King Hill – C.J. Strike Reservoir Subbasin Assessment and Total Maximum Daily Load

Revised
Final
March 2006

Idaho Department of Environmental Quality

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Abbreviations, Acronyms, and Symbols

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

µ micro, one-one thousandth

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

AU assessment unit

AWS agricultural water supply

BLM United States Bureau of Land Management

BMP best management practice

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

CWA Clean Water Act

CWAL cold water aquatic life

DEQ Department of Environmental Quality

DO dissolved oxygen

DWS domestic water supply

EPA United States Environmental Protection Agency

ESA Endangered Species Act

F Fahrenheit

HUC Hydrologic Unit Code

IDAPA Refers to citations of Idaho administrative rules

IDWR Idaho Department of Water Resources

LA load allocation

LC load capacity

m meter

mi mile

mi^2 square miles

MGD million gallons per day

mg/L milligrams per liter

mm millimeter

MOS margin of safety

n.a. not applicable

NA not assessed

NB natural background

nd no data (data not available)

NPDES National Pollutant Discharge Elimination System

NRCS Natural Resources Conservation Service

NTU nephelometric turbidity unit

PCR primary contact recreation

POR period of record

QA quality assurance

QC quality control

SBA subbasin assessment

SCR secondary contact recreation

SMI DEQ's Stream Macroinvertebrate Index

SOD sediment oxygen demand

SSC suspended sediment concentration

SS salmonid (trout) spawning

TDG total dissolved gas

TMDL total maximum daily load

TP total phosphorus

USGS United States Geological Survey

WAG Watershed Advisory Group

WBAG *Water Body Assessment Guidance*

WLA wasteload allocation

WQS water quality standard

Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. 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 King Hill-C.J. Strike Reservoir Subbasin 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 King Hill-C.J. Strike Reservoir Subbasin, located near Mountain Home, Idaho.

The first part of this document, the SBA, is an important first step in leading to the TMDL. The starting point for this assessment was Idaho's current §303(d) list of water quality limited water bodies. Ten segments of the King Hill-C.J. Strike Reservoir Subbasin were listed on this list. The SBA examines the current status of §303(d) listed waters and defines the extent of impairment and causes of water quality limitation throughout the subbasin. The TMDL analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

Subbasin at a Glance

Table A shows the §303(d) listed water bodies within the King Hill-C.J. Strike watershed. Figure A shows the watershed boundaries and the location of each §303(d) listed water within the watershed.

Table A. 303(d)[1] Listed segments in the King Hill-C.J. Strike Reservoir Subbasin.

Water Body	Boundaries	Assessment Unit	303(d) Pollutants
Snake River	King Hill to C.J. Strike Reservoir	ID17050101S W005_07	Sediment
C.J. Strike Reservoir	Entire Reservoir	ID17050101S W001_02, 05, 06, 07	Nutrients, Pesticides
Alkali Creek	Headwaters to Snake River	ID17050101S W013_02, 03	Sediment
Bennett Creek	Headwaters to Snake River	ID17050101S W016_02, 03	Unknown
Browns Creek	Headwaters to Snake River	ID17050101S W003_02, 03, 04 ID17050101S W004_02, 03	Sediment
Cold Springs Creek	Ryegrass Creek to Snake River	ID17050101S W014_03	Unknown
Deadman Creek	Confluence of E. and W. Forks to Snake River	ID17050101S W008_02, 03	Sediment
Little Canyon Creek	Headwaters to Snake River	ID17050101S W012_02, 03, 03a	Sediment, Flow Alteration
Ryegrass Creek	Headwaters to Cold Springs Creek	ID17050101S W015_02	Sediment
Sailor Creek	Headwaters to Snake River	ID17050101S W006_02, 03, 04	Sediment

[1]Refers to a list created by the State of Idaho (using monitoring data) in 1998 or water bodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection “d” of the Clean Water Act.

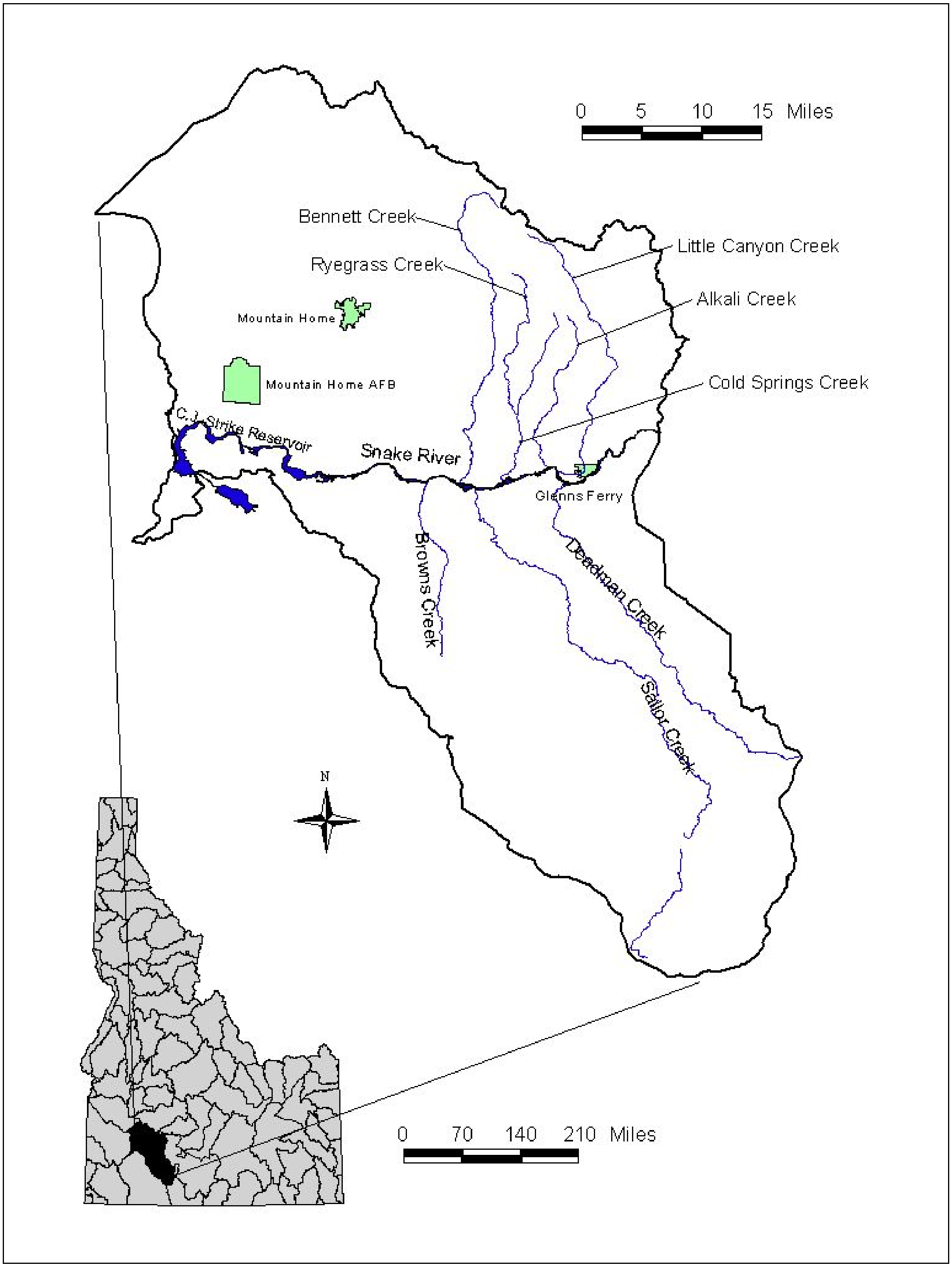

Figure A. §303(d) listed waters in HUC 17050101

Key Findings

Nutrient loading to the Snake River comes primarily from the upstream segment of the Snake River. Other smaller sources include several tributaries and the Glenns Ferry Wastewater Treatment Plant. The primary nutrient impairing beneficial uses in the river is phosphorus. A total phosphorus target of 0.075 milligrams per liter (mg/L) was established for the Snake River between King Hill and C.J. Strike Reservoir. A nutrient TMDL was developed based on meeting this target.

As with nutrients, sediment loading to the Snake River comes primarily from the upstream segment of the Snake River. However, the Snake River between King Hill and C.J. Strike Reservoir does not currently exceed the surrogate water column targets of 50 mg/L (for no longer than 60 days) and 80 mg/L (for no longer than 14 days). Even with the lack of exceedances, a sediment TMDL was established for the Snake River between King Hill and C.J. Strike Reservoir. The intent of the TMDL is to help address a sediment bedload problem in the river, which is contributing to excessive aquatic plant growth.

In-stream channel erosion is the primary source of sediment loading in Little Canyon Creek and Cold Springs Creek. Land management practices contribute to unstable banks in many areas, and the resulting instability has led to sediment delivery to the stream channel. Eighty-percent bank stability was selected as a surrogate target to achieve less than 30% fine material in the stream substrate. TMDLs were developed based on achieving 80% bank stability.

The Snake River arm of C.J. Strike Reservoir currently experiences dissolved oxygen sags in the metalimnion—the middle layer of a thermally stratified water body. These sags occur due to a variety of factors, namely decaying organic matter, including macrophytes, and excess total phosphorus in the water column and increasing sediment oxygen demand (SOD).

Using the CE-QUAL-W2 water quality model, dissolved oxygen conditions in the reservoir were simulated when a water column target of 0.075 mg/L total phosphorus (TP) and 6.0 mg/L dissolved oxygen were met in the Snake River and a SOD of 0.1 gm^{-2} day^{-1} was met in the reservoir. This SOD level is considered a long-term goal. The results showed that the dissolved oxygen criterion (6.0 mg/L) was nearly met in the reservoir. An additional 2.2 tons/year of oxygen is necessary in the metalimnion.

A nutrient TMDL based on the reservoir inflows meeting less than or equal to 0.075 mg/L TP was established for the reservoir. An additional dissolved oxygen load allocation of 2.2 tons/year was also assigned.

Table B summarizes the outcomes of the subbasin assessment and includes those streams for which TMDLs were developed.

Table B. Summary of subbasin assessment outcomes.

Water Body	§303(d) Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List
Snake River ID17050101SW005_07	Sediment	Sediment, Nutrients	None
C.J. Strike Reservoir ID17050101SW001_02, 05, 06, 07	Pesticides, Nutrients	Nutrients, Dissolved Oxygen	De-list Pesticides
Alkali Creek ID17050101SW013_02, 03	Sediment	None	De-list Sediment
Bennett Creek ID17050101SW016_02, 03	Unknown	None	De-list Unknown
Browns Creek ID17050101SW003_02, 03, 04 ID17050101SW004_02, 03	Sediment	None	De-list Sediment
Cold Springs Creek ID17050101SW014_03	Unknown	Sediment	None
Deadman Creek ID17050101SW008_02, 03	Sediment	None	De-list Sediment
Little Canyon Creek ID17050101SW012_02, 03, 03a	Sediment, Flow Alteration	Sediment	No Action for Flow Alteration
Ryegrass Creek ID17050101SW015_02	Sediment	None	De-list Sediment
Sailor Creek ID17050101SW006_02, 03, 04	Sediment	None	De-list Sediment

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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 King Hill-C.J. Strike Reservoir 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 King Hill-C.J. Strike Reservoir 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 will then be used to develop a TMDL for each pollutant of concern for King Hill-C.J. Strike Reservoir Subbasin (Section 5).

1.1 Introduction

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

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

Background

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

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

These requirements result in a list of impaired waters, called the "§303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. A SBA and TMDL provide a summary of the water quality status and allowable TMDL for water bodies on the §303(d) list. The *King Hill-C.J. Strike Reservoir Subbasin Assessment and TMDL* provides this summary for the currently listed waters in the King Hill-C.J. Strike Reservoir Subbasin.

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

Some conditions that impair water quality do not receive TMDLs. The EPA 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 as "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 (ingestion likely), secondary (ingestion not likely)
- Water supply–domestic, agricultural, industrial
- Wildlife habitats
- Aesthetics

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

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

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

1.2 Physical and Biological Characteristics

Describing physical and biological parameters of the subbasin aids assessing characteristics relevant to pollutants impairing beneficial uses. To begin evaluating the King Hill-C.J. Strike subbasin for sensitivity to activities that may impair beneficial uses of its waterbodies, the climate, hydrology, geology, soils, vegetation, and assemblages of aquatic life are identified and described.

The King Hill-C.J. Strike subbasin lies mainly in plains and low hills of the western Snake River plain. Figure 1 shows the location of the subbasin within Idaho. The climate is very arid. The Snake River is the primary drainage with most tributaries intermittent or dry. Irrigation is highly developed in this area. Geology is mainly sedimentary and volcanic rocks. Potential natural vegetation is sagebrush (*Artemisia*) steppe with some saltbush (*Atriplex*) communities where fine, high-mineral soils occur.

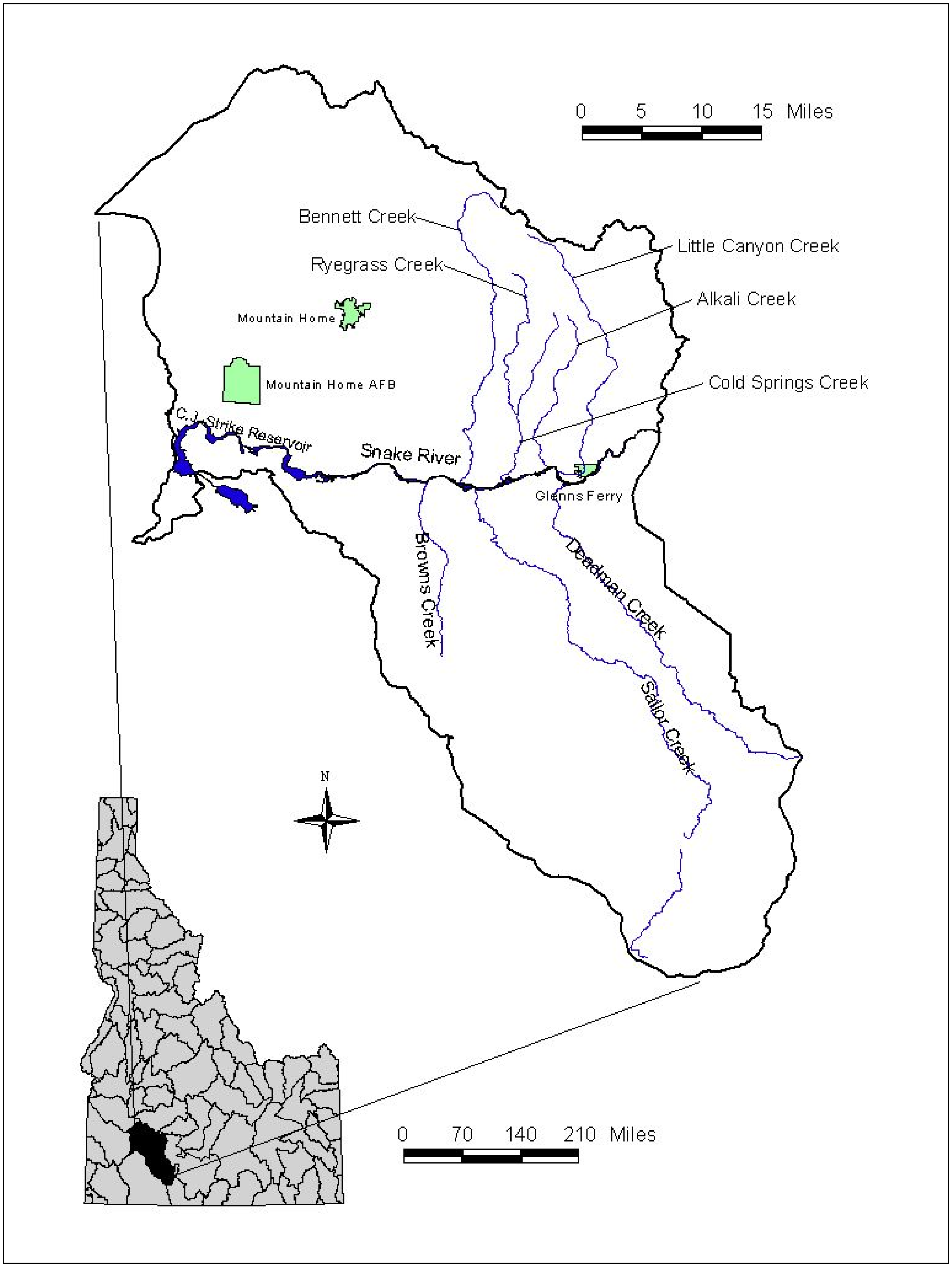


Figure 1. Location of King Hill-C.J. Strike Watershed within Idaho

Climate

The climate of the King Hill-C.J. Strike watershed is dry and temperate. Precipitation values over the Snake River plain as a whole are low because the region is in a large structural depression between two mountain ranges. To the west, the Cascade Mountains capture much of the moisture from oceanic air masses moving east. To the east, the Rocky Mountains shield the Snake River plain from continental cold air masses that sweep from Canada to the Gulf of Mexico (IDWR 1985, Abramovich et al. 1998). Overall, climate differences result more from changes in elevation and aspect rather than latitude.

Primary weather stations (Table 1) in the King Hill-C.J. Strike watershed are located at Glenns Ferry and Mountain Home (Western Regional Climate Center 2004).

Table 1. Summary of monthly data from 1948 through 2003 for Glenns Ferry and Mountain Home weather stations.

Period	Glenns Ferry			Mountain Home		
	Temperature °F		Precipitation	Temperature °F		Precipitation
	Mean Maximum	Mean Minimum	Mean Total (in.)	Mean Maximum	Mean Minimum	Mean Total (in.)
Jan.	39.2	20.3	1.47	38.2	20.4	1.34
Feb.	47.9	24.9	0.98	45.1	24.2	0.86
March	56.8	29.1	0.87	53.7	28.8	1.06
April	66.8	34.9	0.68	63.1	34.4	0.84
May	76.4	42.7	0.82	72.8	42.2	0.87
June	85.5	50.0	0.68	83.0	49.9	0.73
July	95.9	55.4	0.20	93.0	56.4	0.27
August	93.4	52.5	0.26	91.5	54.2	0.28
Sept.	82.6	43.5	0.42	80.9	45.1	0.51
Oct.	69.4	33.4	0.55	67.3	35.1	0.63
Nov.	52.6	27.2	1.24	50.0	27.3	1.19
Dec.	41.2	21.7	1.26	39.3	21.3	1.29
Annual	67.3	36.3	9.43	64.8	36.6	9.87

On average between the two weather stations, monthly mean maximum temperatures climb to the mid 90s (°F) on average during summer months with the highest maximum temperatures occurring in July and August, while mean minimum temperatures can drop as low as 20 °F in the winter. The annual average maximum temperature is 66 °F and the annual average minimum temperature is 36 °F for the region. Total mean annual precipitation averages less than 10 inches for the region (Western Regional Climate Center 2004).

