
| 02/21/2008 | 9:00 | 3.4 | 13.74 | | | 22.59 | 13.4 | | 9.97 |
| 03/06/2008 | 9:00 | 3.6 | 14.14 | | | 28.33 | 235.9 | | 3.36 |
| 03/20/2008 | 9:00 | 4.5 | 13.79 | | | 36.67 | 21.6 | | 7.41 |
| 04/03/2008 | 9:00 | 3.1 | 14.43 | | | 16.53 | 8.6 | | 5.9 |
| 07/06/2008 | 9:20 | | | | | | 15.8 | | |
| 7/10/200/ | 8:30 | 18.9 | 9.65 | | | | 20.3 | | |
| 07/13/2008 | | | | | | | 18.7 | | |
| 07/17/2008 | 8:30 | 18 | 9.84 | | | | 113.7 | | |
| 07/20/2008 | 8:45 | | | | | | 45.9 | 31.5 | |

## Table B-11. Data sources for DivideCreek; Snake River Subbasin Assessment.

| Sample Date | Time | Temp. $C^0$ | D.O | Cond. | pH | Flow (cfs) | E. Coli | E.coli 30 day Geomean | E.coli 5 Sample 30 day Geomean | TSS |
|---|---|---|---|---|---|---|---|---|---|---|
| 03/08/2007 | 9:25 | 5.8 | 13.1 | 88.1 | 8.17 | 13.03 | 816.4 | | | 14.5 |
| 03/22/2007 | 9:47 | 4.8 | 13 | 79.9 | 8.6 | 15.11 | 95.9 | | | 12.1 |
| 04/05/2007 | 9:20 | 8.1 | 11.9 | 86.1 | 8.64 | 14.55 | 50.4 | 158.0 | | 17 |
| 04/19/2007 | 9:30 | 6.4 | 12.1 | 98.6 | | 7.12 | 57.3 | 65.2 | | 12.5 |
| 05/03/2007 | 9:45 | 9.9 | 11.4 | 101.4 | | 8.31 | 154.1 | 76.3 | | 19.4 |
| 05/18/2007 | 10:05 | 15 | 10.1 | 126.5 | | 2.47 | 49.6 | 75.9 | | 14.4 |
| 05/31/2007 | 10:00 | 14 | | 138.7 | | 1.67 | 201.4 | 115.5 | | 12.9 |
| 06/14/2007 | 10:30 | 15.2 | 11.4 | | | 1.95 | 86.2 | 95.1 | | 11.8 |
| 06/28/2007 | 9:30 | 16 | 10.8 | 146.9 | | 1.04 | 47.1 | 93.5 | | 30.8 |
| 07/12/2007 | 9:25 | 20.9 | 9.9 | 162.3 | | 0.59 | 18.7 | 42.3 | | 8.28 |
| 07/26/2007 | 9:15 | 21.5 | 10.5 | | | 0.21 | 5.2 | 16.6 | | 1.45 |
| 08/10/2007 | 9:10 | 20.1 | 10.3 | | | 0.32 | 3.1 | 6.7 | | 2.07 |
| 08/23/2007 | 7:30 | 19.6 | 10.4 | | | 0.52 | 48.8 | 9.2 | | 2.28 |
| 09/06/2007 | 10:00 | 18.7 | 9.4 | | | 0.49 | 73.3 | 22.3 | | 1.44 |
| 09/20/2007 | 10:25 | 13.8 | 10.2 | | | 0.50 | 613.1 | 129.9 | | 1.02 |
| 10/04/2007 | 11:00 | 10.9 | 10.8 | | | 0.64 | 71.6 | 147.6 | | 1.33 |
| 10/18/2007 | 10:00 | 8.5 | 11.5 | | | 0.80 | 54.6 | 133.8 | | 5.87 |
| 11/01/2007 | 10:00 | 6.3 | 13.2 | | | 0.88 | 6.3 | 29.1 | | ND |
| 11/29/2007 | 10:00 | 3.7 | 14.3 | | | 1.15 | 4.1 | 11.2 | | ND |
| 12/13/2007 | 9:30 | 2.6 | 14.9 | | | 1.51 | 7.4 | 5.8 | | ND |
| 01/10/2008 | 10:00 | 2.8 | 14.2 | | | 1.34 | 21.1 | 8.6 | | ND |
| 02/07/2008 | 10:00 | 3.1 | 14 | | | 2.07 | 5.2 | 9.3 | | ND |
| 02/21/2008 | 10:00 | 3.1 | 13.81 | | | 6.27 | 43.7 | 16.9 | | 26.3 |
| 03/06/2008 | 10:00 | 3.1 | 14.26 | | | 14.82 | 5.2 | 10.6 | | 7.77 |
| 03/20/2008 | 10:00 | 5.7 | 13.01 | | | 10.03 | 13.4 | 14.5 | | 8.67 |
| 04/03/2008 | 10:00 | 3.1 | 14.46 | | | | 17.1 | 10.6 | | 5.2 |
| 07/06/2008 | 11:00 | | | | | | 50.4 | | | |
| 07/10/2008 | 10:00 | 18.9 | 9.84 | | | | 65 | | | |
| 07/13/2008 | | | | | | | 29.2 | | | |
| 07/17/2008 | 9:30 | | | | | | 45 | | | |
| 07/20/2008 | 9:30 | | | | | | 16.8 | | 37.3 | |

# Appendix C. Percent Natural Vegetation Loading Tables

## Table C-1. Existing and potential solar loads for Wolf Creek (Hells Canyon Subbasin).

| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load (kWh/m$^2$/day) | Potential Shade (fraction) | Potential Summer Load (kWh/m$^2$/day) | Potential Load minus Existing load (kWh/m$^2$/day) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area (m$^2$) | Existing Summer Load (kWh/day) | Natural Segment Area (m$^2$) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | Lack of Shade (%) | **Wolf Creek** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 590 | 0.3 | 4.256 | 0.95 | 0.304 | -4 | 1 | 1 | 590 | 2511.04 | 590 | 179.36 | -2331.68 | -65 | NP Breakland |
| 50 | 0 | 6.08 | 0 | 6.08 | 0 | 10 | 1 | 500 | 3040 | 50 | 304 | -2736 | 0 | water |
| 120 | 0.3 | 4.256 | 0.95 | 0.304 | -3.952 | 1 | 1 | 120 | 510.72 | 120 | 36.48 | -474.24 | -65 | NP Breakland |
| 160 | 0.5 | 3.04 | 0.95 | 0.304 | -2.736 | 1 | 1 | 160 | 486.4 | 160 | 48.64 | -437.76 | -45 | |
| 340 | 0.3 | 4.256 | 0.95 | 0.304 | -3.952 | 1 | 1 | 340 | 1447.04 | 340 | 103.36 | -1343.68 | -65 | |
| 60 | 0 | 6.08 | 0 | 6.08 | 0 | 12 | 1 | 720 | 4377.6 | 60 | 364.8 | -4012.8 | 0 | water |
| 180 | 0.5 | 3.04 | 0.95 | 0.304 | -2.736 | 1 | 1 | 180 | 547.2 | 180 | 54.72 | -492.48 | -45 | NP Breakland |
| 130 | 0.6 | 2.432 | 0.95 | 0.304 | -2.128 | 1 | 1 | 130 | 316.16 | 130 | 39.52 | -276.64 | -35 | |
| 70 | 0.3 | 4.256 | 0.94 | 0.3648 | -3.8912 | 2 | 2 | 140 | 595.84 | 140 | 51.072 | -544.768 | -64 | |
| 120 | 0.8 | 1.216 | 0.94 | 0.3648 | -0.8512 | 2 | 2 | 240 | 291.84 | 240 | 87.552 | -204.288 | -14 | |
| 90 | 0.3 | 4.256 | 0.94 | 0.3648 | -3.8912 | 2 | 2 | 180 | 766.08 | 180 | 65.664 | -700.416 | -64 | |
| 140 | 0.5 | 3.04 | 0.94 | 0.3648 | -2.6752 | 2 | 2 | 280 | 851.2 | 280 | 102.144 | -749.056 | -44 | |
| 450 | 0.3 | 4.256 | 0.94 | 0.3648 | -3.8912 | 2 | 2 | 900 | 3830.4 | 900 | 328.32 | -3502.08 | -64 | |
| 170 | 0.7 | 1.824 | 0.94 | 0.3648 | -1.4592 | 2 | 2 | 340 | 620.16 | 340 | 124.032 | -496.128 | -24 | |
| 750 | 0.3 | 4.256 | 0.94 | 0.3648 | -3.8912 | 2 | 2 | 1500 | 6384 | 1500 | 547.2 | -5836.8 | -64 | |
| 200 | 0.5 | 3.04 | 0.9 | 0.608 | -2.432 | 3 | 3 | 600 | 1824 | 600 | 364.8 | -1459.2 | -40 | |
| 790 | 0.3 | 4.256 | 0.9 | 0.608 | -3.648 | 3 | 3 | 2370 | 10086.72 | 2370 | 1440.96 | -8645.76 | -60 | |
| 290 | 0.4 | 3.648 | 0.9 | 0.608 | -3.04 | 3 | 3 | 870 | 3173.76 | 870 | 528.96 | -2644.8 | -50 | |
| 130 | 0.6 | 2.432 | 0.9 | 0.608 | -1.824 | 3 | 3 | 390 | 948.48 | 390 | 237.12 | -711.36 | -30 | |
| 480 | 0.5 | 3.04 | 0.9 | 0.608 | -2.432 | 3 | 3 | 1440 | 4377.6 | 1440 | 875.52 | -3502.08 | -40 | |
| 120 | 0.3 | 4.256 | 0.81 | 1.1552 | -3.1008 | 4 | 4 | 480 | 2042.88 | 480 | 554.496 | -1488.384 | -51 | |
| 420 | 0.5 | 3.04 | 0.81 | 1.1552 | -1.8848 | 4 | 4 | 1680 | 5107.2 | 1680 | 1940.736 | -3166.464 | -31 | |
| 230 | 0.3 | 4.256 | 0.81 | 1.1552 | -3.1008 | 4 | 4 | 920 | 3915.52 | 920 | 1062.784 | -2852.736 | -51 | |
| 780 | 0.5 | 3.04 | 0.81 | 1.1552 | -1.8848 | 4 | 4 | 3120 | 9484.8 | 3120 | 3604.224 | -5880.576 | -31 | |
| 330 | 0.4 | 3.648 | 0.73 | 1.6416 | -2.0064 | 5 | 5 | 1650 | 6019.2 | 1650 | 2708.64 | -3310.56 | -33 | |
| 1220 | 0.5 | 3.04 | 0.73 | 1.6416 | -1.3984 | 5 | 5 | 6100 | 18544 | 6100 | 10013.76 | -8530.24 | -23 | |
| 2870 | 0.7 | 1.824 | 0.86 | 0.8512 | -0.9728 | 6 | 6 | 17220 | 31409.28 | 17220 | 14657.664 | -16751.616 | -16 | white alder |
| 3170 | 0.8 | 1.216 | 0.86 | 0.8512 | -0.3648 | 6 | 6 | 19020 | 23128.32 | 19020 | 16189.824 | -6938.496 | -6 | (cottonwood) |

| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load (kWh/m$^2$/day) | Potential Shade (fraction) | Potential Summer Load (kWh/m$^2$/day) | Potential Load minus Existing load (kWh/m$^2$/day) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area (m$^2$) | Existing Summer Load (kWh/day) | Natural Segment Area (m$^2$) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | Lack of Shade (%) | **Wolf Creek** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 0 | 6.08 | 0 | 6.08 | 0 | 18 | 7 | 720 | 4377.6 | 280 | 1702.4 | -2675.2 | 0 | water |
| 770 | 0.7 | 1.824 | 0.81 | 1.1552 | -0.6688 | 7 | 7 | 5390 | 9831.36 | 5390 | 6226.528 | -3604.832 | -11 | white alder |
| 510 | 0.8 | 1.216 | 0.81 | 1.1552 | -0.0608 | 7 | 7 | 3570 | 4341.12 | 3570 | 4124.064 | -217.056 | -1 | (cottonwood) |
| 1210 | 0.7 | 1.824 | 0.81 | 1.1552 | -0.6688 | 7 | 7 | 8470 | 15449.28 | 8470 | 9784.544 | -5664.736 | -11 | |
| 1120 | 0.8 | 1.216 | 0.75 | 1.52 | 0.304 | 8 | 8 | 8960 | 10895.36 | 8960 | 13619.2 | 2723.84 | 0 | |
| 130 | 0.1 | 5.472 | 0.75 | 1.52 | -3.952 | 8 | 8 | 1040 | 5690.88 | 1040 | 1580.8 | -4110.08 | -65 | |
| 250 | 0.6 | 2.432 | 0.75 | 1.52 | -0.912 | 8 | 8 | 2000 | 4864 | 2000 | 3040 | -1824 | -15 | |
| 330 | 0.8 | 1.216 | 0.75 | 1.52 | 0.304 | 8 | 8 | 2640 | 3210.24 | 2640 | 4012.8 | 802.56 | 0 | |
| 2390 | 0.7 | 1.824 | 0.7 | 1.824 | 0 | 9 | 9 | 21510 | 39234.24 | 21510 | 39234.24 | 0 | 0 | |
| 500 | 0.8 | 1.216 | 0.7 | 1.824 | 0.608 | 9 | 9 | 4500 | 5472 | 4500 | 8208 | 2736 | 0 | |
| 930 | 0.7 | 1.824 | 0.7 | 1.824 | 0 | 9 | 9 | 8370 | 15266.88 | 8370 | 15266.88 | 0 | 0 | |
| 1160 | 0.3 | 4.256 | 0.7 | 1.824 | -2.432 | 9 | 9 | 10440 | 44432.64 | 10440 | 19042.56 | -25390.08 | -40 | |
| | | | | | | | **Total** | **139,790** | **309,703** | **138,240** | **182,458** | **-127,245** | **-32** | |

## Table C-2. Existing and potential solar loads for Divide Creek (Hells Canyon Subbasin).

| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load (kWh/m$^2$/day) | Potential Shade (fraction) | Potential Summer Load (kWh/m$^2$/day) | Potential Load minus Existing load (kWh/m$^2$/day) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area (m$^2$) | Existing Summer Load (kWh/day) | Natural Segment Area (m$^2$) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | Lack of Shade (%) | **Divide Creek** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1400 | 0.7 | 1.824 | 0.95 | 0.304 | -2 | 1 | 1 | 1400 | 2553.6 | 1400 | 425.6 | -2128 | -25 | NP Breaklands |
| 1330 | 0.8 | 1.216 | 0.94 | 0.3648 | -0.8512 | 2 | 2 | 2660 | 3234.56 | 2660 | 970.368 | -2264.192 | -14 | |
| 30 | 0 | 6.08 | 0 | 6.08 | 0 | 16 | 2 | 480 | 2918.4 | 60 | 364.8 | -2553.6 | 0 | water |
| 220 | 0.4 | 3.648 | 0.94 | 0.3648 | -3.2832 | 2 | 2 | 440 | 1605.12 | 440 | 160.512 | -1444.608 | -54 | NP Breaklands |
| 310 | 0.5 | 3.04 | 0.94 | 0.3648 | -2.6752 | 2 | 2 | 620 | 1884.8 | 620 | 226.176 | -1658.624 | -44 | |
| 300 | 0.3 | 4.256 | 0.9 | 0.608 | -3.648 | 3 | 3 | 900 | 3830.4 | 900 | 547.2 | -3283.2 | -60 | |
| 280 | 0.9 | 0.608 | 0.9 | 0.608 | 0 | 3 | 3 | 840 | 510.72 | 840 | 510.72 | 0 | 0 | |
| 150 | 0.5 | 3.04 | 0.9 | 0.608 | -2.432 | 3 | 3 | 450 | 1368 | 450 | 273.6 | -1094.4 | -40 | |
| 100 | 0.7 | 1.824 | 0.9 | 0.608 | -1.216 | 3 | 3 | 300 | 547.2 | 300 | 182.4 | -364.8 | -20 | |
| 100 | 0.5 | 3.04 | 0.9 | 0.608 | -2.432 | 3 | 3 | 300 | 912 | 300 | 182.4 | -729.6 | -40 | |
| 740 | 0.7 | 1.824 | 0.9 | 0.608 | -1.216 | 3 | 3 | 2220 | 4049.28 | 2220 | 1349.76 | -2699.52 | -20 | |
| 180 | 0.6 | 2.432 | 0.81 | 1.1552 | -1.2768 | 4 | 4 | 720 | 1751.04 | 720 | 831.744 | -919.296 | -21 | |
| 180 | 0.8 | 1.216 | 0.81 | 1.1552 | -0.0608 | 4 | 4 | 720 | 875.52 | 720 | 831.744 | -43.776 | -1 | |
| 190 | 0.4 | 3.648 | 0.81 | 1.1552 | -2.4928 | 4 | 4 | 760 | 2772.48 | 760 | 877.952 | -1894.528 | -41 | |
| 230 | 0.1 | 5.472 | 0.81 | 1.1552 | -4.3168 | 4 | 4 | 920 | 5034.24 | 920 | 1062.784 | -3971.456 | -71 | |
| 150 | 0.4 | 3.648 | 0.81 | 1.1552 | -2.4928 | 4 | 4 | 600 | 2188.8 | 600 | 693.12 | -1495.68 | -41 | |
| 180 | 0.2 | 4.864 | 0.81 | 1.1552 | -3.7088 | 4 | 4 | 720 | 3502.08 | 720 | 831.744 | -2670.336 | -61 | |
| 180 | 0.4 | 3.648 | 0.81 | 1.1552 | -2.4928 | 4 | 4 | 720 | 2626.56 | 720 | 831.744 | -1794.816 | -41 | |
| 70 | 0.1 | 5.472 | 0.81 | 1.1552 | -4.3168 | 4 | 4 | 280 | 1532.16 | 280 | 323.456 | -1208.704 | -71 | |
| 210 | 0.4 | 3.648 | 0.81 | 1.1552 | -2.4928 | 4 | 4 | 840 | 3064.32 | 840 | 970.368 | -2093.952 | -41 | |
| 260 | 0.2 | 4.864 | 0.81 | 1.1552 | -3.7088 | 4 | 4 | 1040 | 5058.56 | 1040 | 1201.408 | -3857.152 | -61 | |
| 200 | 0.4 | 3.648 | 0.81 | 1.1552 | -2.4928 | 4 | 4 | 800 | 2918.4 | 800 | 924.16 | -1994.24 | -41 | |
| 230 | 0.2 | 4.864 | 0.81 | 1.1552 | -3.7088 | 4 | 4 | 920 | 4474.88 | 920 | 1062.784 | -3412.096 | -61 | |
| 100 | 0.4 | 3.648 | 0.81 | 1.1552 | -2.4928 | 4 | 4 | 400 | 1459.2 | 400 | 462.08 | -997.12 | -41 | |
| 160 | 0.5 | 3.04 | 0.81 | 1.1552 | -1.8848 | 4 | 4 | 640 | 1945.6 | 640 | 739.328 | -1206.272 | -31 | |
| 1450 | 0.4 | 3.648 | 0.81 | 1.1552 | -2.4928 | 4 | 4 | 5800 | 21158.4 | 5800 | 6700.16 | -14458.24 | -41 | |
| 690 | 0.6 | 2.432 | 0.81 | 1.1552 | -1.2768 | 4 | 4 | 2760 | 6712.32 | 2760 | 3188.352 | -3523.968 | -21 | |
| 300 | 0.5 | 3.04 | 0.81 | 1.1552 | -1.8848 | 4 | 4 | 1200 | 3648 | 1200 | 1386.24 | -2261.76 | -31 | |
| 610 | 0.7 | 1.824 | 0.81 | 1.1552 | -0.6688 | 4 | 4 | 2440 | 4450.56 | 2440 | 2818.688 | -1631.872 | -11 | |

| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load (kWh/m$^2$/day) | Potential Shade (fraction) | Potential Summer Load (kWh/m$^2$/day) | Potential Load minus Existing load (kWh/m$^2$/day) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area (m$^2$) | Existing Summer Load (kWh/day) | Natural Segment Area (m$^2$) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | Lack of Shade (%) | **Divide Creek** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 140 | 0.5 | 3.04 | 0.81 | 1.1552 | -1.8848 | 4 | 4 | 560 | 1702.4 | 560 | 646.912 | -1055.488 | -31 | |
| 560 | 0.7 | 1.824 | 0.73 | 1.6416 | -0.1824 | 5 | 5 | 2800 | 5107.2 | 2800 | 4596.48 | -510.72 | -3 | |
| 100 | 0.4 | 3.648 | 0.73 | 1.6416 | -2.0064 | 5 | 5 | 500 | 1824 | 500 | 820.8 | -1003.2 | -33 | |
| 180 | 0.5 | 3.04 | 0.73 | 1.6416 | -1.3984 | 5 | 5 | 900 | 2736 | 900 | 1477.44 | -1258.56 | -23 | |
| 850 | 0.8 | 1.216 | 0.73 | 1.6416 | 0.4256 | 5 | 5 | 4250 | 5168 | 4250 | 6976.8 | 1808.8 | 0 | |
| 160 | 0.7 | 1.824 | 0.73 | 1.6416 | -0.1824 | 5 | 5 | 800 | 1459.2 | 800 | 1313.28 | -145.92 | -3 | |
| 1100 | 0.9 | 0.608 | 0.73 | 1.6416 | 1.0336 | 5 | 5 | 5500 | 3344 | 5500 | 9028.8 | 5684.8 | 0 | |
| 290 | 0.8 | 1.216 | 0.91 | 0.5472 | -0.6688 | 5 | 5 | 1450 | 1763.2 | 1450 | 793.44 | -969.76 | -11 | white alder |
| 370 | 0.9 | 0.608 | 0.91 | 0.5472 | -0.0608 | 5 | 5 | 1850 | 1124.8 | 1850 | 1012.32 | -112.48 | -1 | (cottonwood) |
| 600 | 0.8 | 1.216 | 0.91 | 0.5472 | -0.6688 | 5 | 5 | 3000 | 3648 | 3000 | 1641.6 | -2006.4 | -11 | |
| 1370 | 0.7 | 1.824 | 0.91 | 0.5472 | -1.2768 | 5 | 5 | 6850 | 12494.4 | 6850 | 3748.32 | -8746.08 | -21 | |
| 470 | 0.8 | 1.216 | 0.86 | 0.8512 | -0.3648 | 6 | 6 | 2820 | 3429.12 | 2820 | 2400.384 | -1028.736 | -6 | |
| 430 | 0.9 | 0.608 | 0.86 | 0.8512 | 0.2432 | 6 | 6 | 2580 | 1568.64 | 2580 | 2196.096 | 627.456 | 0 | |
| 300 | 0.7 | 1.824 | 0.86 | 0.8512 | -0.9728 | 6 | 6 | 1800 | 3283.2 | 1800 | 1532.16 | -1751.04 | -16 | |
| 190 | 0.8 | 1.216 | 0.86 | 0.8512 | -0.3648 | 6 | 6 | 1140 | 1386.24 | 1140 | 970.368 | -415.872 | -6 | |
| 1260 | 0.7 | 1.824 | 0.86 | 0.8512 | -0.9728 | 6 | 6 | 7560 | 13789.44 | 7560 | 6435.072 | -7354.368 | -16 | |
| 690 | 0.8 | 1.216 | 0.86 | 0.8512 | -0.3648 | 6 | 6 | 4140 | 5034.24 | 4140 | 3523.968 | -1510.272 | -6 | |
| 630 | 0.6 | 2.432 | 0.86 | 0.8512 | -1.5808 | 6 | 6 | 3780 | 9192.96 | 3780 | 3217.536 | -5975.424 | -26 | |
| 650 | 0.8 | 1.216 | 0.86 | 0.8512 | -0.3648 | 6 | 6 | 3900 | 4742.4 | 3900 | 3319.68 | -1422.72 | -6 | |
| 2430 | 0.7 | 1.824 | 0.86 | 0.8512 | -0.9728 | 6 | 6 | 14580 | 26593.92 | 14580 | 12410.496 | -14183.424 | -16 | |
| 60 | 0.1 | 5.472 | 0.86 | 0.8512 | -4.6208 | 6 | 6 | 360 | 1969.92 | 360 | 306.432 | -1663.488 | -76 | |
| | | | | | | | **Total** | **104,010** | **209,948** | **103,590** | **99,300** | **-110,649** | **-27** | |

## Table C-3. Existing and potential solar loads for Rice Creek (Lower Salmon River Subbasin).

| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load ($kWh/m^2$/ day) | Potential Shade (fraction) | Potential Summer Load ($kWh/m^2$/ day) | Potential Load minus Existing load ($kWh/m^2$/day) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area ($m^2$) | Existing Summer Load (kWh/ day) | Natural Segment Area ($m^2$) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | Lack of Shade (%) | **Rice Creek** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 350 | 0.7 | 1.824 | 0.95 | 0.304 | -2 | 1 | 1 | 350 | 638.4 | 350 | 106.4 | -532 | -25 | NP Breakland |
| 460 | 0.8 | 1.216 | 0.95 | 0.304 | -0.912 | 1 | 1 | 460 | 559.36 | 460 | 139.84 | -419.52 | -15 | |
| 150 | 0.7 | 1.824 | 0.95 | 0.304 | -1.52 | 1 | 1 | 150 | 273.6 | 150 | 45.6 | -228 | -25 | |
| 200 | 0.8 | 1.216 | 0.95 | 0.304 | -0.912 | 1 | 1 | 200 | 243.2 | 200 | 60.8 | -182.4 | -15 | |
| 570 | 0.7 | 1.824 | 0.95 | 0.304 | -1.52 | 1 | 1 | 570 | 1039.68 | 570 | 173.28 | -866.4 | -25 | |
| 870 | 0.8 | 1.216 | 0.95 | 0.304 | -0.912 | 1 | 1 | 870 | 1057.92 | 870 | 264.48 | -793.44 | -15 | |
| 720 | 0.9 | 0.608 | 0.95 | 0.304 | -0.304 | 1 | 1 | 720 | 437.76 | 720 | 218.88 | -218.88 | -5 | |
| 330 | 0.8 | 1.216 | 0.95 | 0.304 | -0.912 | 1 | 1 | 330 | 401.28 | 330 | 100.32 | -300.96 | -15 | |
| 2260 | 0.9 | 0.608 | 0.94 | 0.3648 | -0.2432 | 2 | 2 | 4520 | 2748.16 | 4520 | 1648.896 | -1099.264 | -4 | |
| 490 | 0.8 | 1.216 | 0.94 | 0.3648 | -0.8512 | 2 | 2 | 980 | 1191.68 | 980 | 357.504 | -834.176 | -14 | |
| 550 | 0.9 | 0.608 | 0.94 | 0.3648 | -0.2432 | 2 | 2 | 1100 | 668.8 | 1100 | 401.28 | -267.52 | -4 | |
| 670 | 0.8 | 1.216 | 0.94 | 0.3648 | -0.8512 | 2 | 2 | 1340 | 1629.44 | 1340 | 488.832 | -1140.608 | -14 | |
| 490 | 0.9 | 0.608 | 0.9 | 0.608 | 0 | 3 | 3 | 1470 | 893.76 | 1470 | 893.76 | 0 | 0 | |
| 300 | 0.8 | 1.216 | 0.9 | 0.608 | -0.608 | 3 | 3 | 900 | 1094.4 | 900 | 547.2 | -547.2 | -10 | |
| 1030 | 0.7 | 1.824 | 0.9 | 0.608 | -1.216 | 3 | 3 | 3090 | 5636.16 | 3090 | 1878.72 | -3757.44 | -20 | |
| 430 | 0.8 | 1.216 | 0.9 | 0.608 | -0.608 | 3 | 3 | 1290 | 1568.64 | 1290 | 784.32 | -784.32 | -10 | |
| 710 | 0.7 | 1.824 | 0.9 | 0.608 | -1.216 | 3 | 3 | 2130 | 3885.12 | 2130 | 1295.04 | -2590.08 | -20 | |
| 340 | 0.6 | 2.432 | 0.81 | 1.1552 | -1.2768 | 4 | 4 | 1360 | 3307.52 | 1360 | 1571.072 | -1736.448 | -21 | |
| 350 | 0.8 | 1.216 | 0.81 | 1.1552 | -0.0608 | 4 | 4 | 1400 | 1702.4 | 1400 | 1617.28 | -85.12 | -1 | |
| 760 | 0.7 | 1.824 | 0.81 | 1.1552 | -0.6688 | 4 | 4 | 3040 | 5544.96 | 3040 | 3511.808 | -2033.152 | -11 | |
| 820 | 0.8 | 1.216 | 0.81 | 1.1552 | -0.0608 | 4 | 4 | 3280 | 3988.48 | 3280 | 3789.056 | -199.424 | -1 | |
| 920 | 0.7 | 1.824 | 0.81 | 1.1552 | -0.6688 | 4 | 4 | 3680 | 6712.32 | 3680 | 4251.136 | -2461.184 | -11 | |
| 3860 | 0.8 | 1.216 | 0.73 | 1.6416 | 0.4256 | 5 | 5 | 19300 | 23468.8 | 19300 | 31682.88 | 8214.08 | 0 | |
| 1270 | 0.7 | 1.824 | 0.86 | 0.8512 | -0.9728 | 6 | 6 | 7620 | 13898.88 | 7620 | 6486.144 | -7412.736 | -16 | white alder |
| 1090 | 0.8 | 1.216 | 0.86 | 0.8512 | -0.3648 | 6 | 6 | 6540 | 7952.64 | 6540 | 5566.848 | -2385.792 | -6 | (cottonwood) |
| 3400 | 0.7 | 1.824 | 0.86 | 0.8512 | -0.9728 | 6 | 6 | 20400 | 37209.6 | 20400 | 17364.48 | -19845.12 | -16 | |
| | | | | | | | **Total** | **87,090** | **127,753** | **87,090** | **85,246** | **-42,507** | **-12** | |