Solar radiation values are highest during July. Cloud cover varies throughout the year, but there are an overall high proportion of sunny days in this subbasin. Winter is only moderately sunny, with cloudiest conditions in December and January. Clear, sunny skies are common throughout the summer (IDWR 1985).

Relative humidity is low and evaporation is rapid. Because of the low relative humidity, sensible temperatures are low. Where irrigation occurs throughout the growing season, humidity is several percent above the generally arid summer conditions (IDWR 1985).

Subbasin Characteristics

Ecoregion divisions can provide an overall picture of the King Hill-C.J. Strike watershed. Ecoregions are used by scientists to classify areas with similar climate, vegetative cover, geology, soils, and land use. The King Hill-C.J. Strike subbasin lies mainly within the Snake River Plain ecoregion, a dry area with low hills and plains. This ecoregion generally contains low-gradient streams with warmer temperatures and finer substrates than in more mountainous regions (McGrath 2001).

Geology

The Snake River plain characterizes the King Hill-C.J Strike subbasin. A topographic lowland filled with sedimentary and volcanic deposits, the western Snake River plain is, like most of the Basin and Range province, a *graben*—a block of the Earth's crust that has dropped.. This fault-bounded basin, about 70 kilometers wide by 350 kilometers long, separates the granitic Idaho batholith of west central Idaho from similar granitic rock in the Owyhee highlands to the south. Further east, volcanism and its associated tectonism forms the central Snake River plain similar to the processes shaping the landscape of northern Nevada, southern Idaho, and Yellowstone National Park. The area from Bruneau to Mountain Home is near the intersection of the western graben-type landscape and the central Snake River plain northeast-trending volcanism (Jenks and Bonnichsen 1989).

Much of the King Hill-C.J. Strike subbasin lies within the boundaries of the Lake Idaho basin, a large Tertiary age lake. The approximate shoreline of Lake Idaho follows a major topographic break, following the 3,800-foot elevation contour line (Figure 2). While Lake Idaho was full of water, thick layers of sediment were deposited in a wide area at the edges of the lake. In the Glenns Ferry vicinity, the thick lacustrine (of, or relating to lakes) layers can be seen today. These formations are part of the "Idaho Group" of lacustrine, fluvial, and flood plain sediments that were deposited from late Miocene through early Pleistocene time as the western Snake River plain subsided. Through much of this time, small volcanoes episodically erupted on the western Snake River Plain and deposited thick sequences of basalt in many areas. When volcanic eruptions contacted the margin of Lake Idaho, the lava cooled quickly to form characteristic basaltic formations that can be seen today along much of the 3,800-foot elevation contour line (Jenks and Bonnichsen 1989). In the late Pleistocene, the catastrophic outflow of Lake Bonneville scoured and shaped the current channel formation of the Snake River, breaking the dam for Lake Idaho. Then, a succession of lava flows deflected the Snake River channel into its current course along its south bank.

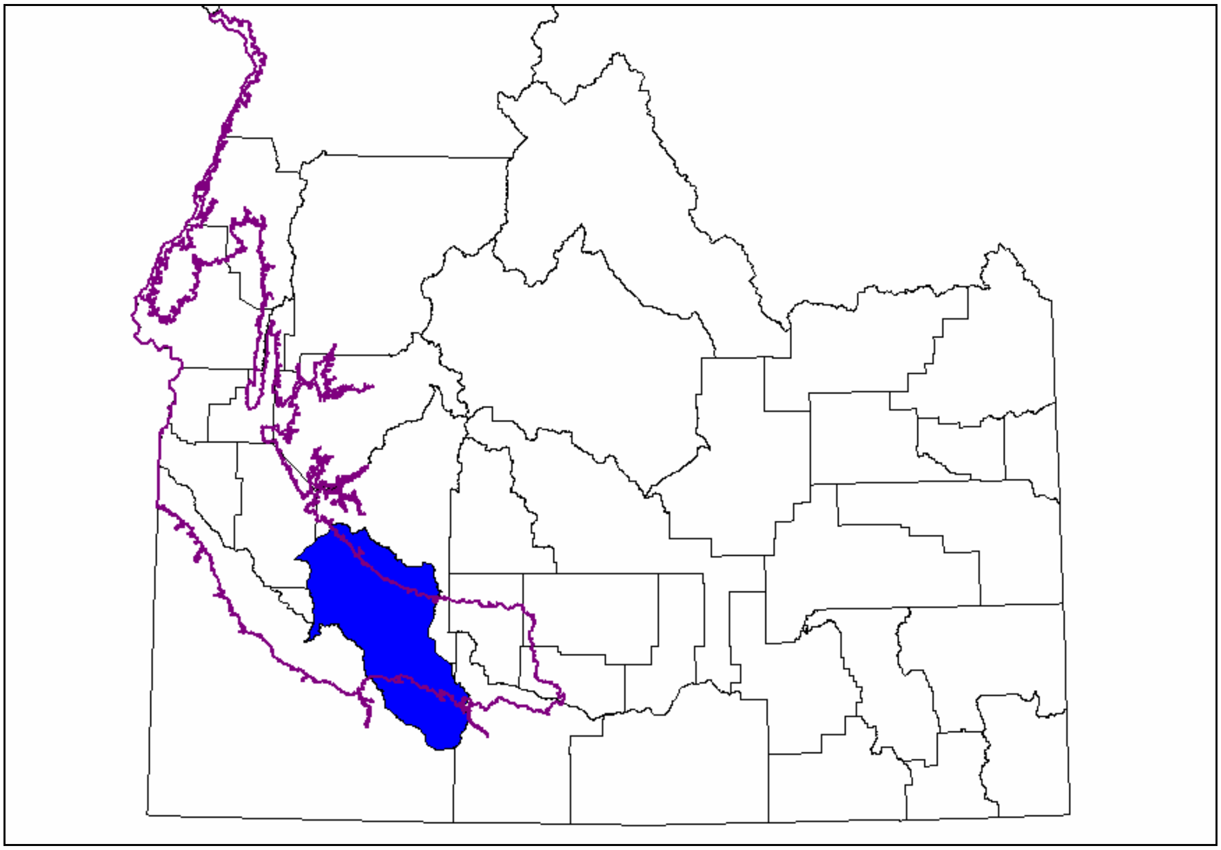


Figure 2. Boundary of Lake Idaho.

Surficial features of the King Hill-C.J. Strike subbasin are all fairly young in geologic age (Figure 3). Most of the lava flows and sedimentary deposits filling the Snake River valley are from the late Tertiary to early Quaternary age. See Table 2 for a review of the geologic timescale. The oldest formations are along the northern boundary of the watershed (Maley 1987). Bowns Creek, Ditto Creek, and the headwaters of Canyon Creek flow from the Danskin Mountains, which have the oldest rock in the subbasin with outcroppings of Cretaceous plutons—igneous bodies crystallized slowly, deep underground. In the Mount Bennett Hills to the southeast are igneous outcrops of the Eocene age. Mount Bennett Hills and part of the Danskin Mountains in the north of the King Hill-C.J. Strike subbasin represent the southernmost extent of the Idaho batholith, a huge mass of granitic plutons covering most of central Idaho (Maley 1987).

At lower elevations north of the Snake River, young Pleistocene lava flows and sedimentary deposits overlay the older igneous outcroppings. The Pleistocene water laid detritus shown in Figure 3 are sedimentary deposits that form the relatively featureless landscape on both sides of Interstate 84 northwest of Mountain Home. Surrounding Mountain Home and reaching nearly to Hammett, the middle Pleistocene plateau and canyon-filling basalts can be seen from Interstate 84. The rest of the landscape north of the river is composed mainly of middle Pleistocene lava-dammed Snake Plain lakebeds near the river and upper Pleistocene lava flows (USGS 1978).

Table 2. Geologic Time Scale

Geologic Time Scale			
Era	Subdivisions		Approximate age before present, millions of years
	Period	Epoch	
Cenozoic	Quaternary	Holocene (Recent)	0.011
		Pleistocene	1.8-0.011
	Tertiary	Pliocene	5-1.8
		Miocene	24-5
		Oligocene	38-24
		Eocene	54-38
		Paleocene	65-54
Mesozoic	Cretaceous		146-65
	Jurassic		208-146
	Triassic		248-208
Paleozoic	Permian		280-248
	Pennsylvanian		325-280
	Mississippian		360-325
	Devonian		408-360
	Silurian		438-408
	Ordovician		505-438
	Cambrian		540-500
Precambrian	No subdivisions recognized worldwide		3,500-540

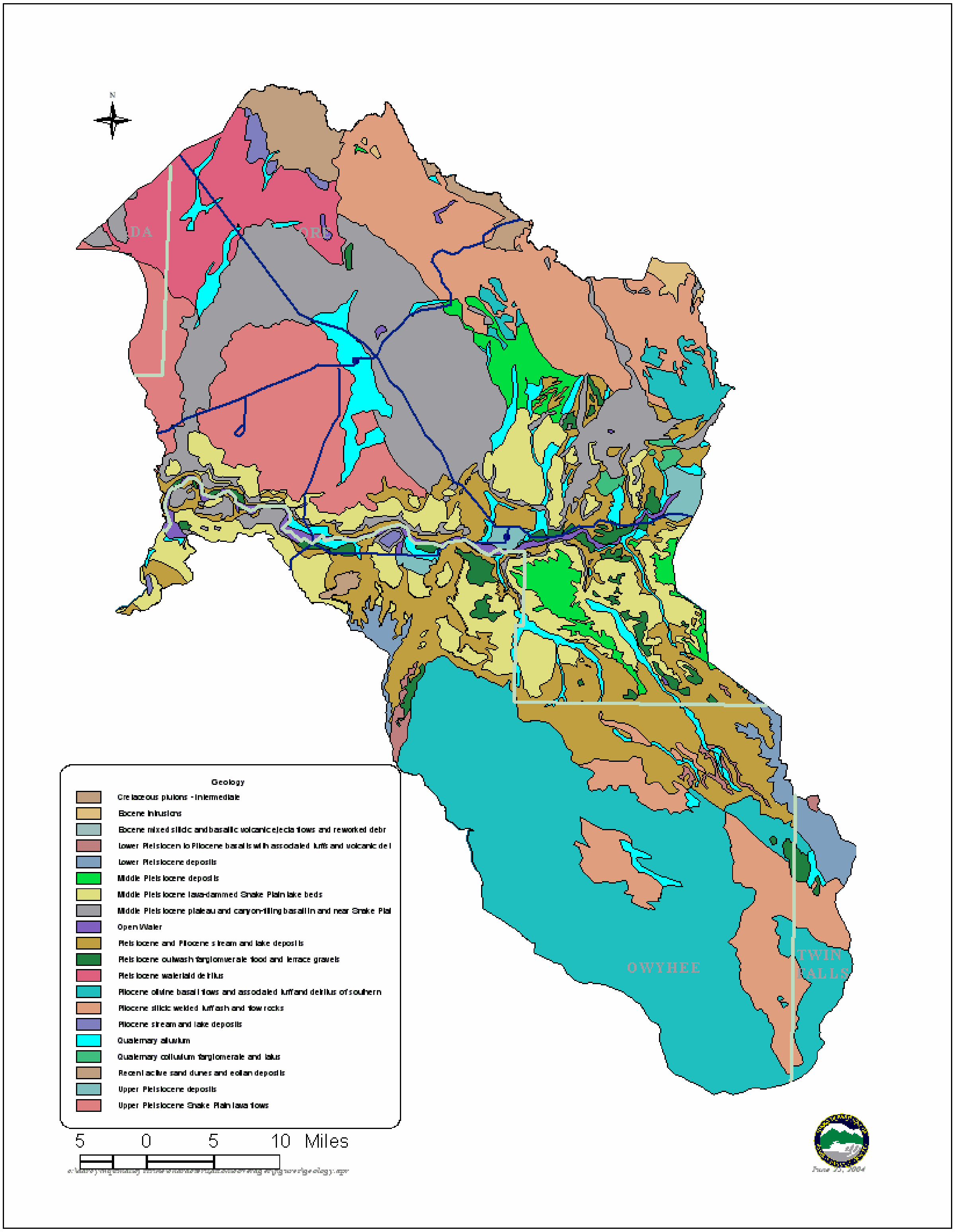


Figure 3. King Hill-C.J. Strike Subbasin Geological Data

Most of the geology south of the Snake River, in the King Hill-C.J. Strike subbasin, is from volcanic activity a little older than that north of the river. From the Saylor Creek Air Force Range, south through the Bruneau desert, the landscape is formed by Pliocene olivine basalt flows, with more silicic welded tuff ash to the east at the headwaters of Rosevear, Sailor, and Pothole Creeks. This is the type of landscape that formed Balanced Rock, because these basalts and welded tuffs are harder and more resistant to weathering (USGS 1978).

The Idaho Geological Survey has surveyed eastern Owyhee County and the proposed expansion of the Saylor Creek Bombing Range for mineral resources. Mineral resources include metallic mineral deposits and industrial materials, such as limestone, sand, and gravel.

Extended periods of volcanic activity provided heat and rare metals to the groundwater. When hot water circulated along fractures in rocks near the surface, gold and silver deposited in thick veins or hairline fractures. This type of epithermal gold and silver deposit has been discovered in western Owyhee County at DeLamar Mine. A rich source of gold has been found in eastern Oregon near Lake Owyhee where the gold is in sandy sediments interbedded with basalt. The geology in the current Saylor Creek Bombing Range is similar to this eastern Oregon site. The proposed expansion to the south of the present bombing range is underlain by basaltic rocks, which would mainly be a source of building materials, like flagstones and gravels (Idaho Geological Survey 2004).

From the legend in Figure 3, the “recent active sand dunes and eolian deposits” have been designated as the Bruneau Sand Dunes State Park. These dunes are unique in the Western Hemisphere. Other dunes in the Americas form at the edges of natural basins; these form near the center. The combination of a source of sand, a relatively constant wind activity, and a natural trap has caused sand to collect in this semicircular basin for over 20,000 years. Geologists believe the dunes seen today may have started with sands from the Bonneville Flood.

Unlike most dunes, these do not drift far. The prevailing winds blow from the southeast 28 percent of the time and from the northwest 32 percent of the time, keeping the dunes fairly stable. Two prominent dunes cover approximately 600 acres and rise 470 feet above ground level. The westernmost dune is reported to be the largest single-structured sand dune in North America (Digital Atlas of Idaho 2004).

Soils

The King Hill-C.J. Strike subbasin contains unconsolidated materials, including windblown dust, river sands and gravels, and talus. Soils derived from these unconsolidated materials range from silty clay loams to gravelly loams. Soils derived mainly from volcanic parent rock often have a stony surface above a hardpan horizon. Other finer-grained, poorly drained soils scattered throughout the region rise from the sedimentary deposits (Gehr et al. 1982).

Soils vary according to ecoregion, as shown in Figure 4. In the northernmost portion of the subbasin in the Danskin Range, the foothill shrublands-grasslands of the Idaho Batholith have mollisol and incepticol soil types with a xeric soil moisture regime. Mollisols are mineral soils that have developed under grasslands. Xeric mollisols have a soil moisture regime with cool moist winters and warm dry summers. Some water is present in the soil but not at optimum times for plant growth.

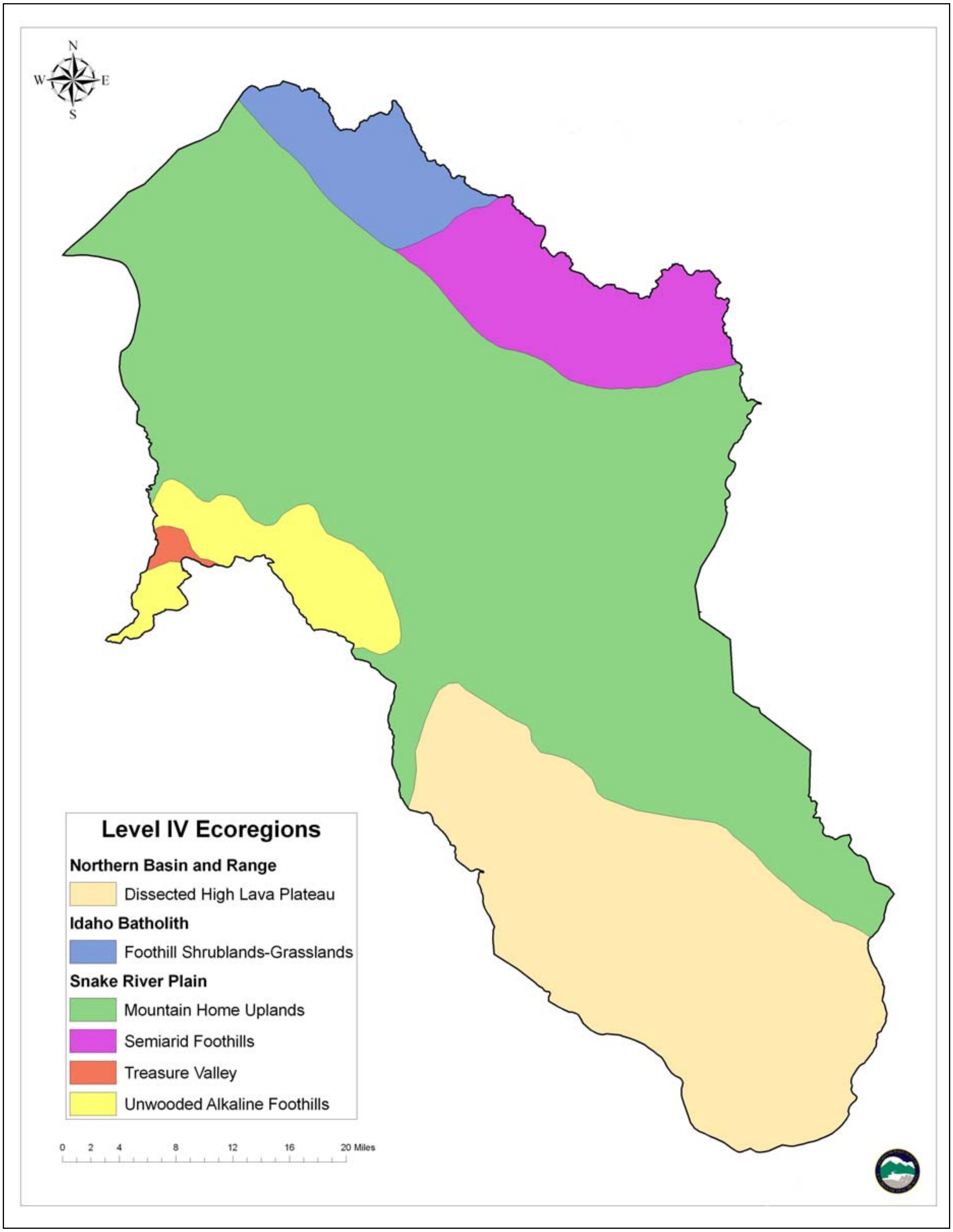


Figure 4. Ecoregions in the King Hill-C.J. Strike Subbasin

To the southeast of the Idaho batholith, in the Mount Bennett Hills, the semi-arid foothills of the Snake River Plain ecoregion contain mollisol and incepticol soil types with a xeric soil moisture regime. The incepticols are only in the steepest portions of this ecoregion.

Most of the King Hill-C.J. Strike subbasin is in the Snake River plain ecoregion, classified as the Mountain Home uplands, with aridisol soil types. Aridisols are mineral soils with an aridic moisture regime, which means that in average years, no water is available for plants for more than half the growing season. Aridisol soils are too dry for most plants. Plants growing in aridisols have to have some special adaptation for drought-tolerance, such as deep taproots or waxy leaf and stem surfaces to conserve water from evaporation. Some aridisols in the area have a salic horizon, which is an enrichment of a mineral soil with secondary salts that are soluble in cold water.

The unwooded alkaline foothills along the Snake River corridor have sandy, alkaline lacustrine deposits with three different soil types occurring in this ecoregion: aridisols, mollisols, and entisols with aridic and xeric moisture regimes. Entisols are characteristic of flood plains, having no diagnostic horizons because these soil types have been so recently deposited. As discussed previously, aridic regimes have water available for only half of the typical growing season; xeric moisture regimes have cool, moist winters with warm, dry summers, so that some water is present in the soil, but not at optimum times for plant growth.

To the south of the subbasin is the dissected high lava plateau ecoregion of the Northern Basin and Range. Here, the soils are aridisols and mollisols with aridic and xeric soil moisture regimes.

Vegetation

Just as soil types vary according to ecoregion, so too do plant types vary. In the foothill shrublands-grasslands of the Idaho batholith, potential natural vegetation is shrub-steppe with bluebunch wheatgrass (*Pseudoroegneria spicata*), basin big sagebrush and Wyoming big sagebrush (*Artemisia tridentata* ssp. *tridentata* and *Artemisia tridentata* ssp. *wyomingensis*), Thurber needlegrass (*Stipa thurberina*), Idaho fescue (*Festuca idahoensis*), bitterbrush (*Purshia tridentata*), and mountain snowberry (*Symphoricarpos oreophilus*). In a project that classified current conditions of low-elevation shrub-steppe vegetation (Rust 2003), the present plant associations in this area are as follows:

- Bluebunch wheatgrass-Sandberg bluegrass (*Poa secunda*), balsamroot daisy (*Balsamorhiza sagittata*) association
- Little sagebrush (*Artemisia arbuscula*) series
- Mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*)-mountain snowberry/Idaho fescue association
- Idaho fescue series
- Bitterbrush series

Comparing the potential natural vegetation with the present vegetation, this area has a healthy shrub-steppe with a good perennial understory of native grasses and forbes.

In the Mount Bennett Hills, the semi-arid foothills of the Snake River Plain ecoregion also contain a healthy shrub-steppe with a good perennial understory of native grasses and forbes. Here, the existing plant associations are:

- Little sagebrush-bitterbrush/bluebunch wheatgrass association
- Idaho fescue-Geyer's sedge (*Carex geyeri*)/silvery lupine (*Lupinus argenteus*)
- Needlegrass (*Stipa occidentalis*)/silvery lupine (Rust 2003).

Healthy shrub-steppe conditions in these two ecoregions may be due to the relatively higher altitudes with higher moisture availability. Other reasons may include lighter grazing pressure or inaccessible areas surrounded by difficult topography.

In the Mountain Home uplands ecoregion of the Snake River plain, potential natural vegetation is Wyoming and mountain big sagebrush, alkali sagebrush (*Artemesia longiloba*), and bitterbrush. On salty, high-mineral soils, the natural shrub species will be four-wing saltbrush and greasewood. Current conditions over most of this ecoregion are a desertified shrub-steppe (West 1999) where existing shrubs have introduced, weedy annuals in the understory. The weedy annuals are dominated by cheatgrass (*Bromus tectorum*), which has been introduced since the 1870s. Native plant regeneration is limited by low available moisture. Livestock can be used in the spring to reduce cheatgrass, but grazing at that time may also reduce any chance the native understory has of recovering (West 1999).

In the unwooded alkaline foothills of the Snake River plain, the potential natural vegetation is greasewood (*Sarcobatus vermiculatus*), shadscale saltbush (*Atriplex confertifolia*), inland saltgrass (*Distichlis spicata*), and desert seepweed (*Suaeda suffrutescens*) on the salty, high-mineral soils. On the sandy sediments that are not so alkaline, Wyoming big sagebrush can potentially occur with bluebunch wheatgrass, Thurber needlegrass, and Indian ricegrass (*Oryzopsis hymenoides*) in the understory. Current conditions have more weedy annual cheatgrass in the understory with some crested wheatgrass (*Agropyron spicatum*) introduced to increase forage production.

Introducing perennial grasses is a common management practice to rehabilitate shrub-steppe areas. Rehabilitation of burned rangeland and land treatments for forage production are successful with nonnative perennial grasses, such as crested wheatgrass or intermediate wheatgrass (*Agropyron intermedium*) because these nonnative species can germinate and survive with less than 12 inches of annual precipitation. However, areas with introduced perennial grasses may have less wildlife diversity than shrub-steppe with native grasses and forbes. If rehabilitation efforts are planned, including seed for native grasses and forbes is advisable.

The dissected high lava plateau of the Northern Basin and Range ecoregion to the south of the subbasin has been extensively rehabilitated with either crested wheatgrass in monocultural grasslands, or as an understory to the native Wyoming big sagebrush. Naturally, the understory in this region would have included Thurber needlegrass, bluebunch wheatgrass, and western wheatgrass.

Aquatic Life

Sensitive species in the King Hill-C.J. Strike subbasin include the white sturgeon (*Acipenser transmontanus*) and the Idaho Springsnail (*Pyrgulopsis idahoensis*). The white sturgeon is listed as a species of special concern by the State of Idaho (Idaho Conservation Data Center 2004) and a species of concern by the U.S. Fish and Wildlife Service. Most of the white sturgeon in this subbasin are in the reservoir, with the highest population in the upper reaches at river miles 504 and 505. Idaho Power Company has indicated that the viability of this population is dependant on the canyon reach of the Snake River from Bliss Dam to King Hill-Glenns Ferry. The Idaho Springsnail is listed as endangered under the Endangered Species Act. It has been found in both the Snake River and Bruneau River arms of the C.J. Strike Reservoir. Even though it is identified as a cold water species, Idaho Power has found the Idaho Springsnail in water temperatures greater than 22°C (Idaho Power 1998). The Idaho Springsnail once occupied the ancient Lake Idaho, so its habitat has been reduced since the ancient lake was drained by the Bonneville flood. In recent times, its habitat may be further reduced by hydroelectric facilities (although this is currently being evaluated) and degraded water quality creating a loss of habitat. This species feeds on plant debris and microorganisms.

Idaho Power Company has entered into agreements with the U.S. Fish and Wildlife Service for management of these sensitive species in the following documents:

- *Mid Snake River Offer of Settlement*—directs that additional studies and analysis are needed for Idaho Springsnail.
- *Snake River White Sturgeon Conservation Plan*, with both U.S. Fish and Wildlife Service and Idaho Department of Fish and Game—outlines management of population.

C.J. Strike Reservoir is utilized as a sport fishery, with smallmouth bass (*Micropterus dolomieui*) being the most abundant game fish sampled. The Bruneau arm of the reservoir is dominated by game fish species and has a higher concentration of fishes. The Idaho Department of Fish and Game and Idaho Power Company stock the reservoir with rainbow trout. There is no known suitable spawning habitat available in the reservoir for naturally-reproducing populations of rainbow trout (Idaho Power 1998).

In the Snake River, the U.S. Geological Survey (USGS) has collected fish species data at King Hill in an on-going study for the last nine years. These data show that main stem Snake River populations are dominated by native, non-game, cool-water species (Table 3 and Figure 5).

Table 3. Fish species data collected by USGS, Snake River at King Hill.

King Hill Fish Population USGS data Total individuals from 1993-2002						
Scientific Name	**Common name**	**Count**	**Native**	**Tolerance**	**Temperature preference**	**Habitat type**
Oncorhynchus mykiss	Rainbow trout	3	Native	S	Cold	hider
Prosopium williamsoni	Mountain whitefish	22	Native	I	Cold	benthic
Acrocheilus alutaceus	Chiselmouth	252	Native	I	Cold	benthic
Cyprinus carpio	Common carp	225	Alien	T	Warm	benthic
Mylocheilus caurinus	Peamouth	25	Native	I	Cool	water column
Ptychocheilus oregonensis	Northern pikeminnow	480	Native	T	Cool	water column
Rhinichthys cataractae	Longnose dace	6	Native	I	Cool	benthic
Rhinichthys falcatus	Leopard dace	6	Native	I	Cool	benthic
Rhinichthys osculus	Speckled dace	127	Native	I	Cool	benthic
Richardsonius balteatus	Redside shiner	390	Native	I	Cool	water column
Catostomus columbianus	Bridgelip sucker	54	Native	T	Cool	benthic
Catostomus macrocheilus	Largescale sucker	1276	Native	T	Cool	benthic
Micropterus dolomieu	Smallmouth bass	41	Alien	I	Cool	water column
Micropterus salmoides	Largemouth bass	5	Alien	T	Warm	water column
Pomoxis annularis	White crappie	55	Alien	T	Warm	water column
Pomoxis nigromaculatus	Black crappie	8	Alien	T	Warm	water column
Perca flavescens	Yellow perch	7	Alien	I	Cool	water column
Cottus bairdi	Mottled sculpin	140	Native	I	Cool	benthic

S: sensitive, T: tolerant, I: intolerant

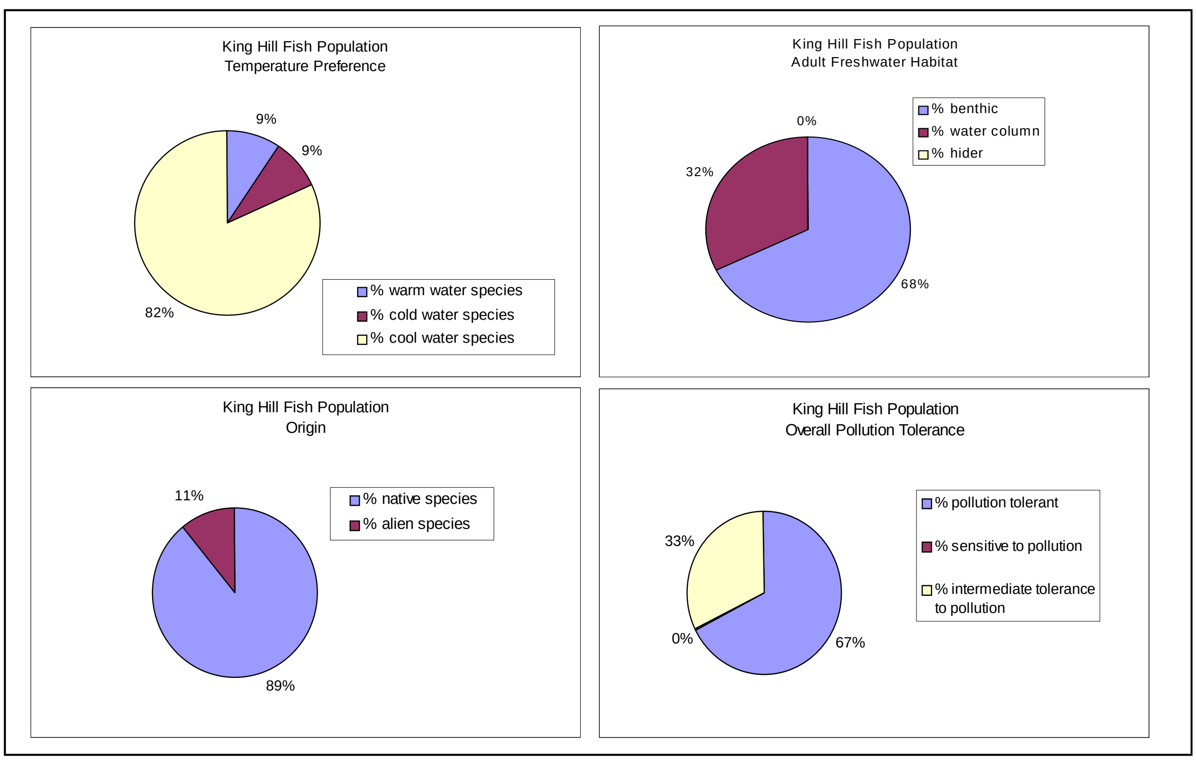


Figure 5. Categorization of fish species at King Hill.

In the tributaries of the King Hill-C.J. Strike subbasin, the only salmonid generally present is redband trout. Redband trout are a variety of rainbow trout that are adapted to the warmer waters of desert watersheds. Although exceedances in the salmonid spawning criteria of Idaho's water quality standards may occur, redband trout are successfully propagating. Figure 6 shows the tributaries where populations of redband trout occur.

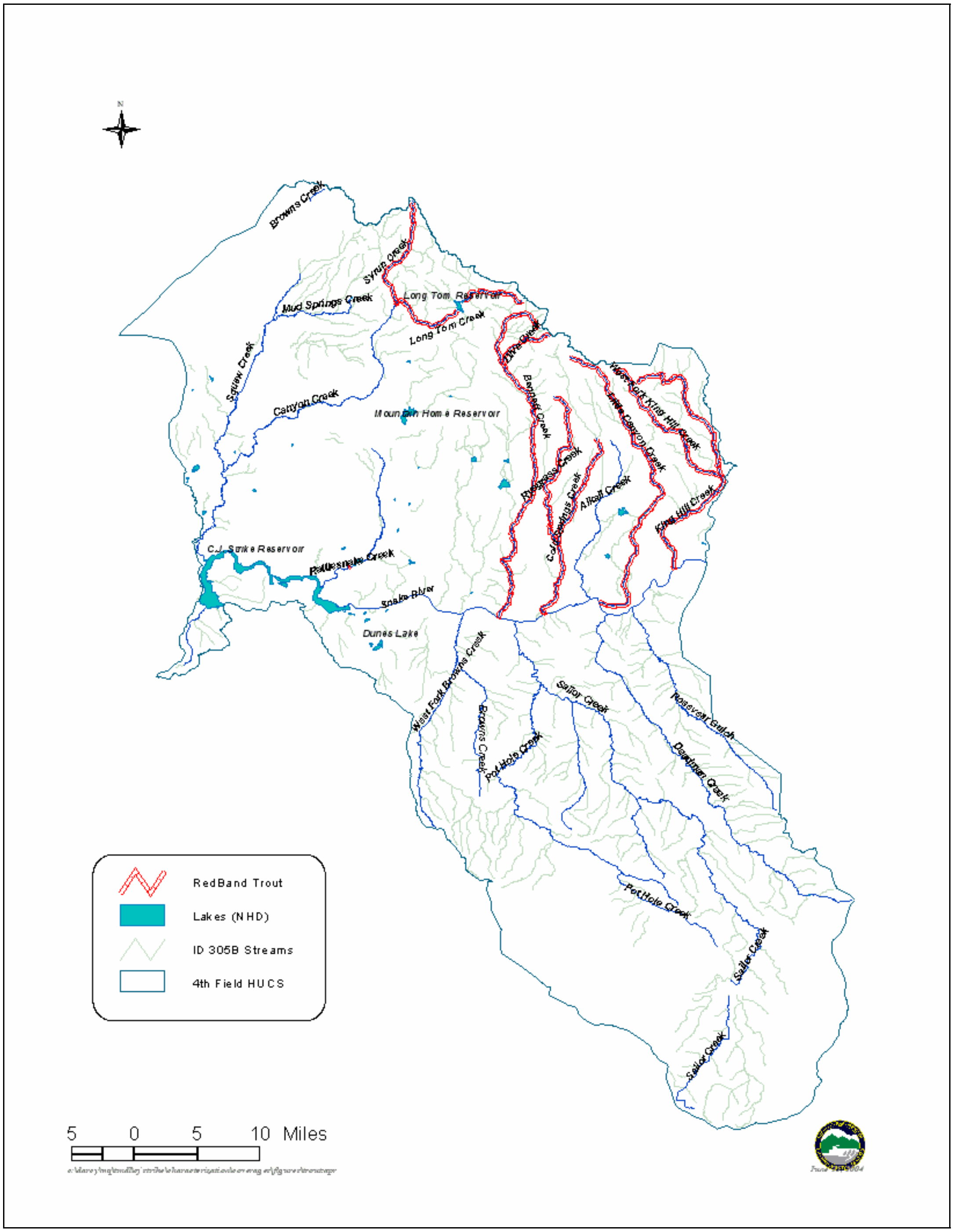


Figure 6. Redband trout distribution.

Subwatershed Characteristics

The primary stream in the King Hill-C.J. Strike subbasin is the Snake River. The importance of the river is enhanced because tributaries contribute very minor stream flow to the watershed. Commonly, water flowing from the mountain valleys does not reach the Snake River in tributary drainages but disappears from the surface and enters the aquifer (Gehr 1982). See Figure 7 for the watersheds in this subbasin.

In cooperation with other agencies, the Idaho Department of Water Resources (IDWR) is currently in the process of updating the numbering system and boundaries of the watersheds in this subbasin. Any discrepancies in the current numbering system of the 5th and 6th field watersheds will be resolved in this review and revision process. The topographic statistics for the watersheds are given in Table 4, which shows fifth level hydrologic unit codes (HUCs) for the watersheds in the subbasin.

Table 4. Characteristics of the major HUC 5 watersheds in the King Hill-C.J. Strike Subbasin.