## Table C-4. Existing and potential solar loads for Rock Creek (Lower Salmon River Subbasin).

| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load ($kWh/m^2$/ day) | Potential Shade (fraction) | Potential Summer Load ($kWh/m^2$ /day) | Potential Load minus Existing load ($kWh/m^2$/day) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area ($m^2$) | Existing Summer Load (kWh/ day) | Natural Segment Area ($m^2$) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | Lack of Shade (%) | **Rock Creek** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1510 | 0.2 | 4.864 | 0.5 | 3.04 | -2 | 10 | 10 | 15100 | 73446.4 | 15100 | 45904 | -27542.4 | -30 | NP Breakland |
| 330 | 0.1 | 5.472 | 0.5 | 3.04 | -2.432 | 10 | 10 | 3300 | 18057.6 | 3300 | 10032 | -8025.6 | -40 | |
| 230 | 0.2 | 4.864 | 0.5 | 3.04 | -1.824 | 10 | 10 | 2300 | 11187.2 | 2300 | 6992 | -4195.2 | -30 | |
| 280 | 0.5 | 3.04 | 0.5 | 3.04 | 0 | 10 | 10 | 2800 | 8512 | 2800 | 8512 | 0 | 0 | |
| 710 | 0.4 | 3.648 | 0.5 | 3.04 | -0.608 | 10 | 10 | 7100 | 25900.8 | 7100 | 21584 | -4316.8 | -10 | |
| 270 | 0.2 | 4.864 | 0.5 | 3.04 | -1.824 | 10 | 10 | 2700 | 13132.8 | 2700 | 8208 | -4924.8 | -30 | |
| 690 | 0.4 | 3.648 | 0.75 | 1.52 | -2.128 | 10 | 10 | 6900 | 25171.2 | 6900 | 10488 | -14683.2 | -35 | Black |
| 80 | 0.2 | 4.864 | 0.75 | 1.52 | -3.344 | 10 | 10 | 800 | 3891.2 | 800 | 1216 | -2675.2 | -55 | cottonwood |
| 290 | 0.3 | 4.256 | 0.75 | 1.52 | -2.736 | 10 | 10 | 2900 | 12342.4 | 2900 | 4408 | -7934.4 | -45 | |
| 370 | 0.5 | 3.04 | 0.75 | 1.52 | -1.52 | 10 | 10 | 3700 | 11248 | 3700 | 5624 | -5624 | -25 | |
| 600 | 0.3 | 4.256 | 0.7 | 1.824 | -2.432 | 11 | 11 | 6600 | 28089.6 | 6600 | 12038.4 | -16051.2 | -40 | |
| 370 | 0.2 | 4.864 | 0.7 | 1.824 | -3.04 | 11 | 11 | 4070 | 19796.48 | 4070 | 7423.68 | -12372.8 | -50 | |
| 190 | 0.3 | 4.256 | 0.7 | 1.824 | -2.432 | 11 | 11 | 2090 | 8895.04 | 2090 | 3812.16 | -5082.88 | -40 | |
| 2770 | 0.1 | 5.472 | 0.7 | 1.824 | -3.648 | 11 | 11 | 30470 | 166731.84 | 30470 | 55577.28 | -111154.56 | -60 | |
| 260 | 0.2 | 4.864 | 0.66 | 2.0672 | -2.7968 | 12 | 12 | 3120 | 15175.68 | 3120 | 6449.664 | -8726.016 | -46 | |
| 450 | 0.3 | 4.256 | 0.66 | 2.0672 | -2.1888 | 12 | 12 | 5400 | 22982.4 | 5400 | 11162.88 | -11819.52 | -36 | |
| 500 | 0.1 | 5.472 | 0.66 | 2.0672 | -3.4048 | 12 | 12 | 6000 | 32832 | 6000 | 12403.2 | -20428.8 | -56 | |
| 540 | 0.3 | 4.256 | 0.66 | 2.0672 | -2.1888 | 12 | 12 | 6480 | 27578.88 | 6480 | 13395.456 | -14183.424 | -36 | |
| 260 | 0.4 | 3.648 | 0.66 | 2.0672 | -1.5808 | 12 | 12 | 3120 | 11381.76 | 3120 | 6449.664 | -4932.096 | -26 | |
| 360 | 0.3 | 4.256 | 0.66 | 2.0672 | -2.1888 | 12 | 12 | 4320 | 18385.92 | 4320 | 8930.304 | -9455.616 | -36 | |
| 400 | 0.2 | 4.864 | 0.62 | 2.3104 | -2.5536 | 13 | 13 | 5200 | 25292.8 | 5200 | 12014.08 | -13278.72 | -42 | |
| 220 | 0.3 | 4.256 | 0.62 | 2.3104 | -1.9456 | 13 | 13 | 2860 | 12172.16 | 2860 | 6607.744 | -5564.416 | -32 | |
| 550 | 0.4 | 3.648 | 0.62 | 2.3104 | -1.3376 | 13 | 13 | 7150 | 26083.2 | 7150 | 16519.36 | -9563.84 | -22 | |
| 600 | 0.5 | 3.04 | 0.62 | 2.3104 | -0.7296 | 13 | 13 | 7800 | 23712 | 7800 | 18021.12 | -5690.88 | -12 | |
| 280 | 0.7 | 1.824 | 0.62 | 2.3104 | 0.4864 | 13 | 13 | 3640 | 6639.36 | 3640 | 8409.856 | 1770.496 | 8 | |
| 270 | 0.3 | 4.256 | 0.62 | 2.3104 | -1.9456 | 13 | 13 | 3510 | 14938.56 | 3510 | 8109.504 | -6829.056 | -32 | |
| 160 | 0.5 | 3.04 | 0.62 | 2.3104 | -0.7296 | 13 | 13 | 2080 | 6323.2 | 2080 | 4805.632 | -1517.568 | -12 | |
| 200 | 0.3 | 4.256 | 0.62 | 2.3104 | -1.9456 | 13 | 13 | 2600 | 11065.6 | 2600 | 6007.04 | -5058.56 | -32 | |
| 170 | 0.4 | 3.648 | 0.62 | 2.3104 | -1.3376 | 13 | 13 | 2210 | 8062.08 | 2210 | 5105.984 | -2956.096 | -22 | |

| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load (kWh/$m^2$/ day) | Potential Shade (fraction) | Potential Summer Load (kWh/$m^2$ /day) | Potential Load minus Existing load (kWh/$m^2$/day) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area ($m^2$) | Existing Summer Load (kWh/ day) | Natural Segment Area ($m^2$) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | Lack of Shade (%) | **Rock Creek** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 430 | 0.3 | 4.256 | 0.62 | 2.3104 | -1.9456 | 13 | 13 | 5590 | 23791.04 | 5590 | 12915.136 | -10875.904 | -32 | |
| 360 | 0.5 | 3.04 | 0.62 | 2.3104 | -0.7296 | 13 | 13 | 4680 | 14227.2 | 4680 | 10812.672 | -3414.528 | -12 | |
| 90 | 0.3 | 4.256 | 0.62 | 2.3104 | -1.9456 | 13 | 13 | 1170 | 4979.52 | 1170 | 2703.168 | -2276.352 | -32 | |
| 90 | 0.1 | 5.472 | 0.62 | 2.3104 | -3.1616 | 13 | 13 | 1170 | 6402.24 | 1170 | 2703.168 | -3699.072 | -52 | |
| | | | | | | | **Total** | **168,930** | **738,428** | **168,930** | **375,345** | **-363,083** | **-32** | |