HUC 5 code	HUC 5 name	Area (square miles)	Stream miles	Mean elevation (ft)	Minimum elevation (ft)	Mean stream gradient (%)
1705010101	Lower C.J. Strike Reservoir	144.92	290.12	4232.84	3158.64	2
1705010102	Fraser Reservoir	111.90	207.45	4219.72	3739.20	2
1705010103	Bowns Creek	191.84	390.48	3665.40	2486.24	2
1705010104	Ditto Creek	167.90	299.26	4498.52	2469.84	5
1705010105	Long Tom Reservoir	196.54	355.72	3409.56	2469.84	3
1705010106	Mountain Home Reservoir	187.60	463.72	4931.48	2463.28	6
1705010107	Middle C.J. Strike Reservoir	214.95	419.65	4895.73	2460.00	5
1705010108	Dry Creek	271.76	321.93	3926.16	2446.88	3
1705010109	Browns Creek	198.57	463.95	4114.76	2935.60	3
1705010110	Bennett Creek	122.41	99.48	2907.72	2450.16	2
1705010111	Sailor Creek	203.03	312.10	4465.06	2453.44	5
1705010119	Pot Hole Creek	74.46	137.69	4529.68	4014.72	1

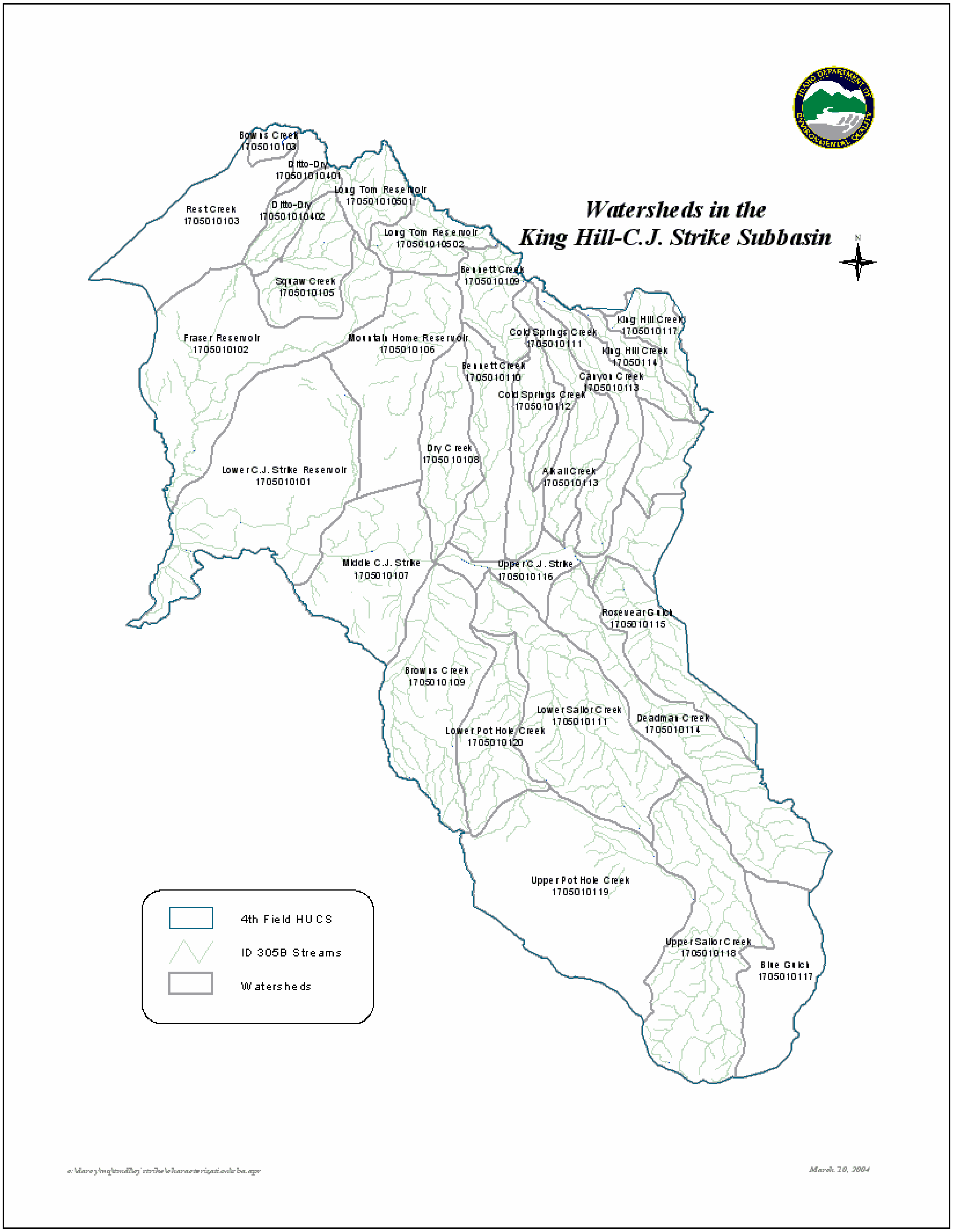


Figure 7. Watersheds in the King Hill-C.J. Strike Subbasin

Stream Characteristics

Snake River

The Snake River originates at 9,500 feet, along the continental divide in Wyoming, and flows 1,038 miles to the confluence with the Columbia River in Pasco, Washington. The King Hill-C.J. Strike reach begins at river mile 547 at King Hill and ends at river mile 494 at the C.J. Strike Dam for a total length of 53 river miles. The Snake River is a large volume, n^{th} order (greater than fifth order) river that is one of the most important water resources in the state. The King Hill-C.J. Strike reach is an important agricultural, recreational, and wildlife resource as well as a hydroelectric power source. In this reach, the river flows through basalt canyons, rangeland, and agricultural land. The channel shape varies from being confined in the canyons to wide single channel areas with extensive floodplains and meandering channels with island complexes.

The USGS stream gauging program has continually collected streamflow data at King Hill, from 1910 to the present time. Figure 8 shows the mean monthly flows from 1992-2002. A coarse water balance can be also computed from the major irrigation withdrawals and tributary flows from the most recently gauged data (Figure 9.)

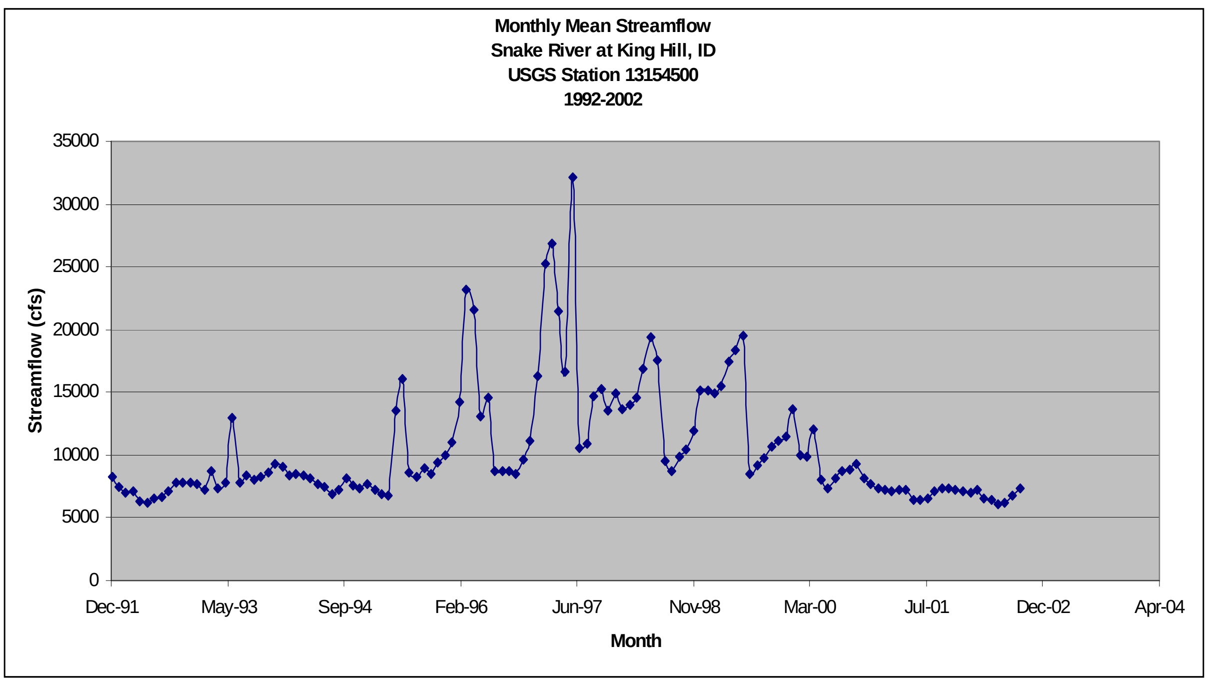
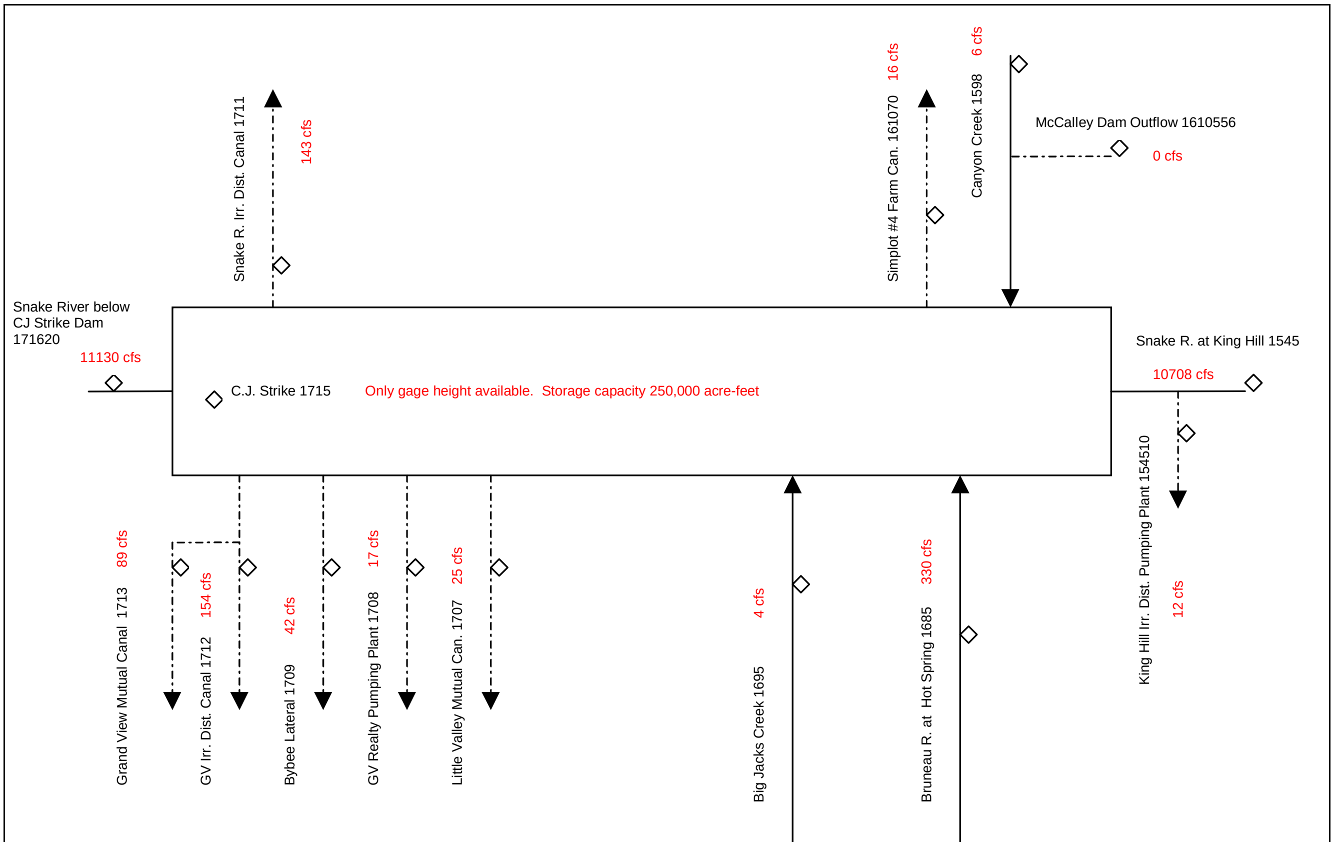


Figure 8. Hydrograph of USGS streamflow data for Snake River at King Hill.



Mean discharge based on yearly average streamflow data for the most recently-recorded 10-year period.

Change in storage = Δin – Δout

Change in storage = (10708 + 36 + 330 + 4) – (0 + 16 + 25 + 17+ 89 + 11130) = 11078-11277 = -199

Net loss of 199 cfs annual average discharge for last 10 years in watershed.

Figure 9. Water balance of the King Hill-C.J. Strike subbasin from USGS stream flow data.

Tributaries

The Idaho DEQ Beneficial Use Reconnaissance Program (BURP) has collected most of the data describing the tributaries in the King Hill-C.J. Strike subbasin. The BURP Data describing some of the stream channels surveyed is given in Table 5. Major streams in the subbasin are shown in Figure 10.

Table 5. Beneficial Use Reconnaissance Program channel characteristics.

Stream Name	BURP Identification Numbers	Dates surveyed	Morphology (Rosgen)	Stream sinuosity	Channel shape
Alkali Creek	1996SBOIA002 1996SBOIA003 1996SBOIA004 2003SBOIA018	6/5/1996 6/5/1996 6/5/1996 (Dry) 7/23/2003 (Dry)	Rosgen D to F	Moderate	Trough-like valley
Bennett Creek	1993SBOIA054 1997SBOIC016 2003SBOIA013 2003SBOIA037	5/23/1993 9/8/1997 (Dry) 7/22/2003 (Dry) 8/26/2003	Rosgen C	Moderate to low	U-shaped
Browns Creek	1995SBOIA061 1998SBOIB002 2003SBOIA011	5/31/1995 (Dry) 6/10/1998 (Dry) 7/21/2003 (Dry)	--	--	--
Canyon Creek	2003SBOIA034	8/20/2003	--	Low	--
Cold Springs Creek	1995SBOIA002 1997SBOIC023 1997SBOIC024 2003SBOIA015 2003SBOIA016	5/30/1995 9/11/1997 (Dry) 9/11/1997 (Dry) 7/22/2003 (Dry) 7/22/2003	Rosgen C	Low to moderate	Trough-like valley
Deadman Creek	1995SBOIA060 1998SBOIB004	5/31/1995 (Dry) 6/10/1998 (Dry)	--	--	--
King Hill Creek	1997SBOIC022 2003SBOIA019	9/11/1997 7/28/2003	Rosgen B	Low to moderate	V-shaped valley
Little Canyon Creek	1993SBOIA044 1993SBOIA045 1997SBOIC017 1997SBOIC018 2003SBOIA002 2003SBOIA034	7/16/1993 7/16/1993 9/8/1997 9/8/1997 7/2/2003 8/20/2003	Rosgen B to E	Moderate	Flat-bottomed valley
Long Tom Creek	2003SBOIA017	7/23/2003	Rosgen B	Low	--
Pony Creek	1998SBOIB019 2003SBOIA036	6/25/1998 8/26/2003 (Dry)	Rosgen B	Moderate	V-shaped valley
Ryegrass Creek	1996SBOIA001 1996SBOIB001 1996SBOIB002 2003SBOIA014	6/4/1996 6/4/1996 6/5/1996 7/22/2003 (Dry)	Rosgen B to D	Moderate	Trough-like valley
Sailor Creek	1995SBOIA063 1998SBOIB003	5/31/1995 (Dry) 6/10/1998 (Dry)	--	--	--
Unnamed tributary to Pot Hole Creek	2003SBOIA012	7/21/2003 (Dry)	--	--	--

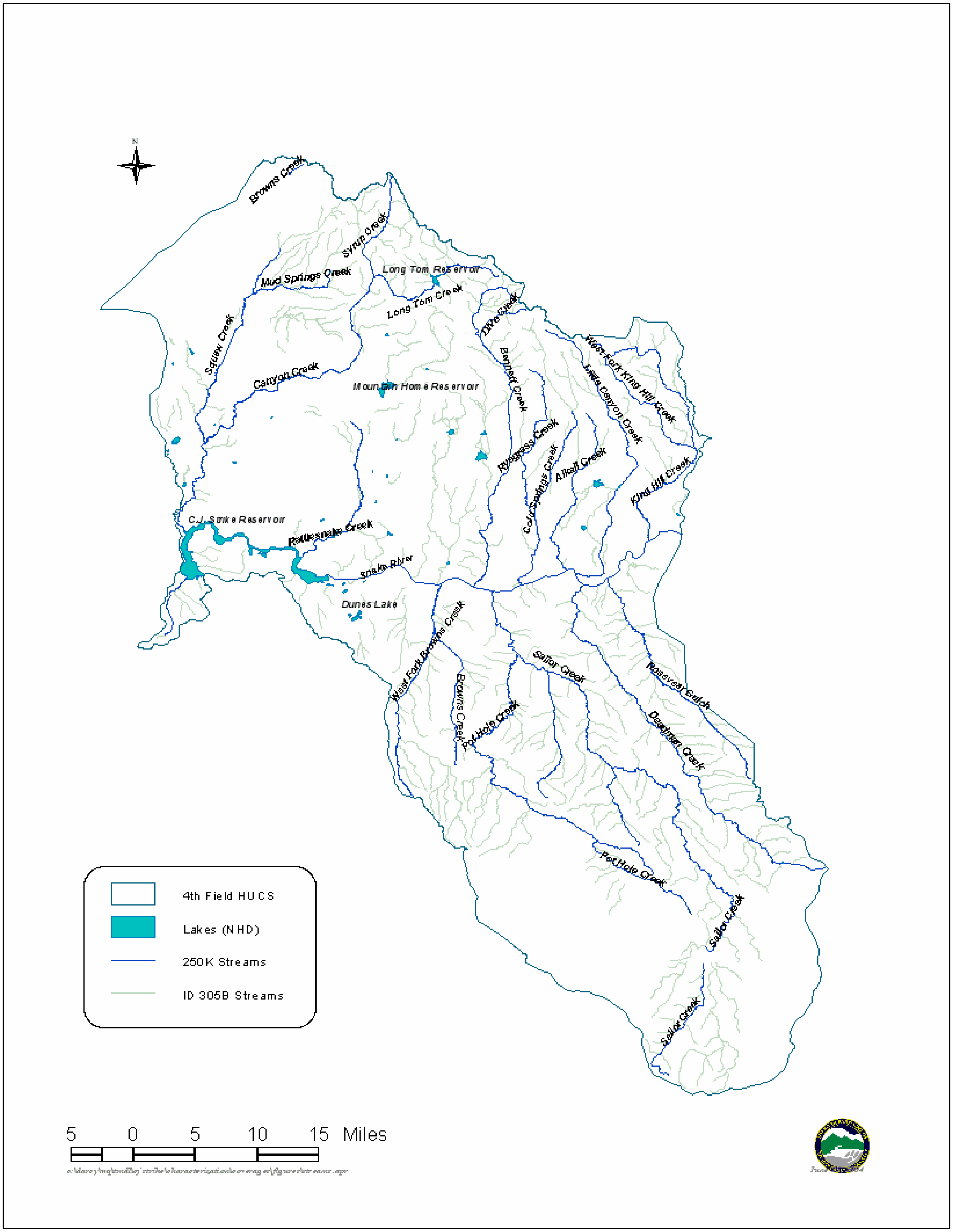


Figure 10. Major Streams in the King Hill-C.J. Strike Subbasin.

Ground Water

The King Hill-C.J. Strike subbasin lies within the Snake River Plain Aquifer, which covers an area over 10,000 square miles and contains over twice the volume of water in Lake Erie. It is the largest aquifer in Idaho and may be one of the most productive in the world, consisting of numerous interconnected ground water systems. In the King Hill-C.J. Strike subbasin, the western Snake River plain aquifer is composed of permeable sand and gravel aquifers overlaid with impermeable clay layers. Water moves through pore spaces of sand or gravel and often exhibits positive pressure, meaning that a well drilled through the confining clay layer will be an artesian well.