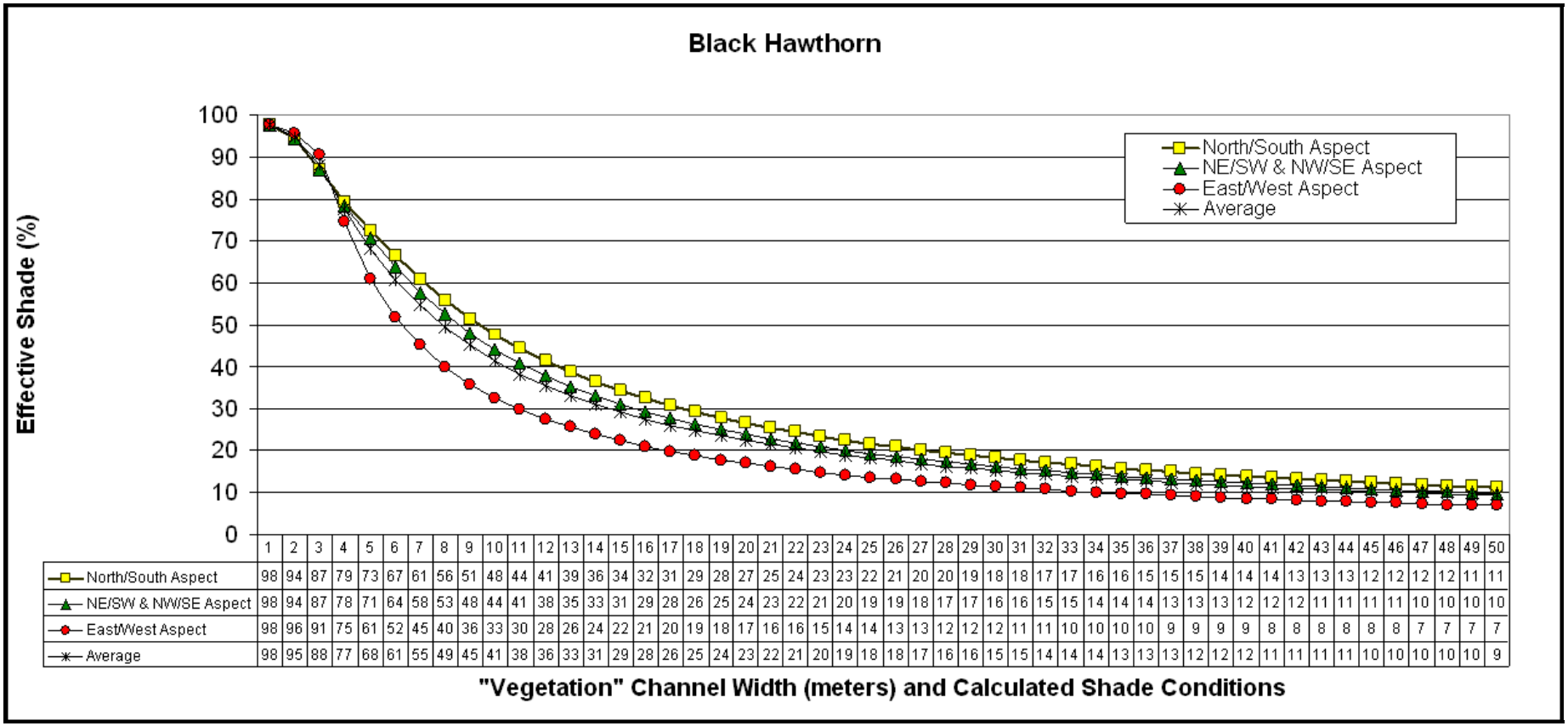
## Table C-5. Existing and potential solar loads for John's Creek (Lower Salmon River Subbasin).

| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load (kWh/m$^2$/ day) | Potential Shade (fraction) | Potential Summer Load (kWh/m$^2$/ day) | Potential Load minus Existing load (kWh/m$^2$/ day) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area (m$^2$) | Existing Summer Load (kWh /day) | Natural Segment Area (m$^2$) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | Lack of Shade (%) | **John's Creek** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1580 | 0.9 | 0.608 | 0.95 | 0.304 | -0.304 | 1 | 1 | 1580 | 960.64 | 1580 | 480.32 | -480.32 | -5 | NP breaklands |
| 140 | 0 | 6.08 | 0 | 6.08 | 0 | 50 | 1 | 7000 | 42560 | 140 | 851.2 | -41708.8 | 0 | water |
| 230 | 0.8 | 1.216 | 0.94 | 0.3648 | -0.8512 | 2 | 2 | 460 | 559.36 | 460 | 167.808 | -391.552 | -14 | NP breaklands |
| 30 | 0 | 6.08 | 0 | 6.08 | 0 | 30 | 2 | 900 | 5472 | 60 | 364.8 | -5107.2 | 0 | water |
| 190 | 0.8 | 1.216 | 0.94 | 0.3648 | -0.8512 | 2 | 2 | 380 | 462.08 | 380 | 138.624 | -323.456 | -14 | NP breaklands |
| 130 | 0.7 | 1.824 | 0.94 | 0.3648 | -1.4592 | 2 | 2 | 260 | 474.24 | 260 | 94.848 | -379.392 | -24 | |
| 690 | 0.5 | 3.04 | 0.95 | 0.304 | -2.736 | 2 | 2 | 1380 | 4195.2 | 1380 | 419.52 | -3775.68 | -45 | hawthorn |
| 100 | 0.3 | 4.256 | 0.95 | 0.304 | -3.952 | 2 | 2 | 200 | 851.2 | 200 | 60.8 | -790.4 | -65 | |
| 240 | 0.9 | 0.608 | 0.95 | 0.304 | -0.304 | 2 | 2 | 480 | 291.84 | 480 | 145.92 | -145.92 | -5 | |
| 440 | 0.6 | 2.432 | 0.95 | 0.304 | -2.128 | 2 | 2 | 880 | 2140.16 | 880 | 267.52 | -1872.64 | -35 | |
| 220 | 0.4 | 3.648 | 0.88 | 0.7296 | -2.9184 | 3 | 3 | 660 | 2407.68 | 660 | 481.536 | -1926.144 | -48 | |
| 410 | 0.9 | 0.608 | 0.88 | 0.7296 | 0.1216 | 3 | 3 | 1230 | 747.84 | 1230 | 897.408 | 149.568 | 0 | |
| 280 | 0.3 | 4.256 | 0.88 | 0.7296 | -3.5264 | 3 | 3 | 840 | 3575.04 | 840 | 612.864 | -2962.176 | -58 | |
| 390 | 0.5 | 3.04 | 0.88 | 0.7296 | -2.3104 | 3 | 3 | 1170 | 3556.8 | 1170 | 853.632 | -2703.168 | -38 | |
| 320 | 0.7 | 1.824 | 0.88 | 0.7296 | -1.0944 | 3 | 3 | 960 | 1751.04 | 960 | 700.416 | -1050.624 | -18 | |
| 160 | 0.2 | 4.864 | 0.88 | 0.7296 | -4.1344 | 3 | 3 | 480 | 2334.72 | 480 | 350.208 | -1984.512 | -68 | |
| 80 | 0 | 6.08 | 0 | 6.08 | 0 | 20 | 3 | 1600 | 9728 | 240 | 1459.2 | -8268.8 | 0 | water |
| 180 | 0.2 | 4.864 | 0.8 | 1.216 | -3.648 | 3 | 3 | 540 | 2626.56 | 540 | 656.64 | -1969.92 | -60 | hawthorn |
| 40 | 0.9 | 0.608 | 0.77 | 1.3984 | 0.7904 | 4 | 4 | 160 | 97.28 | 160 | 223.744 | 126.464 | 0 | |
| 420 | 0.7 | 1.824 | 0.77 | 1.3984 | -0.4256 | 4 | 4 | 1680 | 3064.32 | 1680 | 2349.312 | -715.008 | -7 | |
| 2910 | 0.1 | 5.472 | 0.77 | 1.3984 | -4.0736 | 4 | 4 | 11640 | 63694.08 | 11640 | 16277.376 | -47416.704 | -67 | |
| 4350 | 0.1 | 5.472 | 0.68 | 1.9456 | -3.5264 | 5 | 5 | 21750 | 119016 | 21750 | 42316.8 | -76699.2 | -58 | |
| 120 | 0 | 6.08 | 0 | 6.08 | 0 | 40 | 6 | 4800 | 29184 | 720 | 4377.6 | -24806.4 | 0 | water |
| 1240 | 0.1 | 5.472 | 0.61 | 2.3712 | -3.1008 | 6 | 6 | 7440 | 40711.68 | 7440 | 17641.728 | -23069.952 | -51 | hawthorn |
| 360 | 0.5 | 3.04 | 0.67 | 2.0064 | -1.0336 | 6 | 6 | 2160 | 6566.4 | 2160 | 4333.824 | -2232.576 | -17 | NP breaklands |
| 590 | 0.3 | 4.256 | 0.67 | 2.0064 | -2.2496 | 6 | 6 | 3540 | 15066.24 | 3540 | 7102.656 | -7963.584 | -37 | |
| 400 | 0.2 | 4.864 | 0.67 | 2.0064 | -2.8576 | 6 | 6 | 2400 | 11673.6 | 2400 | 4815.36 | -6858.24 | -47 | |
| | | | | | | | **Total** | **76,570** | **373,768** | **63,430** | **108,442** | **-265,326** | **-29** | |

## Table C-6. Existing and potential solar loads for Telcher Creek (Lower Salmon River Subbasin).

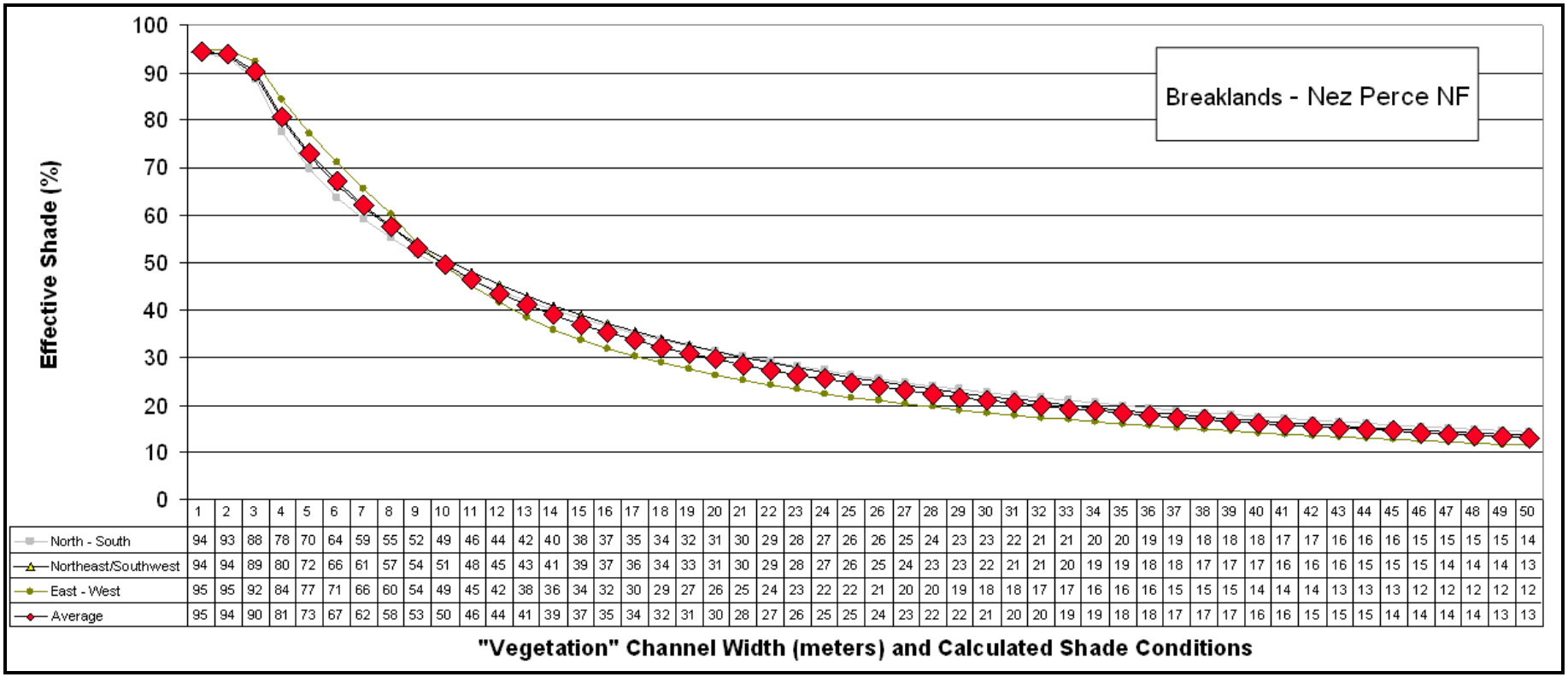
| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load ($kWh/m^2$/ day) | Potential Shade (fraction) | Potential Summer Load ($kWh/m^2$/ day) | Potential Load minus Existing load ($kWh/m^2$/ day) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area ($m^2$) | Existing Summer Load (kWh/ day) | Natural Segment Area ($m^2$) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | Lack of Shade (%) | **Telcher Creek** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 330 | 0.9 | 0.608 | 0.95 | 0.304 | 0 | 1 | 1 | 330 | 200.64 | 330 | 100.32 | -100.32 | -5 | NP Breaklands |
| 330 | 0.8 | 1.216 | 0.95 | 0.304 | -0.912 | 1 | 1 | 330 | 401.28 | 330 | 100.32 | -300.96 | -15 | |
| 940 | 0.9 | 0.608 | 0.95 | 0.304 | -0.304 | 1 | 1 | 940 | 571.52 | 940 | 285.76 | -285.76 | -5 | |
| 410 | 0.8 | 1.216 | 0.94 | 0.3648 | -0.8512 | 2 | 2 | 820 | 997.12 | 820 | 299.136 | -697.984 | -14 | |
| 300 | 0.7 | 1.824 | 0.94 | 0.3648 | -1.4592 | 2 | 2 | 600 | 1094.4 | 600 | 218.88 | -875.52 | -24 | |
| 190 | 0.9 | 0.608 | 0.94 | 0.3648 | -0.2432 | 2 | 2 | 380 | 231.04 | 380 | 138.624 | -92.416 | -4 | |
| 280 | 0.8 | 1.216 | 0.95 | 0.304 | -0.912 | 2 | 2 | 560 | 680.96 | 560 | 170.24 | -510.72 | -15 | |
| 190 | 0.7 | 1.824 | 0.95 | 0.304 | -1.52 | 2 | 2 | 380 | 693.12 | 380 | 115.52 | -577.6 | -25 | hawthorn |
| 190 | 0.9 | 0.608 | 0.95 | 0.304 | -0.304 | 2 | 2 | 380 | 231.04 | 380 | 115.52 | -115.52 | -5 | |
| 180 | 0.6 | 2.432 | 0.88 | 0.7296 | -1.7024 | 3 | 3 | 540 | 1313.28 | 540 | 393.984 | -919.296 | -28 | |
| 530 | 0.8 | 1.216 | 0.88 | 0.7296 | -0.4864 | 3 | 3 | 1590 | 1933.44 | 1590 | 1160.064 | -773.376 | -8 | |
| 40 | 0.2 | 4.864 | 0.88 | 0.7296 | -4.1344 | 3 | 3 | 120 | 583.68 | 120 | 87.552 | -496.128 | -68 | |
| 150 | 0.7 | 1.824 | 0.88 | 0.7296 | -1.0944 | 3 | 3 | 450 | 820.8 | 450 | 328.32 | -492.48 | -18 | |
| 350 | 0.8 | 1.216 | 0.88 | 0.7296 | -0.4864 | 3 | 3 | 1050 | 1276.8 | 1050 | 766.08 | -510.72 | -8 | |
| 500 | 0.6 | 2.432 | 0.88 | 0.7296 | -1.7024 | 3 | 3 | 1500 | 3648 | 1500 | 1094.4 | -2553.6 | -28 | |
| 770 | 0.2 | 4.864 | 0.77 | 1.3984 | -3.4656 | 4 | 4 | 3080 | 14981.12 | 3080 | 4307.072 | -10674.048 | -57 | |
| 2960 | 0.1 | 5.472 | 0.68 | 1.9456 | -3.5264 | 5 | 5 | 14800 | 80985.6 | 14800 | 28794.88 | -52190.72 | -58 | |
| 1210 | 0 | 6.08 | 0.61 | 2.3712 | -3.7088 | 6 | 6 | 7260 | 44140.8 | 7260 | 17214.912 | -26925.888 | -61 | |
| 280 | 0.2 | 4.864 | 0.55 | 2.736 | -2.128 | 7 | 7 | 1960 | 9533.44 | 1960 | 5362.56 | -4170.88 | -35 | |
| 310 | 0.3 | 4.256 | 0.55 | 2.736 | -1.52 | 7 | 7 | 2170 | 9235.52 | 2170 | 5937.12 | -3298.4 | -25 | |
| 310 | 0.2 | 4.864 | 0.62 | 2.3104 | -2.5536 | 7 | 7 | 2170 | 10554.88 | 2170 | 5013.568 | -5541.312 | -42 | NP Breaklands |
| 840 | 0.4 | 3.648 | 0.58 | 2.5536 | -1.0944 | 8 | 8 | 6720 | 24514.56 | 6720 | 17160.192 | -7354.368 | -18 | |
| 1080 | 0.3 | 4.256 | 0.58 | 2.5536 | -1.7024 | 8 | 8 | 8640 | 36771.84 | 8640 | 22063.104 | -14708.736 | -28 | |
| | | | | | | | **Total** | **56,770** | **245,395** | **56,770** | **111,228** | **-134,167** | **-26** | |