In the King Hill-C.J. Strike subbasin, there are three ground water management areas:

1. The Cinder Cone Butte Critical Ground Water Area
2. The Mountain Home Ground Water Management Area
3. The Grand View-Bruneau Ground Water Management Area

Ground water is managed by the Idaho Department of Water Resources (IDWR). *Critical Ground Water Areas* (a portion of the aquifer does not contain enough water for current and projected uses) are designated according to Idaho Code § 42-226 and 42-233a, and *Ground Water Management Areas* (approaching the conditions of a Critical Ground Water Area) are designated according to Idaho Code § 42-233b. Once designated, the Director of IDWR can deny an application for a proposed use and may require diversion and water use reporting within the Critical Ground Water Management Area. A new application for a proposed use will be approved only if the Director of IDWR determines that a sufficient supply of ground water is available for the use of the water (Harrington 1999).

A 1982 IDWR ground water investigation in the Mountain Home plateau determined that a perched aquifer and a larger regional aquifer would not supply sufficient resource for the use of that time. A water budget calculation showed that withdrawals exceeded recharge by 600 acre-feet per year under 1980 conditions. As a result of this study and continued data collection, IDWR recommended that the perched and regional aquifers should be protected by Ground Water Management Area designation (Norton 1982). In 1981, the Cinder Cone Butte Critical Ground Water Area was designated. In 1982, the surrounding aquifer was designated as the Mountain Home Ground Water Area (Harrington 1999).

In the perched aquifer, ground water levels have varied according to the climate and seasonal cycles. Overall, the perched aquifer has been relatively stable. In the regional aquifer, ground water levels have shown the following trends (Harrington 1999):

- Water levels in the southern and eastern portions of the aquifer, near the Mountain Home Air Force Base, have experienced:
  - steep declines in the late 1960s and early 1970s,
  - stability in the mid-1970s to early 1980s, and
  - declines from the mid-1980s through to 1996, the time of the report.
- Water levels in the north central portion of the aquifer have declined since 1976.

- Water levels in the northwest portion of the aquifer have been stable and increased slightly since 1966.

Hydrographs of all monitored ground water levels in these management areas can be found at the IDWR website (www.idwr.state.id.us/hydrologic/projects/gwma).

1.3 Cultural Characteristics

Watersheds are affected by cultural characteristics in that human activities have affected land use. Cultural features include the history of the area, the past and current economic climate, and the distribution of the population within the watershed.

In the King Hill-C.J. Strike subbasin, land is predominantly rangeland managed by the Bureau of Land Management (BLM) Lower Snake River District. Other than the major population centers at Mountain Home and Mountain Home Air Force Base, the subbasin is mainly rural with a very sparse population.

History and Economics

Territories of the Western Shoshone and Northern Paiutes often collectively called the *Bannock Indians*, overlapped in the C.J. Strike area. Archaeological data shows that occupation density was higher in the canyon areas, with winter camps and cache pits. The Snake River Plain had the lowest population density with small, temporary campsites. The Mount Bennet hills show 7,000 years of occupation, mainly for temporary fall use of hunting and gathering, specifically butchering, berry and seed preparation, and hunting complexes.

Here is evidence of open campsites with lithic scatters, a few quarries and rock alignment structures, some rock art, and a few rock shelters. These inhabitants followed the “Desert Culture” way of life, with a sparse population of small groups in a migratory seasonal hunting and gathering pattern. Food collection was non-specialized, with an intensive exploitation of the total environment. Small seeds from sunflower, goosefoot, and Indian ricegrass were harvested and prepared. The inhabitants also collected roots, chokecherries, and service berries. Fishing was seasonal at Glenns Ferry and the Bruneau River with weirs, hooks, nets, and spears. They also hunted deer, elk, and bighorn sheep when available.

Lifestyles changed significantly in the early 1700s, with the introduction of the horse, increasing the effective range of nomadic groups by increasing their mobility. Also at this time, the Bannocks began contacting other groups for trade.

Significant milestones in Idaho history left the King Hill-C.J. Strike subbasin relatively untouched compared to travel centers like Fort Hall and Fort Boise. For instance, the fur trade from 1810 to 1839 had only peripheral contact in this area. During the overland migration and settlement era from 1840 to 1859, southern Idaho was an obstacle to travel rather than a destination. During summer, when emigrant trains passed through the Snake River valley, the native inhabitants were mostly in the mountains for hunting and collecting. The western Shoshone and northern Paiutes feared and avoided the whites, so these populations were not as affected by smallpox and cholera epidemics as other native populations elsewhere. However, they experienced more starvation because the presence of the emigrants made food collection more difficult.

The Oregon Trail passed through this subbasin, with the most popular campsites mainly outside the watershed boundaries. Stops along the North Trail Segment included the following:

- Salmon Falls Creek
- Salmon Falls
- Big Pilgrim Gulch
- Three-Island Crossing
- Boise Valley

Stops along the Southern Sinker Creek segment of the Oregon Train included these spots:

- Bruneau Crossing
- Castle Creek
- Walter’s Ferry
- Givens Hot Springs

Goodale’s Cutoff of the Oregon Trail entirely bypassed this subbasin, traveling to the north through the Camas Prairie.

Most of the significant events of the mining frontier and Snake Indian wars of 1860 through 1879 were peripheral to this region. However, the Bannock War of 1878 occurred at Bennett Creek, marking the last major Native American resistance to white settlement in the region, the dispute being mainly over use of the Camas Prairie. The Bannock War resulted in the remaining resistant Bannocks being sent to Fort Hall. Today, the Shoshone-Paiute tribes are consolidated on 289,819 acres of tribal land on Duck Valley Reservation, and the Shoshone-Bannock tribes are on 544,000 acres on Fort Hall Indian Reservation.

After hostilities ceased, farm settlement and development began. The 1877 Desert Land Act enabled agriculture in this area by allowing a resident to file ownership on up to 320 acres and patent the holding when it was developed. Another settlement phase followed railroad building, with town sites growing along the Oregon Short Line. After statehood, in 1890, the Carey Act of 1894 allowed reclamation of desert lands by approving irrigation and reclamation projects. Extensive irrigation projects used the abundant water supply from the Snake River. Agricultural settlements formed around irrigation made possible near creeks or the Snake River. Even the current population centers of Elmore and Owyhee Counties are an intensified pattern of this irrigation-based settlement.

In 1934, the Taylor Grazing Act allowed the management of rangelands to control grazing. Before the Taylor Grazing Act, there was vigorous competition between ranchers and sheepherders for land. The act required a fixed base of operations rather than entirely nomadic herds. The next development in rangeland management came when the Taylor Grazing Service and the General Land Office merged, in 1946, to form the Bureau of Land

Management (BLM). More comprehensive planning for rangelands came in 1976, with the Federal Land Policy and Management Act, which mandated multiple use and sustained yield of resources.

Land Ownership, Cultural Features, and Population

Most of the land in the King Hill-C.J. Strike subbasin is managed by BLM (Table 6 and Figure 11), with 64% of the total land area. Privately-owned land is 22% of the land area, with smaller percentages managed by the State of Idaho and Department of Defense (USGS 2002).

Table 6. Land Ownership in the King Hill-C.J. Strike Subbasin.

Land Owner	Area (square miles)	Area (percentage)
BLM	1,366.94	64
Private	462.88	22
State of Idaho	152.85	7
Department of Defense	132.42	6
Open Water	14.74	< 1
U.S. Forest Service	2.96	< 1
Total land area	2,132.79	--

The Department of Defense owns land used for the Mountain Home Air Force Base (MHAFB) and the Saylor Creek Range. The MHAFB provides the most significant employment in the area, with 4,666 people from Mountain Home working for national defense (Idaho Department of Commerce 2004). First built as the Mountain Home Army Air Field in 1943, the MHAFB is now home to the 366th Fighter Wing, and the Saylor Creek Range is the existing training range for the 366th Wing. Consisting of approximately 110,000 acres total, the exclusive use area of 12,200 acres, located in a fenced area near the center of the range, includes all of the training targets. A buffer zone of about 97,800 acres surrounds the exclusive use area and is used mainly for livestock grazing and hunting.

The two significant towns in the subbasin are Mountain Home and Glenns Ferry. Table 7 gives some demographic information, from the Idaho Department of Commerce, about these towns.

Where junction, where once Idaho Highway 20 met the old Oregon Trail and the old Boise stage road, was known as Rattlesnake Station, which is the original site of Mountain Home. Mountain Home moved to its current location when the Oregon Short Line Railroad arrived in the area in 1883 and became the Elmore County seat in 1891.

Table 7. Demographics of Mountain Home and Glenns Ferry

Community	2002 Population	Top Five Employers
Mountain Home	11,531	U.S. Air Force Base - 4,666 Mountain Home School District – 500 Wal-Mart – 300 Elmore Medical Center – 198 Simplot Livestock - 150
Glenns Ferry	1,571	Magic West Potato – 180 Glenns Ferry School District – 85 Health Electronics – 35 Idaho Circuit Technology – 35 Carmela Winery - 29

Glenns Ferry was incorporated in 1909 but has a history back to 1834 and the establishment of the Oregon Trail. On the trail between Fort Hall and Fort Boise, the Three Island Ford was a place for wagon trains to cross the Snake River. In 1863, Gus Glenn began operating a ferry across the Snake River about two miles above Three Island Ford. The ferry was used to move freight from Utah to Boise but was outmoded when the Oregon Short Line Railroad arrived and became the main means of transport.

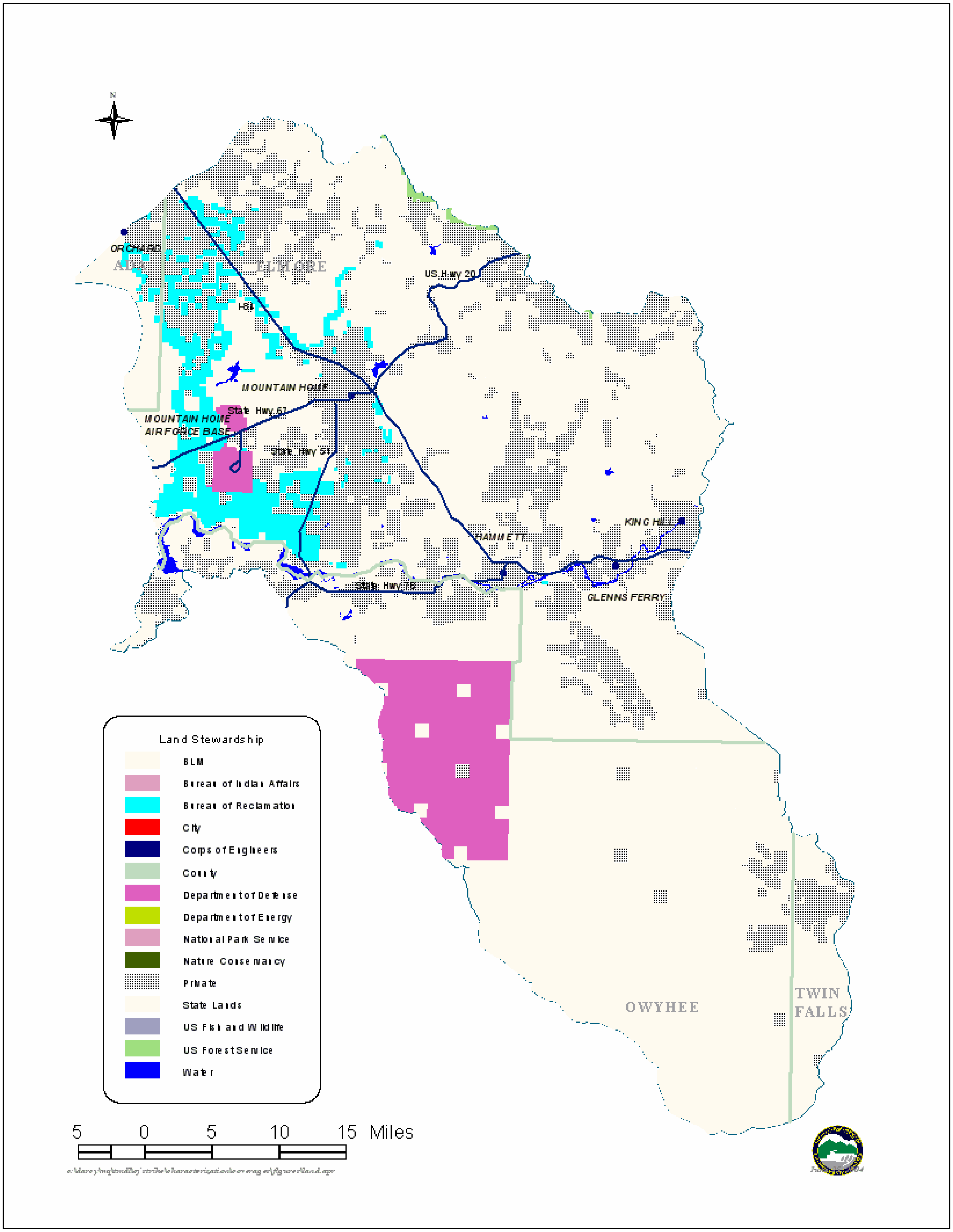


Figure 11. Land Ownership in the King Hill –C.J. Strike Subbasin.

Land Use

As indicated in Table 8 and Figure 12, most of the land (86%) in the King Hill-C.J. Strike subbasin is used for rangeland. Of that 86%, the Bureau of Land Management manages the vast majority. Grazing management practices and facilities are typically implemented locally on an allotment or watershed basis. Grazing management programs are based on a combination of appropriate grazing management practices and facilities developed through consultation, coordination, and cooperation with the Bureau of Land Management, permittees, other agencies, Indian tribes, and interested publics.

Table 8. Land Use in the King Hill-C.J. Strike Subbasin

Land Use		Area (square miles)		Area (percentage)
Rangeland		1,835.72		86%
Irrigated – Sprinkler Irrigated - Gravity	Total Irrigated	163.47 34.19	197.66	9%
Riparian		38.78		2%
Dryland Agriculture		35.35		2%
Open Water		8.52		<1%
Township		7.36		<1%
Bare Rock		5.35		<1%
U.S. Forest Service		4.04		<1%
Total land area		2,132.79		--

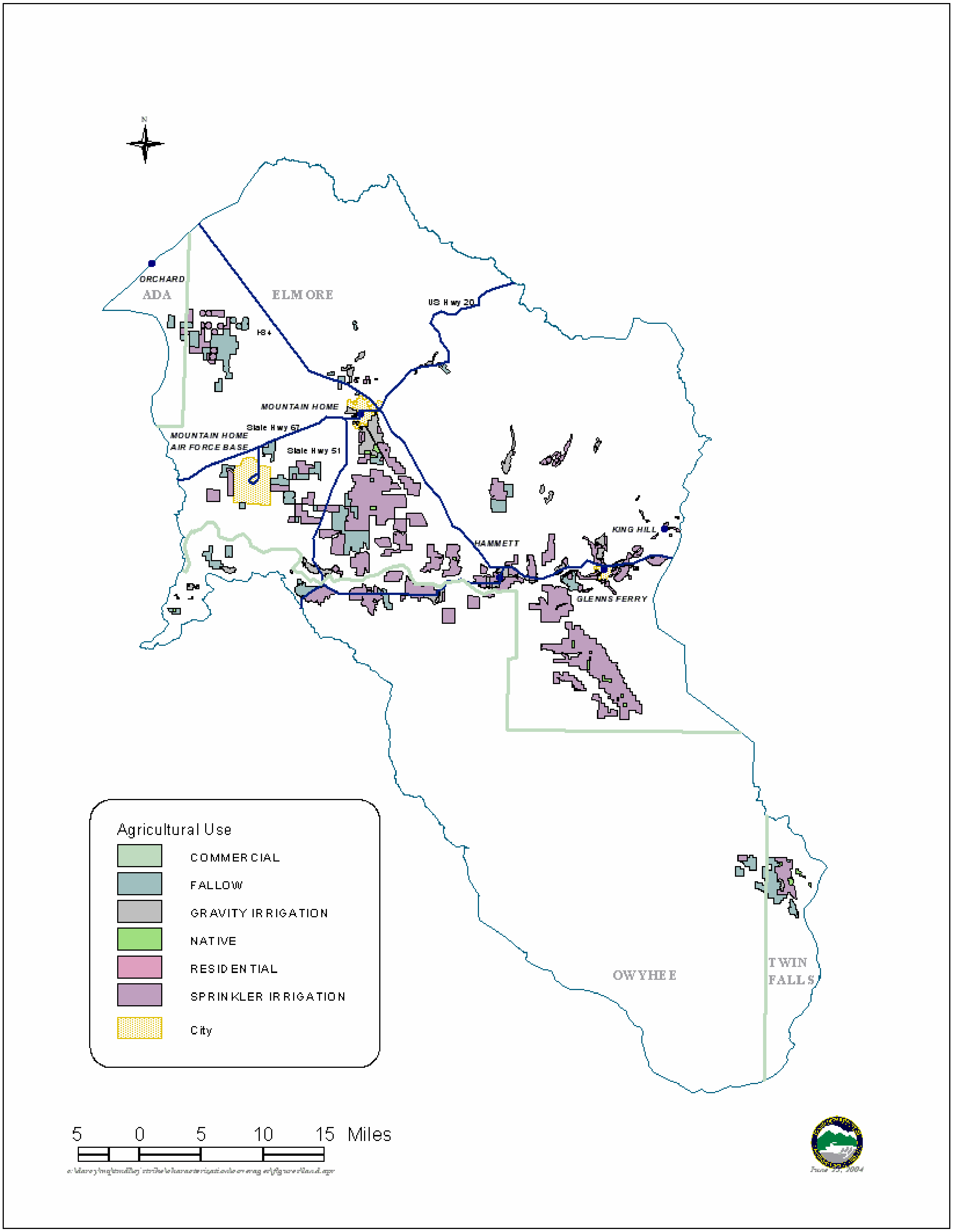


Figure 12. Land Use in the King Hill-C.J. Strike Subbasin.

Water Resource Activities

One of Idaho Power's 17 hydropower projects on the Snake River and its tributaries is the C.J. Strike Project. Located on the Snake River at river mile 494, just below the confluence of Bruneau River with the Snake, it is about 20 miles southwest of Mountain Home, and 7 miles east of Grand View. Idaho Power began constructing the C.J. Strike Project in 1950, the project was named after Clifford J. Strike, general manager of Idaho Power from 1938 to 1948. Energy was first produced there in March 1952.

C.J. Strike Dam is an earthfill structure, 3,220 feet long and 115 feet high with a crest elevation of 2,465 feet above sea level. On the north abutment, a spillway with eight bays is capable of passing 99,200 cubic feet per second (cfs) of water at normal reservoir elevation. The current discharge capacity of the three existing units at the C.J. Strike powerhouse is 15,500 cfs. Therefore, spill flows occur when total Snake River flows exceed hydraulic capacity of the powerhouse. On the south abutment, an intake structure is fitted with trash racks and connections to three penstocks, which direct water to the three generating units in the powerhouse.

C.J. Strike Reservoir is not used to store water on a seasonal basis but is fluctuated daily to meet power needs. The project is operated to increase power generation at times of peak demand, approximately 7:00 to 10:00 A.M. and 5:00 to 7:00 P.M. Mean headwater fluctuations for a typical day are 0.3 feet, and 90% of the maximum daily change in headwater elevation is less than 0.4 feet per day. Because peak demands last approximately three hours, elevation changes of up to 3 feet can be expected below C.J. Strike Dam during a typical day (Idaho Power Company 1998).

In addition to hydroelectric development, the flow patterns of the Snake River have been significantly altered by agricultural demands and several large pumping diversions have reduced water supply during irrigation season. Average annual withdrawal volumes are given, in Table 9, for pump sites moving irrigation water from the Snake River. These are pump sites with a period of record from USGS gauging. See Figure 13 for approximate locations of the pump sites monitored (Maupin 1999).

Table 9. Irrigation withdrawal averages, 1990-1995.

	Pump site name	Average annual withdrawal (1990-95), in acre-feet
Pump sites from the Snake River in the reach from King Hill to C.J. Strike	King Hill Irrigation District at King Hill	5,125
	King Hill Irrigation District at Glenns Ferry	25,100
	Sailor Creek	11,720
	Grindstone Butte	28,840
	Danskin Cattle Company	2,695
	Chalk Flats Farm	2,495
	Bledsoe Farm	1,185
	Upper Indian Cove	Only measured in 1990
	Lower Indian Cove	Only measured in 1990
	Wes Farris	1,580
	Flying H Ranch	3,785
	West Indian Cove	Only measured in 1990
	Mecham & Sons	1,690
	Rocking R Ranch	10,710
	South Elmore	15,775
	Sand Dunes Farm	1,460
	Eagle Cove	3,100
	Triple C Farm	3,535
	Ken Johns & Sons	1,515
	River Ranch	2,640
	Roger Young	6,065
	Simplot No. 4 Farm	7,350
Pump sites from the Bruneau River arm of the C.J. Strike Reservoir	Basin Mutual	1,120
	Grand View No. 3 Farm	2,980
	Little Valley Mutual	12,835
	Grand View Realty	7,170
	Bybee Lateral	18,475
	Total average withdrawal From 1990-1995	**178,945**

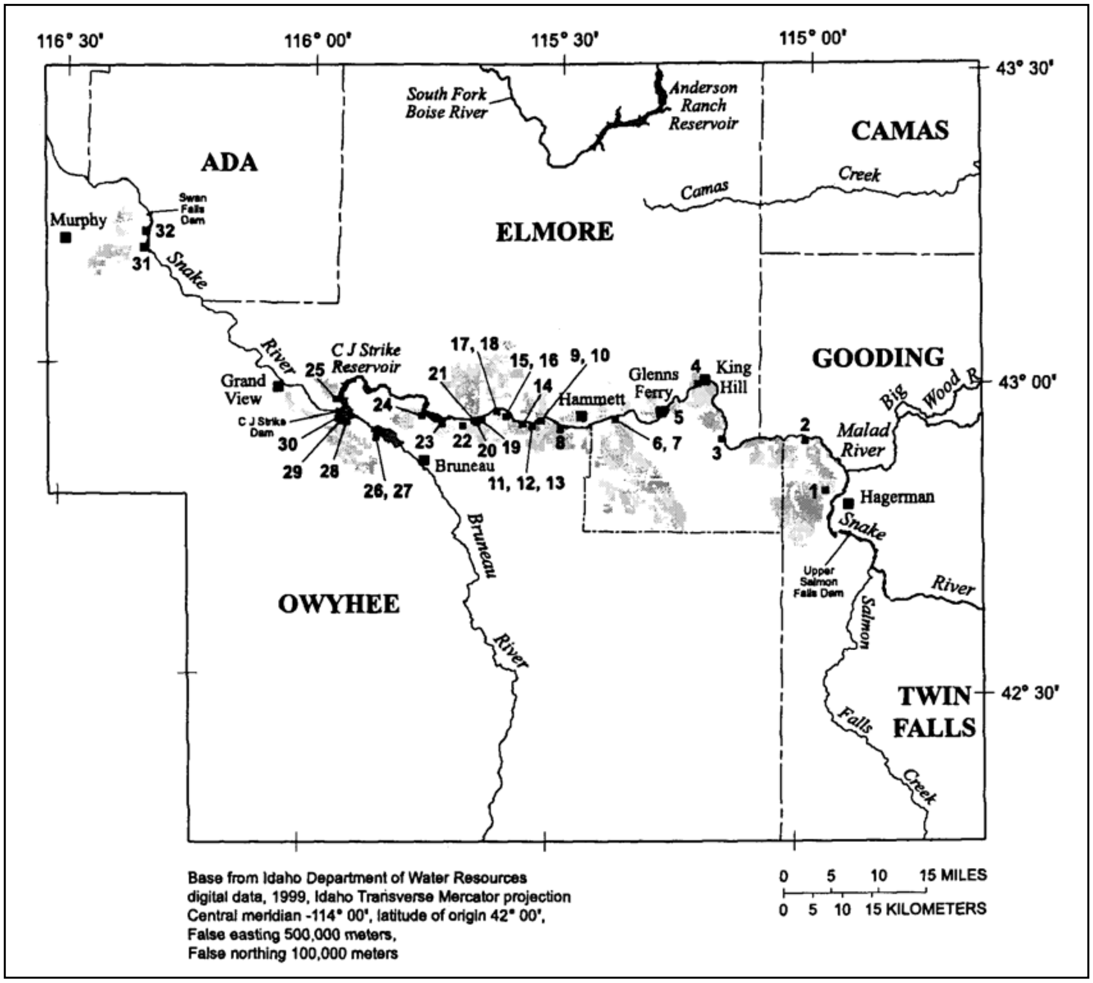


Figure 13. Pump site locations.

2. Subbasin Assessment – Water Quality Concerns and Status

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

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

Water quality is now assessed on the basis of assessment units, some of which end up being listed as impaired. Assessment units and a list of the impaired waters for the subbasin are discussed in the following.

About Assessment Units

Assessment units now define all the waters of the state of Idaho. These units and the methodology used to describe them can be found in the WBAGII (Grafe et al. 2002). Assessment units (AUs) are groups of similar streams that have similar land use practices, ownership, or land management. Stream order, however, is the main basis for determining AUs—although ownership and land use can change significantly, the AU remains the same.

Using assessment units to describe water bodies offers many benefits, the primary benefit being that all the waters of the state are now defined consistently. In addition, using AUs fulfills the fundamental requirement of EPA's 305(b) report, a component of the Clean Water Act wherein states report on the condition of all the waters of the state. Because AUs are a subset of water body identification numbers, 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 (HUC), so that all the waters in the drainage are and have been considered for TMDL purposes 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 subbasin assessments and TMDLs. All AUs contained in the listed segment were carried forward to the 2002 303(d) listings 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 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 10 shows the pollutants listed and the basis for listing for each §303(d) listed AU in the subbasin. Figure 14 shows the location of each 303(d) listed water body within the basin. 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 this 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 10. §303(d) Segments in the King Hill-C.J. Strike Reservoir Subbasin.

Water Body Name	Assessment Unit ID Number	1998 §303(d) Boundaries	Pollutants	Listing Basis[1]
Snake River	ID17050101SW005_ 07	King Hill to Hwy 51 Bridge (Loveridge Bridge)	Sediment	305(b) Appendix D, 1994 §303(d) List
C.J. Strike Reservoir	ID17050101SW001_ 02, 05, 06, 07	Entire Reservoir	Pesticides, Nutrients	305(b) Appendix D
Alkali Creek	ID17050101SW013_ 02, 03	Headwaters to Snake River	Sediment	305(b) Appendix D
Bennett Creek	ID17050101SW016_ 02, 03	Headwaters to Snake River	Unknown[2]	Unknown
Browns Creek	ID17050101SW003_ 02, 03, 04 ID17050101SW004_ 02, 03	Headwaters to Snake River	Sediment	305(b) Appendix D
Cold Springs Creek	ID17050101SW014_ 03	Ryegrass Creek to Snake River	Unknown	305(b) Appendix D
Deadman Creek	ID17050101SW008_ 02, 03	Headwaters to Snake River	Sediment	305(b) Appendix D
Little Canyon Creek	ID17050101SW012_ 02, 03, 03a	Headwaters to Snake River	Sediment, Flow Alteration	305(b) Appendix D
Ryegrass Creek	ID17050101SW015_ 02	Headwaters to Cold Springs Creek	Sediment	305(b) Appendix D
Sailor Creek	ID17050101SW006_ 02, 03, 04	Headwaters to Snake River	Sediment	305(b) Appendix D

[1]Based on 1996 §303(d) List
[2] Data suggesting beneficial use impairment are available, but impairment has not been linked to a specific pollutant

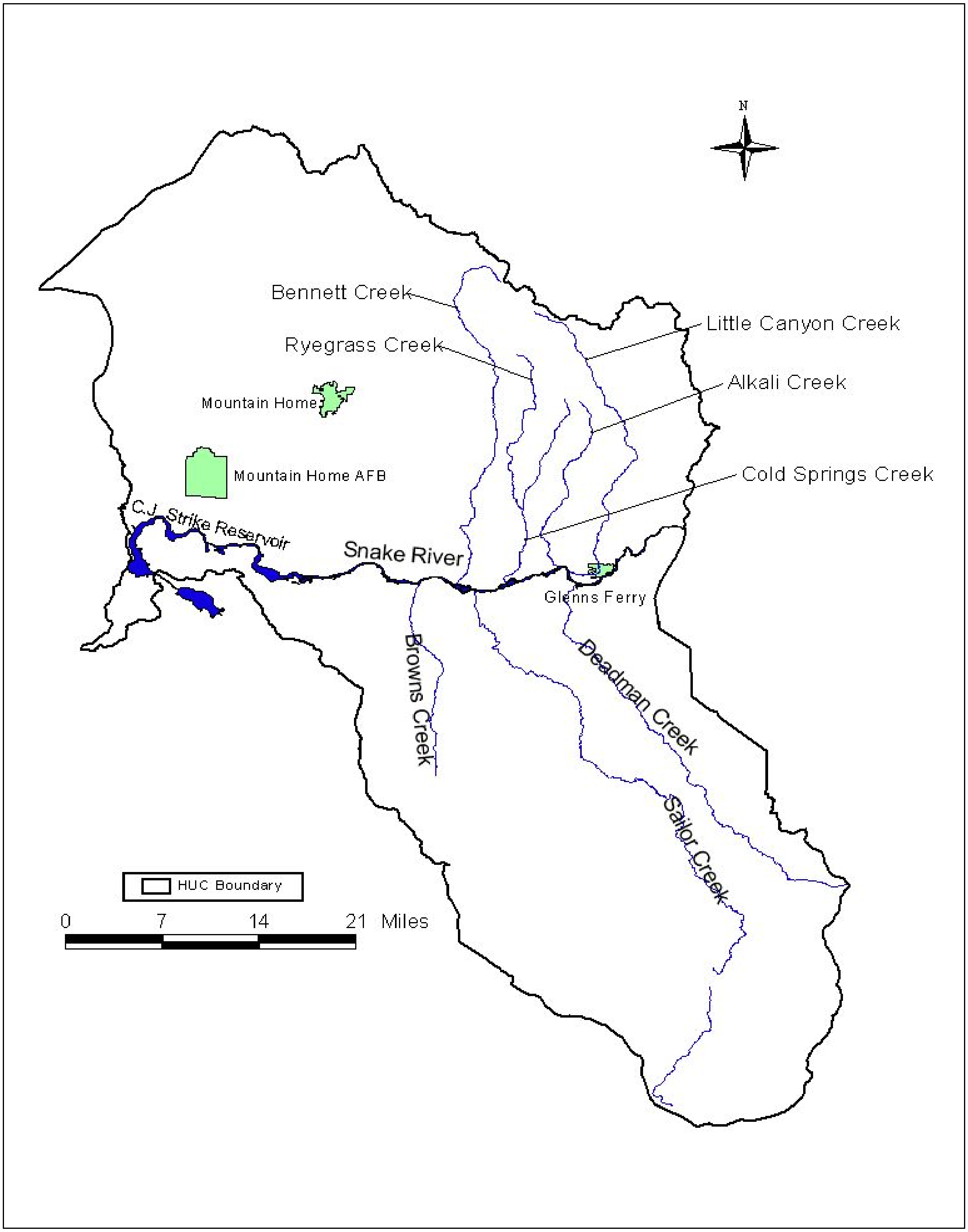


Figure 14. 303(d) water bodies in the King Hill – C.J. Strike Reservoir watershed.

2.2 Applicable Water Quality Standards

Idaho adopts both narrative and numeric water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. By designating the beneficial use or uses for water bodies, Idaho has created a mechanism for setting criteria necessary to protect those uses and prevent degradation of water quality through anti-degradation provisions. According to IDAPA 58.01.02.050 (02)a, “wherever attainable, surface waters of the state shall be protected for beneficial uses which for surface waters includes all recreational use in and on the water surface and the preservation and propagation of desirable species of aquatic life.”

Beneficial use support is determined by DEQ through its water body assessment process. Table 11 contains a listing of the designated beneficial uses for each listed segment in the subbasin. Additionally, agricultural and industrial water supply, wildlife habitat, and aesthetics beneficial uses apply to all surface waters of the state (IDAPA 58.01.02.100.03, 04, 05). Table 12 is a summary of the water quality standards associated with the beneficial uses. For streams with no designated beneficial uses, coldwater aquatic life and recreation are presumed to be uses. Table 12 and the following discussion focuses on beneficial uses and the water quality criteria, both narrative and numeric, that apply to each of the listed water bodies. A more detailed explanation of the numeric water quality targets developed as an interpretation of the narrative standards for nutrients and sediment can be found in the Water Quality Targets section (page 160) of this TMDL.

Table 11. King Hill-C.J Strike Reservoir Subbasin Designated Beneficial Uses

Water Body	Designated Uses[1]	1998 §303(d) List[2]
Snake River- King Hill to Hwy 51 Bridge	CW, PCR, DWS, SRW[3]	Sediment
C.J. Strike Reservoir	CW, PCR, DWS, SRW[3]	Nutrients, Pesticides
Alkali Creek	Undesignated	Sediment
Bennett Creek	Undesignated	Unknown
Browns Creek	Undesignated	Sediment
Cold Springs Creek	Undesignated	Unknown
Deadman Creek	Undesignated	Sediment
Little Canyon Creek	Undesignated	Sediment, Flow Alteration
Ryegrass Creek	Undesignated	Sediment
Sailor Creek	Undesignated	Sediment

[1]CW – Cold Water, SS – Salmonid Spawning, PCR – Primary Contact Recreation, SCR – Secondary Contact Recreation, AWS – Agricultural Water Supply, DWS – Domestic Water Supply

[2]Refers to a list created by the State of Idaho in 1998. Monitoring data was used to identify water bodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection “d” of the Clean Water Act.
[3]Special Resource Water. A waters designated as a special resource water meets at least one of the following criteria: 1) outstanding quality for recreation and aquatic life; 2) unique ecological significance; 3) outstanding recreational or aesthetic qualities; 4) protection is paramount to the interest of the people in Idaho; 5) within a wild and scenic river system, state or national park system or wildlife refuge; and 6) intensive protection is necessary to maintain an existing, but jeopardized beneficial use.

Table 12. Water Quality Standards Associated with Beneficial Uses

Pollutant & IDAPA Citation	Beneficial Use(s) to Which Standard Applies	Applicable Water Quality Standard
Sediment (58.01.02.200.08)	Cold Water Aquatic Life Salmonid Spawning	Sediment shall not exceed quantities specified in general surface water quality criteria (IDAPA 58.01.02.250 or 252) or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses
Turbidity (58.01.02.250.02.d)	Cold Water Aquatic Life	Less than 50 NTU[2] above background for any given sample or less than 25 NTU for more than 10 consecutive days (below any applicable mixing zone set by DEQ)
Excess Nutrients (58.01.02.200.06)	Cold Water Aquatic Life Contact Recreation	Surface waters shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses
Dissolved Oxygen (58.01.02.250.02.a)	Cold Water Aquatic Life Salmonid Spawning	Greater than 6.0 mg/L[2] except in hypolimnion of stratified lakes and reservoirs
pH (58.01.02.250.01.a)	Cold Water Aquatic Life	Hydrogen ion concentration (pH) values within the range of 6.5 to 9.0
Floating, Suspended, or Submerged Matter (Nuisance Algae) (58.01.02.200.05)	Contact Recreation	Surface waters shall be free from floating, suspended, or submerged matter of any kind in concentration causing nuisance or objectionable conditions or that impair designated beneficial uses and be free from oxygen demanding materials in concentrations that would result in an anaerobic water condition
Toxic Substances (Pesticides) (58.01.02.210.01)	Cold Water Aquatic Life Contact Recreation Domestic Water Supply	Refer to the table located in IDAPA 58.01.02.210.01 for a complete listed of the numeric standards
Total Dissolved Gases (58.01.02.250.b)	Cold Water Aquatic Life Salmonid Spawning	The total concentration of dissolved gas not exceeding one hundred ten percent (110%) if saturation at atmospheric pressure at the point of sample collection

[1]NTU = nephlometric turbidity unit
[2]mg/L = milligrams per liter

It is DEQ's position that habitat modification and flow alteration, which may adversely affect beneficial uses, are not pollutants under § 303(d) of the CWA. Idaho has no water quality standards for habitat or flow, nor are they suitable for estimation of load capacity or load allocations. Because of these practical limitations, TMDLs will not be developed to address habitat modification or flow alteration.

Additionally, the CWA states that, "TMDLs are required to be established for water bodies impaired by a pollutant, but not by pollution." EPA goes on to say that "EPA does not believe that flow, or lack of flow, is a pollutant as defined by CWA Section 502(6)."

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 that could support salmonid spawning if spawning occurred on or after November 28, 1975 as determined by the *Water Body Assessment Guidance*, second edition, 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 .02.109-.02.160 in addition to citations for existing uses).

Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. As shown in Table 13, this is the case for all the §303(d) listed tributaries to the Snake River in the King Hill-C.J. Strike Subbasin. These undesignated uses have yet to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel dissolved oxygen, temperature). 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 13 shows the designated/presumed uses as well as the documented existing uses for the each §303(d) listed water body in the King Hill-C.J. Strike Subbasin. It should be noted that if the designated use is more protective than the existing use, the designated use must be protected, regardless of whether or not the use has been documented.