# Appendix D. Shade Curves



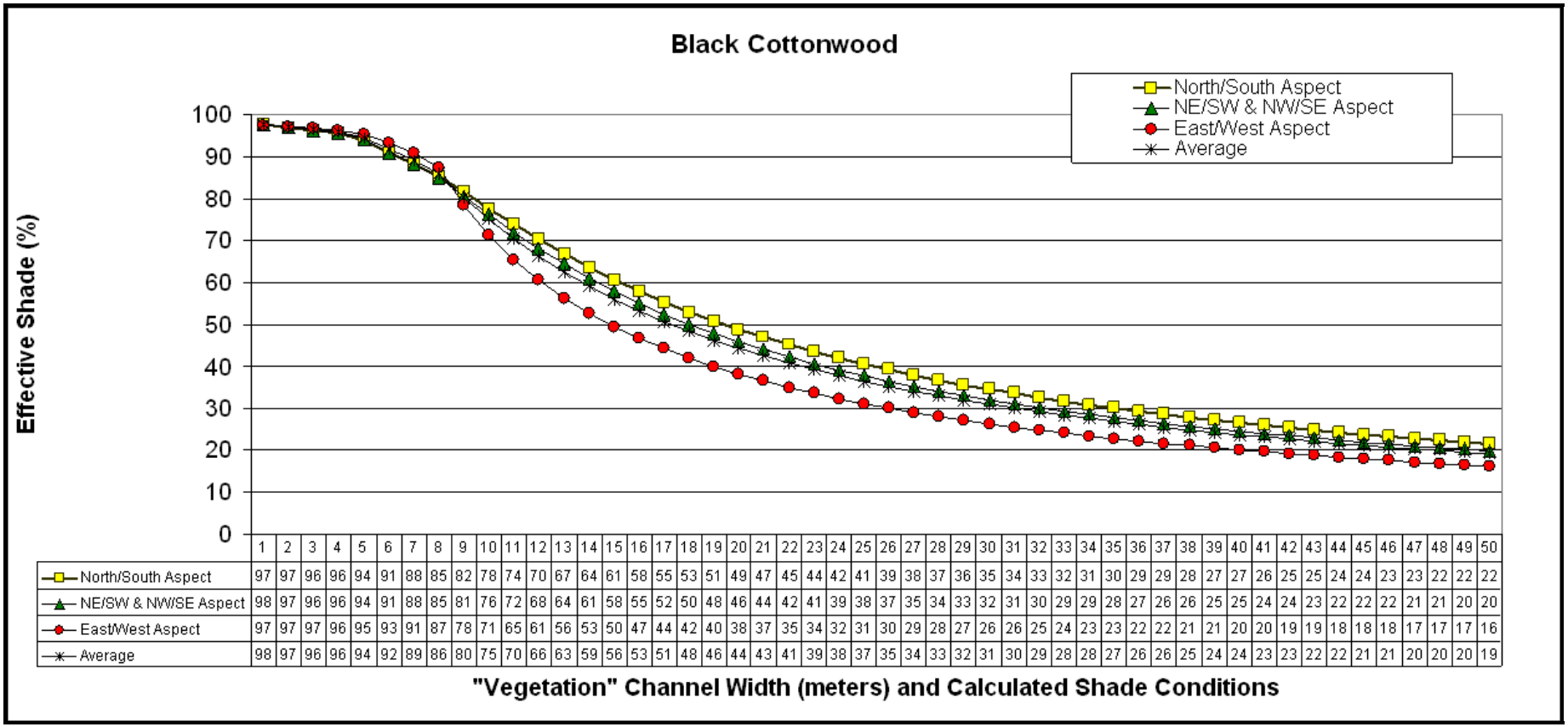

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North/South Aspect | 98 | 94 | 87 | 79 | 73 | 67 | 61 | 56 | 51 | 48 | 44 | 41 | 39 | 36 | 34 | 32 | 31 | 29 | 28 | 27 | 25 | 24 | 23 | 23 | 22 | 21 | 20 | 20 | 19 | 18 | 18 | 17 | 17 | 16 | 16 | 15 | 15 | 15 | 14 | 14 | 14 | 13 | 13 | 13 | 12 | 12 | 12 | 12 | 11 | 11 |
| NE/SW & NW/SE Aspect | 98 | 94 | 87 | 78 | 71 | 64 | 58 | 53 | 48 | 44 | 41 | 38 | 35 | 33 | 31 | 29 | 28 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 19 | 18 | 17 | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 14 | 13 | 13 | 13 | 12 | 12 | 12 | 11 | 11 | 11 | 11 | 10 | 10 | 10 | 10 |
| East/West Aspect | 98 | 96 | 91 | 75 | 61 | 52 | 45 | 40 | 36 | 33 | 30 | 28 | 26 | 24 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 16 | 15 | 14 | 14 | 13 | 13 | 12 | 12 | 12 | 11 | 11 | 10 | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 7 |
| Average | 98 | 95 | 88 | 77 | 68 | 61 | 55 | 49 | 45 | 41 | 38 | 36 | 33 | 31 | 29 | 28 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 18 | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 14 | 13 | 13 | 13 | 12 | 12 | 12 | 11 | 11 | 11 | 11 | 10 | 10 | 10 | 10 | 10 | 9 |

**Figure D-1. Black Hawthorn Shade Curve**



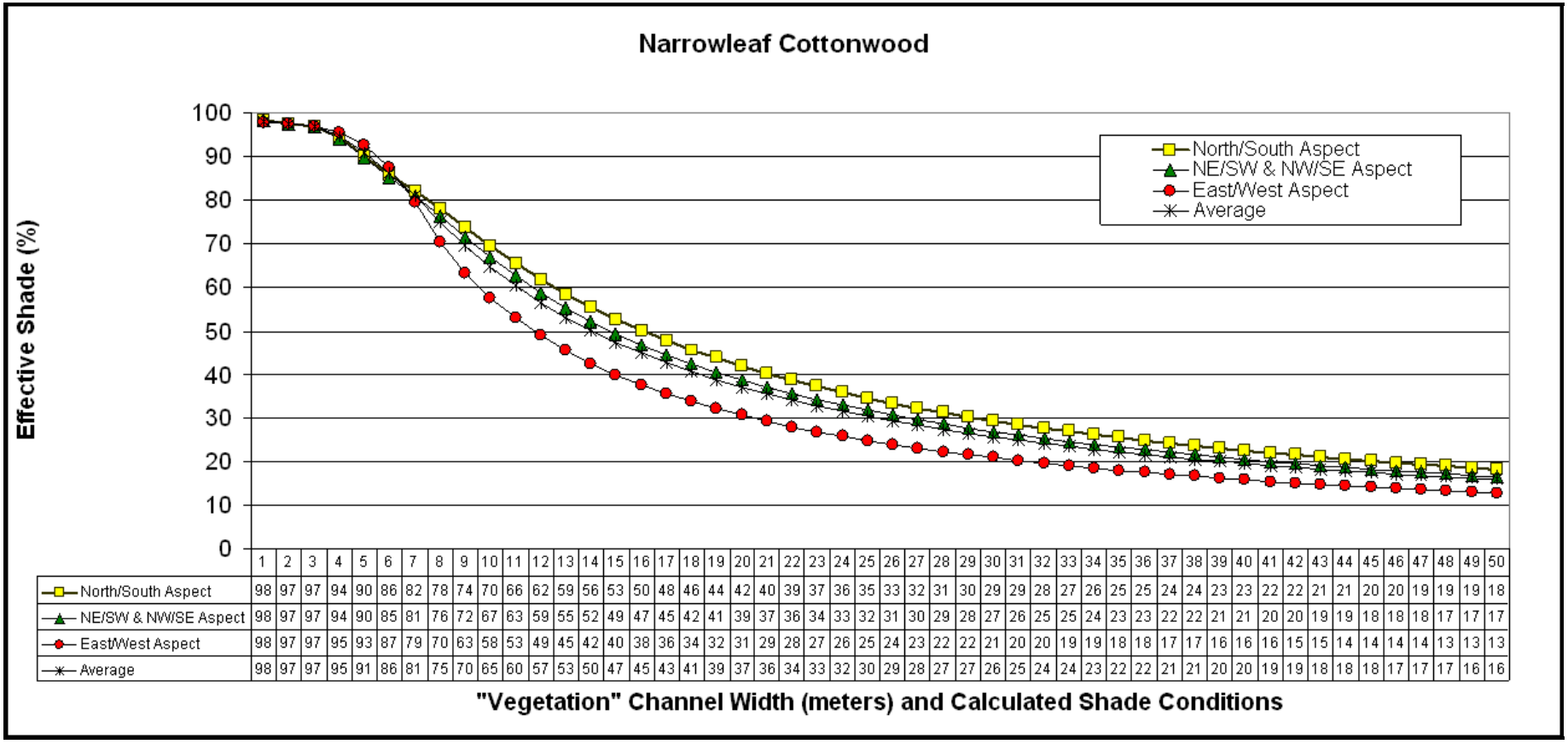

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North - South | 94 | 93 | 88 | 78 | 70 | 64 | 59 | 55 | 52 | 49 | 46 | 44 | 42 | 40 | 38 | 37 | 35 | 34 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 26 | 25 | 24 | 23 | 23 | 22 | 21 | 21 | 20 | 20 | 19 | 19 | 18 | 18 | 18 | 17 | 17 | 16 | 16 | 16 | 15 | 15 | 15 | 15 | 14 |
| Northeast/Southwest | 94 | 94 | 89 | 80 | 72 | 66 | 61 | 57 | 54 | 51 | 48 | 45 | 43 | 41 | 39 | 37 | 36 | 34 | 33 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 23 | 22 | 21 | 21 | 20 | 19 | 19 | 18 | 18 | 17 | 17 | 17 | 16 | 16 | 16 | 15 | 15 | 15 | 14 | 14 | 14 | 13 |
| East - West | 95 | 95 | 92 | 84 | 77 | 71 | 66 | 60 | 54 | 49 | 45 | 42 | 38 | 36 | 34 | 32 | 30 | 29 | 27 | 26 | 25 | 24 | 23 | 22 | 22 | 21 | 20 | 20 | 19 | 18 | 18 | 17 | 17 | 16 | 16 | 16 | 15 | 15 | 15 | 14 | 14 | 14 | 13 | 13 | 13 | 12 | 12 | 12 | 12 | 12 |
| Average | 95 | 94 | 90 | 81 | 73 | 67 | 62 | 58 | 53 | 50 | 46 | 44 | 41 | 39 | 37 | 35 | 34 | 32 | 31 | 30 | 28 | 27 | 26 | 25 | 25 | 24 | 23 | 22 | 22 | 21 | 20 | 20 | 19 | 19 | 18 | 18 | 17 | 17 | 17 | 16 | 16 | 15 | 15 | 15 | 14 | 14 | 14 | 14 | 13 | 13 |