Table 13. King Hill-C.J. Strike Subbasin, Beneficial uses of §303(d) listed streams.

Water Body	Designated Uses[1]	Existing Uses
Snake River (Clover Creek to Browns Creek)	CW, PCR, DWS, SRW	CW, PCR, DWS, SRW
C.J. Strike Reservoir	CW, PCR, DWS, SRW	CW, PCR, DWS, SRW
Alkali Creek	Undesignated	CW, SCR
Bennett Creek	Undesignated	SS, CW, SCR
Browns Creek	Undesignated	CW, SCR
Cold Springs Creek	Undesignated	SS, CW, SCR
Deadman Creek	Undesignated	CW, SCR
Little Canyon Creek	Undesignated	SS, CW, SCR
Ryegrass Creek	Undesignated	CW, SCR
Sailor Creek	Undesignated	CW, SCR

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

Criteria to Support Beneficial Uses

As shown in Table 12, the above-mentioned 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 dissolved oxygen, pH, and turbidity (IDAPA 58.01.02.250) (Table 12).

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 (Grafe et al. 2002). This guidance requires the use of the most complete data available to make beneficial use support status determinations.

Figure 15 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.

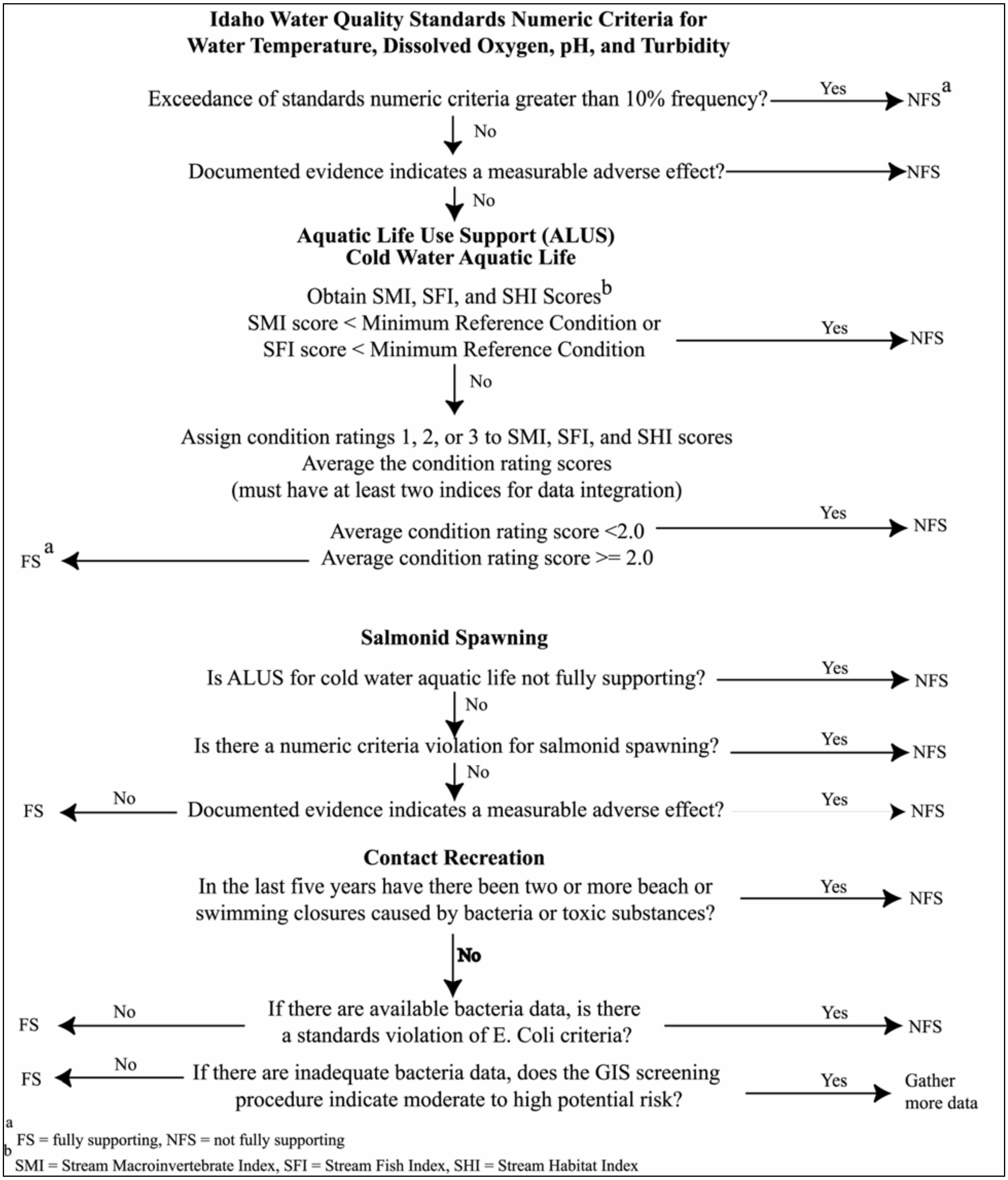


Figure 15. Determination Steps and Criteria for Determining Support Status of Beneficial Uses in Wadeable Streams: *Water Body Assessment Guidance*, Second Addition (Grafe *et al*. 2002)

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. For example, streams naturally contain sediment, nutrients, but when anthropogenic sources cause these to reach unnatural levels, they are considered “pollutants” and can impair the beneficial uses of a stream. The following summaries discuss the effects of each related “pollutant” or the side effect of the pollutant on aquatic life and where relevant, contact recreation.

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. Oxygen sags 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. In many cases excess aquatic plants can cause supersaturation, whereby DO levels may reach unusually high levels during the daylight hours.

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. Channels that have been altered to increase the effectiveness of conveying water often have fewer riffles and less aeration. Thus, these systems may show depressed levels of DO in comparison to levels before the alteration. Nutrient enriched waters have a higher biochemical oxygen demand due to the amount of oxygen required for organic matter decomposition and other chemical reactions. This oxygen demand results in lower in-stream DO levels.

Sediment

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

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

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

Settleable solids are defined as the volume (milliliters [ml]) or weight (mg) of material that settles out of a liter of water in one hour (Franson et al. 1998). Settleable solids may consist of large silt, sand, and organic matter. Total suspended solids (TSS) are defined as the material collected by filtration through a 0.45 µm (micrometer) filter (APHA 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.

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

Pesticides

DDT and dieldrin have been identified as the primary pesticides of concern in C.J. Strike Reservoir. Many pesticides, including DDT and dieldrin, and their breakdown products have potential effects on reproductive, nervous, and immune systems, as well as on chemically sensitive individuals. For example, some of the most frequently detected pesticides are suspected endocrine disrupters that have potential to affect reproduction or development of aquatic organisms or wildlife by interfering with natural hormones.

Total Dissolved Gas

Total dissolved gas (TDG) concentrations are considered elevated when they exceed 110%. Beyond this level, TDG is known to have detrimental effects on aquatic life, primarily fish. High concentrations of gas dissolved in water can result in a phenomenon known as gas bubble trauma. This condition occurs when air bubbles form in the circulatory system. The severity of the effects of gas bubble trauma varies among different aquatic species and life stages within those species.

2.4 Summary and Analysis of Existing Water Quality Data

The following presents the data assessment methods used during this assessment, followed by analyses for the subwatersheds (Snake River, Snake River tributaries, and the C.J. Strike Reservoir), and comments regarding additional resource management considerations addressed by the assessment.

The amount of available data varied substantially between subwatersheds. Types of available data also ranged widely, but typically represent biological, chemical, and physical parameters. Data pertinent to the water quality issues being addressed are presented for each listed stream in this section.

Data Assessment Methods

Several primary analysis methods were used to evaluate the data for this subbasin assessment:

- Evaluation Using the DEQ-Water Body Assessment Guidance – Second Edition
- Evaluation Using Stream Bank Erosion Inventory
- Evaluations of Intermittence for Selected Streams
- Evaluation Using Bioaccumulation Factors for (t)-DDT and Dieldrin
- Evaluation Using the CE-QUAL-W2 Water Quality Model

Detailed descriptions of these methods are located in Appendices E, F, G, and H. A brief description of each method follows.

DEQ-Water Body Assessment Guidance – Second Edition

The Water Body Assessment Guidance II (WBAG) (Grafe et al. 2002) describes DEQ's methods used to consistently evaluate data and determine the beneficial use support status of Idaho water bodies. The WBAG is not used to determine pollutant-specific impairment. Rather, it utilizes a multi-index approach to determine overall stream support status. The methodology addresses many reporting requirements of state and federal rules, regulations, and policies. For the most part, DEQ Beneficial Use Reconnaissance Program (BURP) data is used in the assessment. However, where available, other data is integrated into the assessment process. Figure 15 (above) shows the details of the assessment process.

An assessment entails analyzing and integrating multiple types of water body data, such as biological, physical/chemical, and landscape data to address multiple objectives. The objectives include the following:

1. Determine beneficial use support status of the water body (i.e., fully supporting versus not fully supporting).
2. Determine biological integrity using biological information or other measures.
3. Compile descriptive information about the water body and data used in the assessment.

The multi-metric index approach measures biological, physiochemical, and physical habitat conditions within a stream. The indexes include several characteristics to gauge overall stream health. Three primary indexes are used, which include the Stream Macroinvertebrate Index (SMI), the Stream Fish Index (SFI) and the Stream Habitat Index (SHI). The SMI is a direct measure of cold water aquatic life health. The SFI is also a direct measure of cold water aquatic life health, but is specific to fish populations. The SHI is used to measure in-stream habitat suitability, although some of the measurements used to generate the SHI are linked to the riparian area.

Stream Bank Erosion Inventory

The stream bank inventory was used to estimate background and existing stream bank and channel erosion. The inventory follows methods outlined in the proceedings from the National Resource Conservation Service (NRCS) Channel Evaluation Workshop (1983). The NRCS stream bank erosion inventory is a field-based method that measures bank and channel characteristics—such as stability, length of eroding banks, and depth of eroding banks—to calculate a long-term lateral recession rate. The recession rate is expressed in terms of the feet of stream bank lost due to erosion per year (ft/year). The lateral recession rate can then be combined with the volumetric mass of the bank material and the length of the segment to determine the sediment load from the stream banks.

The stream bank erosion inventories are linked to bank stability, which is used as a surrogate for in-stream particle size distributions. Previous TMDLs (DEQ 2001a, 2001b, 2003) have established a linkage between 80% stream bank stability and less than 30% fine substrate material in riffles. This linkage allows for the restoration of beneficial uses to be assessed based on bank stability (i.e. streams with >80% bank stability will likely support cold water aquatic life beneficial uses). Of course, this linkage is based on sediment related use impairment only. If factors other than excess sediment are impairing uses, this method will not detect them, and they must be addressed elsewhere.

For the King Hill-C.J. Strike TMDL, DEQ staff calculated the stream bank erosion rates of stream types where banks are expected to be greater than 80% stable and the particle size distribution in riffles is expected to contain less than 30% fines (particles <6.0 mm in diameter). These erosion rates were then used as reference rates for similar morphological channel types on the §303(d) listed streams where banks are eroding and fine materials exceed 30% in riffles. The reference rates become the benchmark for the impaired stream and, thus, the basis of load reductions.

Evaluations of Intermittence for Selected Streams

The state of Idaho defines an intermittent stream as one that has a period of zero flow for at least one week during most years or that has a 7Q2 (a measure of the annual minimum 7-day mean stream flow, based on a 2 year low) hydrologically based flow of less than 0.10 cfs (IDAPA 58.01.02.003.51). If a stream contains naturally perennial pools with significant aquatic life, it is not considered intermittent.

Using this definition as guidance, DEQ identified eight §303(d) listed intermittent stream segments, as shown in Table 14. (Appendix F provides a detailed analysis showing why each stream segment was determined to be intermittent.) The implication of this determination is that TMDLs with the intent of restoring local (in the intermittent segment) beneficial uses will not be performed for these stream segments because water is not present during the critical loading period (typically the growing season) or when aquatic life beneficial uses are expected to be fully supported based on life cycles (middle to late summer months). IDAPA 58.01.02.070.07 states that water quality standards shall only apply to intermittent waters during optimum flow periods sufficient to support the beneficial uses for which the water body has been designated. The optimum flow for contact recreation is equal to or greater than 5.0 cfs. The optimum flow for aquatic life is equal to or greater than 1.0 cfs. However, TMDLs developed for downstream, perennial segments may apply to these segments because of their potential to contribute pollutants when water is flowing. For example, if an intermittent segment is typified by unstable, eroding banks due to anthropogenic causes, the load created during flow periods would be subject to a TMDL.

Table 14. §303(d) listed intermittent stream segments in the King Hill-C.J. Strike Subbasin.

Water Body	§303(d) Boundary	Intermittent Segment(s)
Bennett Creek	Headwaters to Snake River	Near 3,773 feet[1] to Snake River
Ryegrass Creek	Headwaters to Cold Springs Creek	Near 3,609 feet to Cold Springs Creek
Cold Springs Creek	Ryegrass Creek to Snake River	Near 3,609 feet to near 2,821 feet
Alkali Creek	Headwaters to Snake River	Near 3,444 feet to near 2,821 feet
Little Canyon Creek	Headwaters to Snake River	Near 4,101 feet to near 2,624 feet
Browns Creek	Headwaters to Snake River	Headwaters to near Snake River
Sailor Creek	Headwaters to Snake River	Headwaters to near Snake River
Deadman Creek	Headwaters to Snake River	Headwaters to near Snake River

[1] elevation, in feet, above sea level

Bioaccumulation Factors for (t)-DDT and Dieldrin

C.J. Strike Reservoir is §303(d) listed for pesticides. However, no water column pesticide or pesticide related data (such as fish tissue data) are available for the transition and lacustrine zones of the reservoir. Fish tissue data are, however, available at Loveridge Bridge, which falls within riverine zone of the reservoir. Using the Loveridge Bridge data as a surrogate for the entire reservoir, Bioaccumulation Factors (BAF) were developed for (t)-DDT and dieldrin to estimate the water column concentrations of total DDT and dieldrin in C.J. Strike Reservoir. The water column concentrations were then compared to the applicable criteria in the *Idaho Water Quality Standards and Wastewater Treatment Requirements* for DDT and dieldrin to determine beneficial use support status for domestic water supply and cold water aquatic life. Bioaccumulation Factors were developed following the guidance outlined in *"Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health"* (EPA 2000). Appendix G outlines in more detail the process and calculations used to develop the final estimated concentration.

CE-QUAL-W2 Water Quality Model

CE-QUAL-W2, Version. 3.1 is a two-dimensional, longitudinal/vertical, hydrodynamic water quality model that has been applied to rivers, lakes, reservoirs and estuaries throughout the world. The model assumes lateral homogeneity, making it best suited for long and narrow waterbodies exhibiting strong longitudinal and vertical water quality gradients, such as C.J. Strike Reservoir.

Setup of the model requires geometric, bathymetric, and meteorologic data and boundary condition information. The boundary condition information includes flow, water temperature and water quality data. All of this information is available from a variety of sources. Model output capabilities include hydrodynamic functions, such as water surface elevations, velocities, and temperatures. Water quality constituents include parameters, such as dissolved oxygen and nutrients (among many others).

The CE-QUAL-W2 model was to set up and applied to C.J. Strike Reservoir by Idaho Power Company in cooperation with HDR Engineering, HyQual, and Scott Wells of Portland State University. Appendix H summarizes the use of the model as it applies to C.J Strike Reservoir.

Snake River Data Analysis

The Snake River is a complex system that has been studied by numerous entities along its length. The following data analysis pertains to the river segment between King Hill (River Mile 546.3) and Indian Cove (River Mile 525.3). More specifically, the analysis pertains to sediment and nutrients and their related water quality parameters. Unfortunately, it is not possible at this time to perform a fully comprehensive study pertaining to all known issues within the river.

Flow Characteristics / Selection of a Baseline Flow

The USGS has collected flow data from the Snake River near King Hill since 1910. These data represent the most comprehensive data within the §303(d) listed segment and are the flow data used by nearly every researcher investigating the Snake River. Figure 16 shows the annual mean flow for each year during the period of record (POR) at King Hill.

However, in evaluating the water quality data for this assessment, the POR flow data were not used (for reasons that will shortly be described), but they do give some insight into the historic flow regimes. Is should be noted that the construction of several dams on the Snake River above King Hill has change the look of the hydrograph.

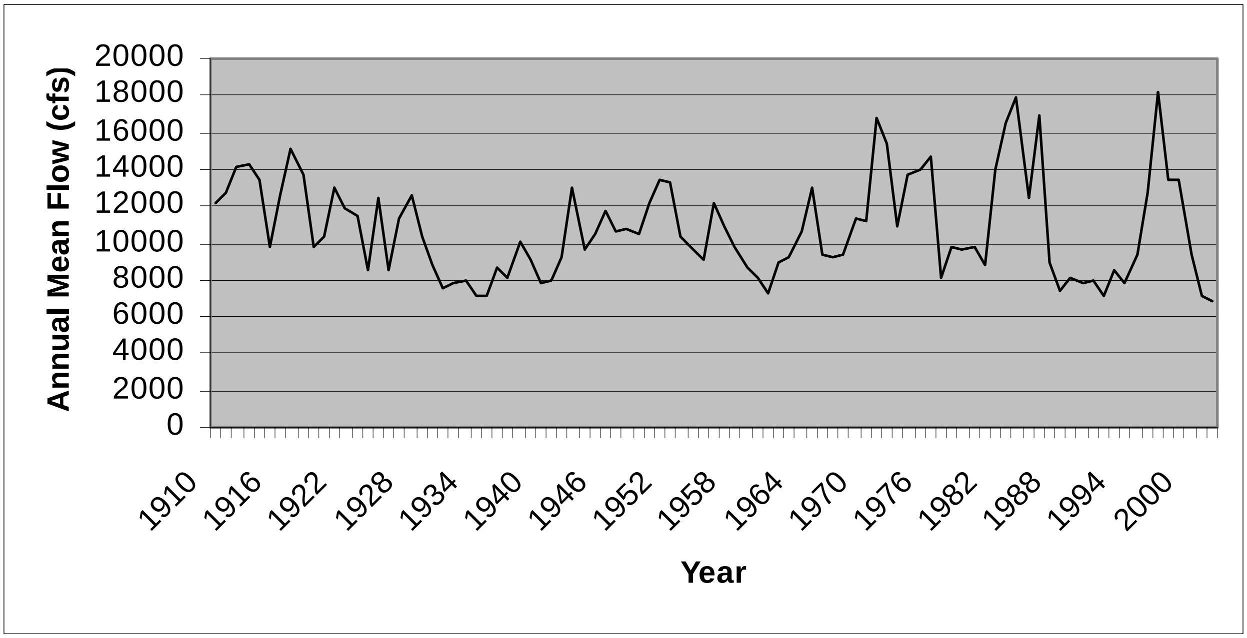


Figure 16. Snake River at King Hill, 1910 – 2002 Annual Mean Flow

The entirety of the 1910-2002 flow data do not represent current flow conditions in the Snake River at King Hill, but the 1986-2002 flow data do—for a couple of reasons: 1) based on the POR flow data, these years capture the full range of flows expected to occur (high through low), and 2) extensive water quality data are available during those years, whereas such data are not available for the years prior to 1986. These years best represent “typical” flow conditions in the Snake River at King Hill, and determining this flow is an important step in determining the baseline flow for development of the TMDL.