**Figure D-2. Nez Perce NF Breaklands Shade Curve**




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North/South Aspect | 97 | 97 | 96 | 96 | 94 | 91 | 88 | 85 | 82 | 78 | 74 | 70 | 67 | 64 | 61 | 58 | 55 | 53 | 51 | 49 | 47 | 45 | 44 | 42 | 41 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | 31 | 30 | 29 | 29 | 28 | 27 | 27 | 26 | 25 | 25 | 24 | 24 | 23 | 23 | 22 | 22 | 22 |
| NE/SW & NW/SE Aspect | 98 | 97 | 96 | 96 | 94 | 91 | 88 | 85 | 81 | 76 | 72 | 68 | 64 | 61 | 58 | 55 | 52 | 50 | 48 | 46 | 44 | 42 | 41 | 39 | 38 | 37 | 35 | 34 | 33 | 32 | 31 | 30 | 29 | 29 | 28 | 27 | 26 | 26 | 25 | 25 | 24 | 24 | 23 | 22 | 22 | 22 | 21 | 21 | 20 | 20 |
| East/West Aspect | 97 | 97 | 97 | 96 | 95 | 93 | 91 | 87 | 78 | 71 | 65 | 61 | 56 | 53 | 50 | 47 | 44 | 42 | 40 | 38 | 37 | 35 | 34 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 26 | 25 | 24 | 23 | 23 | 22 | 22 | 21 | 21 | 20 | 20 | 19 | 19 | 18 | 18 | 18 | 17 | 17 | 17 | 16 |
| Average | 98 | 97 | 96 | 96 | 94 | 92 | 89 | 86 | 80 | 75 | 70 | 66 | 63 | 59 | 56 | 53 | 51 | 48 | 46 | 44 | 43 | 41 | 39 | 38 | 37 | 35 | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 28 | 27 | 26 | 26 | 25 | 24 | 24 | 23 | 23 | 22 | 22 | 21 | 21 | 20 | 20 | 20 | 19 |

**Figure D-3. Black Cottonwood Shade Curve**




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North/South Aspect | 98 | 97 | 97 | 94 | 90 | 86 | 82 | 78 | 74 | 70 | 66 | 62 | 59 | 56 | 53 | 50 | 48 | 46 | 44 | 42 | 40 | 39 | 37 | 36 | 35 | 33 | 32 | 31 | 30 | 29 | 29 | 28 | 27 | 26 | 25 | 25 | 24 | 24 | 23 | 23 | 22 | 22 | 21 | 21 | 20 | 20 | 19 | 19 | 19 | 18 |
| NE/SW & NW/SE Aspect | 98 | 97 | 97 | 94 | 90 | 85 | 81 | 76 | 72 | 67 | 63 | 59 | 55 | 52 | 49 | 47 | 45 | 42 | 41 | 39 | 37 | 36 | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 25 | 24 | 23 | 23 | 22 | 22 | 21 | 21 | 20 | 20 | 19 | 19 | 18 | 18 | 18 | 17 | 17 | 17 |
| East/West Aspect | 98 | 97 | 97 | 95 | 93 | 87 | 79 | 70 | 63 | 58 | 53 | 49 | 45 | 42 | 40 | 38 | 36 | 34 | 32 | 31 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 22 | 21 | 20 | 20 | 19 | 19 | 18 | 18 | 17 | 17 | 16 | 16 | 16 | 15 | 15 | 14 | 14 | 14 | 14 | 13 | 13 | 13 |
| Average | 98 | 97 | 97 | 95 | 91 | 86 | 81 | 75 | 70 | 65 | 60 | 57 | 53 | 50 | 47 | 45 | 43 | 41 | 39 | 37 | 36 | 34 | 33 | 32 | 30 | 29 | 28 | 27 | 27 | 26 | 25 | 24 | 24 | 23 | 22 | 22 | 21 | 21 | 20 | 20 | 19 | 19 | 18 | 18 | 18 | 17 | 17 | 17 | 16 | 16 |

**Figure D-4. Narrowleaf Cottonwood Shade Curve**

# Appendix E. Public Comments

The Watershed Advisory Group voted to provide a 30-day public comment period for the March 2009 draft of the *Lower Salmon River and Hells Canyon Tributaries Assessments and TMDLs* document during the March 11, 2009 Watershed Advisory Group meeting. Notice was provided to the general public through the Idaho County Free Press and Current News In Riggins.

Copies of the document were made available through the Lewiston, Grangeville and State Offices of the Idaho Department of Environmental Quality, the Idaho Soil and Water Conservation District Office, the US Forest Service Slate Creek Ranger Station Office, and the US Environmental Protection Agency's Idaho Operations Office.

The comments received were reviewed and discussed by the Lower Salmon River Watershed Advisory Group during the April 24, 2009 Watershed Advisory Group meeting.

Written comments were received from:

William Stewart, Environmental Protection Specialist, US Environmental Protection Agency, Region 10, Idaho Operations Office, 1435 N. Orchard St., Boise, Idaho.

Ashley Leach.

Comments received are summarized and addressed below.

Comment: I strongly approve of the proposal to manage pollutants in the Lower Salmon River and Hells Canyon Subbasins. This area is crucial salmon and trout habitat, and due to the existing four dams along the Snake River, these populations have already been severely impacted. Any action that can be taken to improve this situation for these crucial species is much needed.

Response: The Lower Salmon River Watershed Advisory Group recognizes the unique characteristics of the Lower Salmon River and Hells Canyon (Snake River) fisheries and advised DEQ to apply sediment and shade targets through the development of sediment and temperature TMDLs that, when implemented, will fully support the cold water aquatic life beneficial use.

Comment: The title of this TMDL document, Lower Salmon River and Hells Canyon Subbasins Assessments and TMDLs, seems to imply that the mainstems of these rivers are included in the TMDL. They are not, in fact, included in this document. This TMDL is for the tributaries leading to the Lower Salmon and Snake Rivers. Either the title should be changed or some explanation should be given for this near the front of the document.

Response: The title of the document has been changed, and is now titled, Lower Salmon River and Hells Canyon Tributaries Assessments and TMDLs.

Comment: On page 48, Table 14, is an explanation of beneficial use support of listed waters. This table is confusing to the reader. For example, Wolf Creek appears to have no BURP assessment or assessment of cold water aquatic life and yet has been declared full support. The same is true for Deep Creek. Why is this?

Response: The text has been revised to explain that the contact recreation beneficial use full support determinations for Wolf Creek and Deep Creek are based on an assessment of E. coli bacteria data generated in 2008. The cold water aquatic life beneficial use has not been assessed for Wolf Creek, Deep Creek, and Cottonwood Creek.

Comment: On page 53, first paragraph, is a description of point sources. The paragraph states that none of the point sources discharge to water bodies addressed in this document. Are any of the water bodies discharged to listed in the most recent integrated list? Also, it should be noted that if any new point sources wish to discharge to waters with TMDLs, no discharge will be allowed without a wasteload allocation in the TMDL. In other words, the TMDL will have to be re-opened and modified before a permit could be issued.

Response: The TMDL has been revised to provide waste load allocations for future growth based on water quality standards and associated TMDL targets.

Comment: In looking at your Lower Salmon Hells Canyon TMDL, I noticed that you have not built in a reserve for growth. I really think you should include a reserve for growth in all of your TMDLs from now on. This is an ever increasing problem for watersheds in Idaho. Every time a new source wants a permit, the TMDLs have to be recalculated. Please give serious consideration to including reserves for growth in this TMDL.

Response: The TMDL has been revised to provide waste load allocations for future growth based on water quality standards and associated TMDL targets.

# Appendix F. Distribution List

Department of Environmental Quality – Lewiston Regional Office, 1118 F Street, Lewiston, Idaho 83501

Department of Environmental Quality – State Office, 1410 North Hilton, Boise, Idaho 83706

US Environmental Protection Agency – Idaho Operations Office, 1435 North Orchard, Boise, Idaho 83706

Clearwater Basin Advisory Group Members

Lower Salmon River Watershed Advisory Group Members

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