Figure 17 shows the annual mean flows for 1986-2002 as compared to the mean flow for the entire period. Figure 18 shows the monthly averages for 1986-2002.

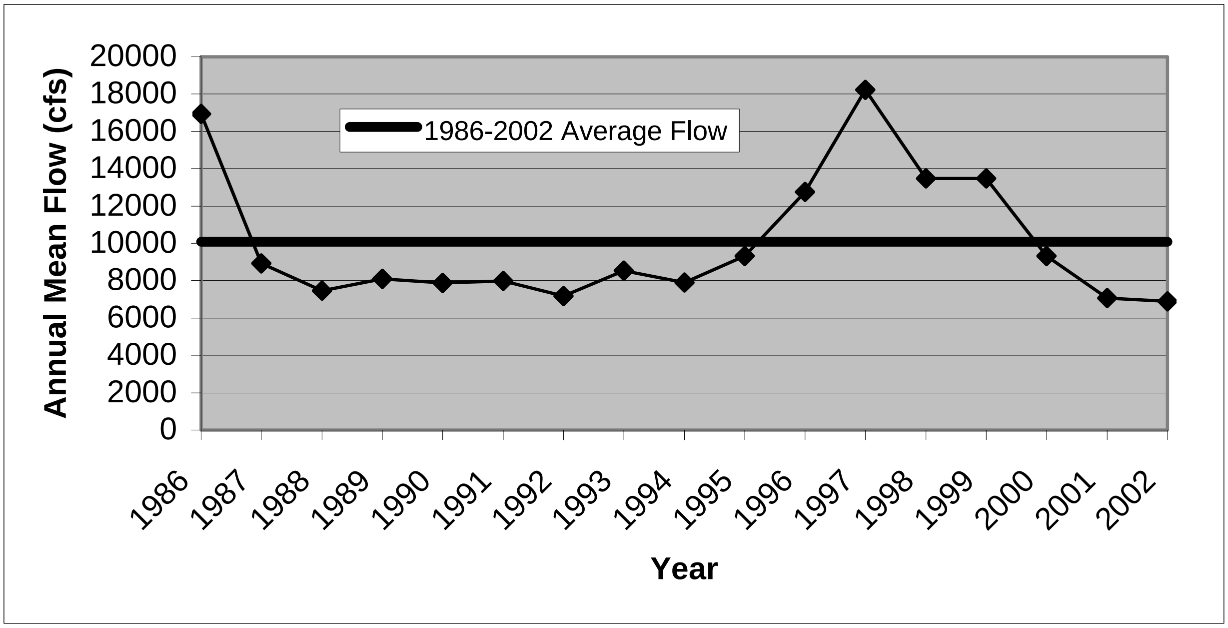


Figure 17. Snake River at King Hill, 1986-2002 Annual Mean Flows

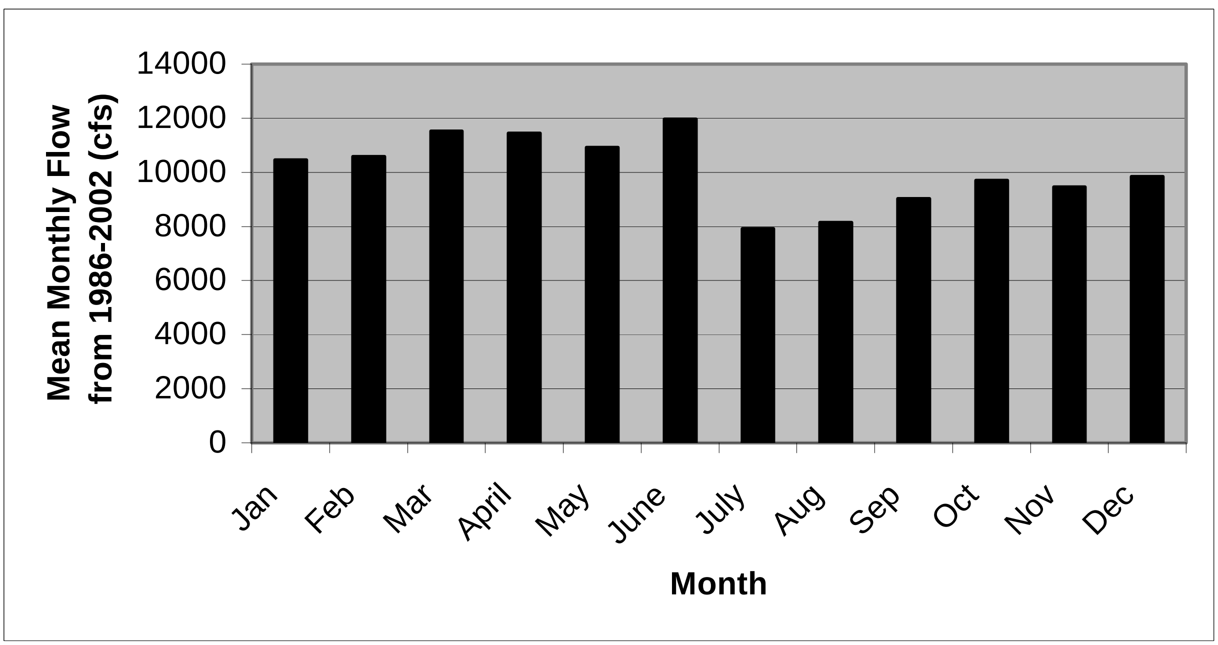


Figure 18. Snake River at King Hill, 1986-2002 Monthly Average Flows

The monthly flow figure illustrates that the river reaches a base flow in October, after water has been removed for irrigation purposes along the system, which occurs primarily in July, August, and September. The increase in April, May, and June is primarily due to spring runoff flows.

Using the 1986-2002 flow data as a starting point, the flow years were further evaluated to determine a narrower span of years that are representative of flow conditions in the river. While the 1986-2002 data are representative of a long-term unmanaged (no dams) flow regime, it is typically not necessary to evaluate such a long period. Figure 16 (above) shows that the years 1997-2002 also capture the full range of flows expected to occur (high through low). The water quality data are also fairly robust during this period. **Thus, the 1997-2002 flows were chosen to represent the baseline flow conditions for TMDL development.** Figure 19 shows the 1997-2002 flow data compared to the monthly means and the mean of the monthly means.

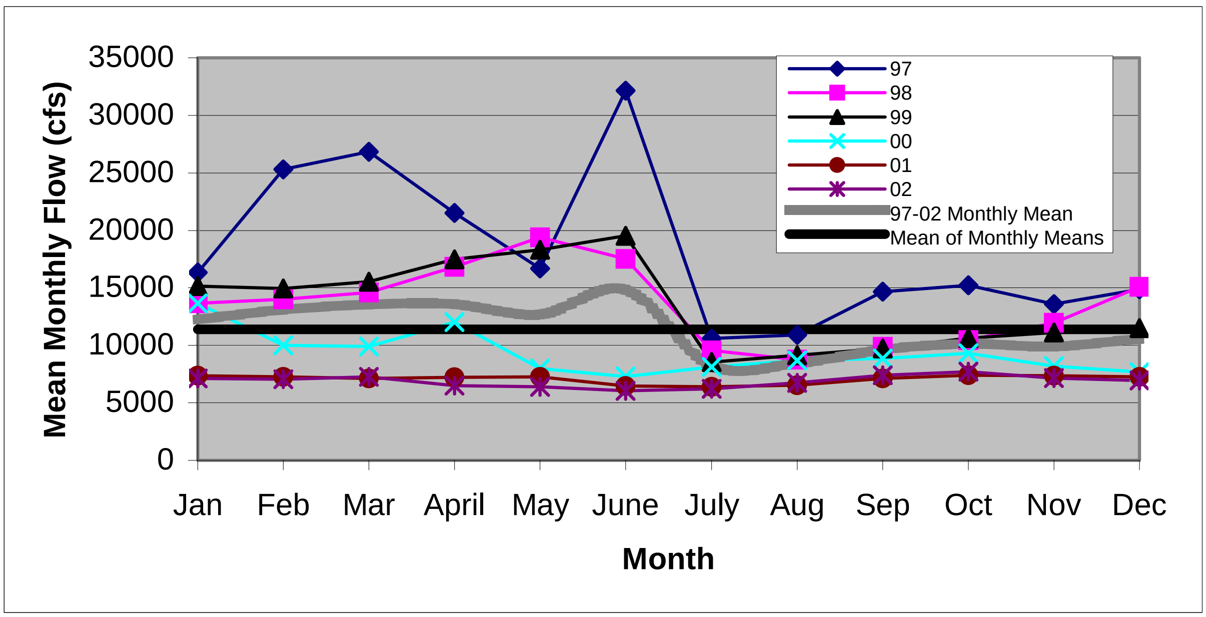


Figure 19. Mean monthly flows at King Hill for the period 1997-2002

As illustrated in Figure 19, the mean of the monthly mean flows is slightly over 11,000 cfs. The actual value is 11,407 cfs. This flow was used as the baseline for TMDL development. That is, **the King Hill sediment and nutrient load allocations presented in Chapter 5 are based on a flow of 11,407 cfs**. Based on the use of 1997-2002 flow data, a flow of 11,407 cfs is likely to occur relatively frequently by comparison to the highest flows (1997) and the lowest flows (2002) making it an appropriate flow for establishing load targets.

Water Chemistry Data

This section describes and analyzes the chemical and biological data for the Snake River between King Hill and Indian Cove. While Indian Cove is often not considered part of C.J. Strike Reservoir, velocity analysis performed by Idaho Power Company and DEQ shows that during full pool the riverine portion of C.J Strike Reservoir extends past Loveridge Bridge up to Indian Cove. Based on this analysis, Indian Cove serves as the downstream end of the Snake River segment for the purposes of assessing Snake River water quality data. The analysis showing the velocity data can be found in more detail in the C.J. Strike Reservoir water quality assessment to follow.

Figure 20 shows the locations of King Hill and Indian Cove sampling stations within the King Hill-C.J Strike watershed. Idaho Power Company and the USGS have sampled extensively at King Hill. DEQ has also sampled at King Hill, but on a less extensive basis. At Indian Cove, Idaho Power Company collected most of the data, although in recent years DEQ has collected data at King Hill. For purposes of the water quality analysis, data from all three entities were used.

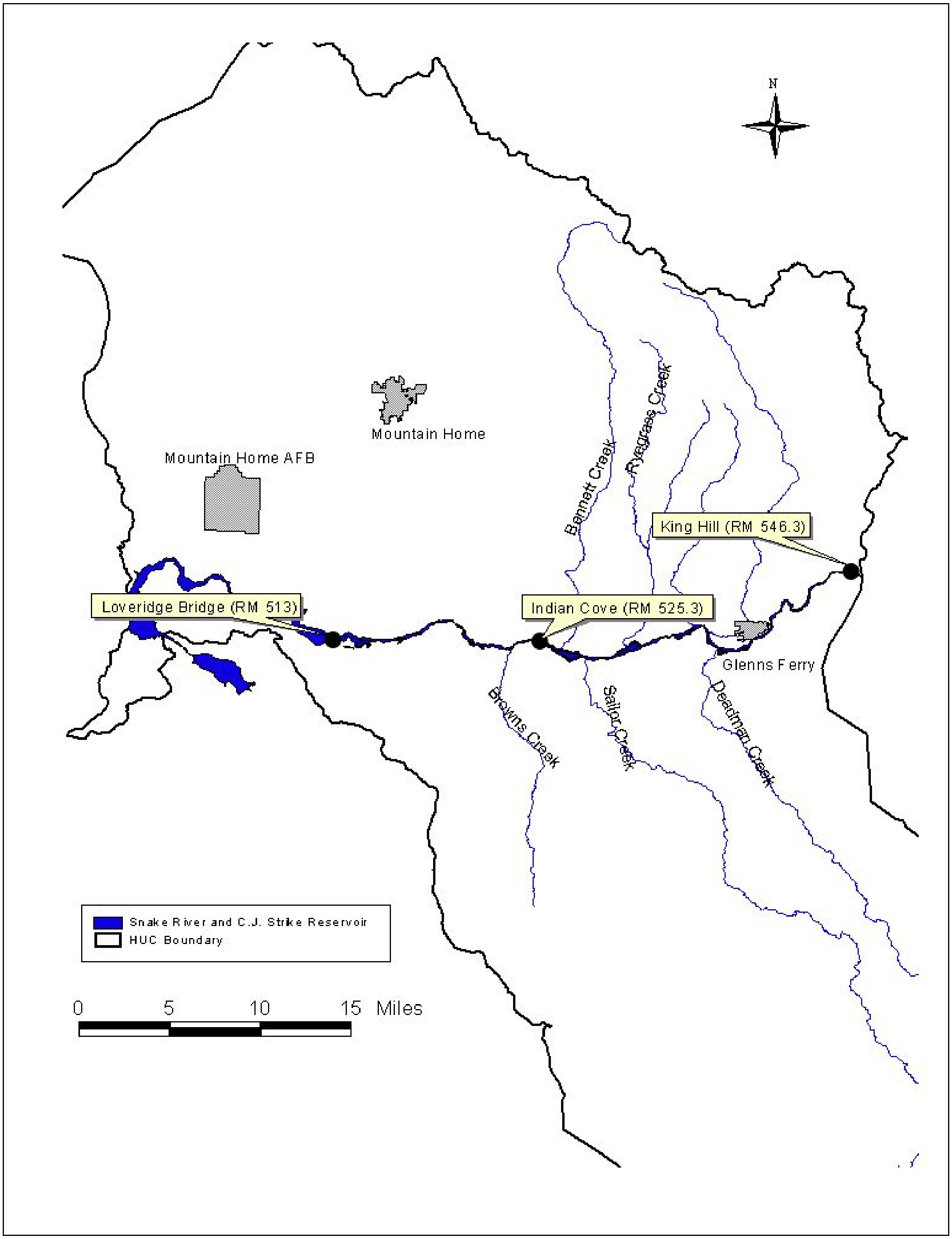


Figure 20. Location of King Hill and Indian Cove sampling stations

Sediment Loading Analysis

In determining whether excess sediment is impairing aquatic life beneficial uses in a water body, a thorough analysis should consider both water column and substrate sediment (sediment on the river bottom) characteristics. This is especially the case if spawning is a beneficial use.

However, in systems as large as the Snake River, the analysis of substrate sediment conditions is difficult to perform and often cost prohibitive. For those reasons, very little quantitative sediment composition data exists within the listed reach. Upstream of the listed segment, near Crystal Springs (~RM 599), the sediments were characterized by Falter and Burris (1994). While the length of the study segment was limited, the authors found that fine, organic-rich surficial sediment depths ranged from 0.68 meters to 0.23 meters in depth. These excess depths of fine, organic rich sediment were found to be very influential in the growth of nuisance macrophytes. This concept is discussed further in the forthcoming biological analysis.

Recognizing that the ability to fully assess substrate sediments in the Snake River is limited, the evaluation of sediment conditions as they relate to cold water aquatic life support status is initially based on water column sediment. While salmonid (trout) spawning in the Snake River is not a designated use, it has not been conclusively determined that it is not an existing use. Thus, water column sediment is evaluated initially with the intent of further evaluating substrate sediment conditions when the chance arises.

Water Column Sediment Targets

As was shown in Table 12, the standard for sediment is narrative. The standard says "*sediment shall not exceed quantities specified in general surface water quality criteria (IDAPA 58.01.02.250 or 252) or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses*." However, no specific sediment criteria exist for the Snake River between King Hill and Indian Cove, so two-tiered durational surrogate targets to the narrative standard were used instead.

Surrogates can be defined as alternative, numeric measures to narrative water quality standards. The surrogate targets are specifically designed to be protective of the designated aquatic life beneficial use (cold water aquatic life) and the potential existing salmonid spawning use. The targets were first developed as part of the Lower Boise River sediment TMDL (DEQ 1999) and are based on the extensive work of Newcombe and Jensen (1996). Newcombe and Jensen evaluated 80 published and adequately documented reports on fish response to suspended sediment concentration (SSC) in streams. The result of their work was several species and age specific dose-response matrices showing the expected effects of SSC on different species and ages of fish over different durations of exposure. For example, Newcombe and Jensen determined that adult salmonids could withstand an SSC of 20 mg/L for two weeks without experiencing major physiological stress. However, if the exposure duration were to increase to four months, major physiological stress would be noted.

Following this concept, the two-tiered durational targets shown below were developed. The targets are designed to account for both chronic and acute exposure to excess water column sediment.

- **a geometric mean of 50 mg/L suspended sediment for no longer than 60 consecutive days**
- **a geometric mean of 80 mg/L suspended sediment for no longer than 14 consecutive days**

The targets shown above are expressed in terms of suspended sediment concentration. SSC is a protective (of aquatic life) measure of water column sediment because the laboratory analysis for SSC has the finite ability to capture sand size and smaller particles in the water column. Particles of this size can be particularly dangerous to fish when present in excess.

In addition to employing the above-mentioned SSC targets, the analysis of water column sediment conditions in the Snake River between King Hill and Indian Cove also considers turbidity conditions. As shown in Table 12, the state of Idaho has a numeric water quality standard for turbidity for the protection of aquatic life. The standard says turbidity levels shall be "*less than 50 NTU (nephelometric turbidity unit) above background for any given sample or less than 25 NTU for more than 10 consecutive days (below any applicable mixing zone set by DEQ)*.

- **less than 50 NTU above background for any given sample**
- **less than 25 NTU for more than 10 consecutive days**

Analysis of Suspended Sediment Concentration (SSC) Data

Suspended sediment concentration data have been collected by the USGS at King Hill since 1974. Data were typically collected monthly and are available from 1974-2002. These data are ideal for determining the SSC boundary condition to the King Hill–Indian Cove segment of the Snake River. Initially, the entire data set (1974-2002) is used to generally characterize the levels and determine seasonal variability. From there, the 1997-2002 data are evaluated against the SSC targets to determine whether the Snake River at King Hill is meeting the targets. Figures 21 and 22 show the 1974-2002 SSC data, based on all seasons (Figure 21), and the growing season (Figure 22). The growing season typically corresponds with the irrigation season, which runs from March through October. This is the time of year when elevated levels of sediment can traditionally be noticed in surface waters that are near agricultural land uses (such as the Snake River). For this reason, the growing season data are evaluated separately to determine if there is any seasonal variability.

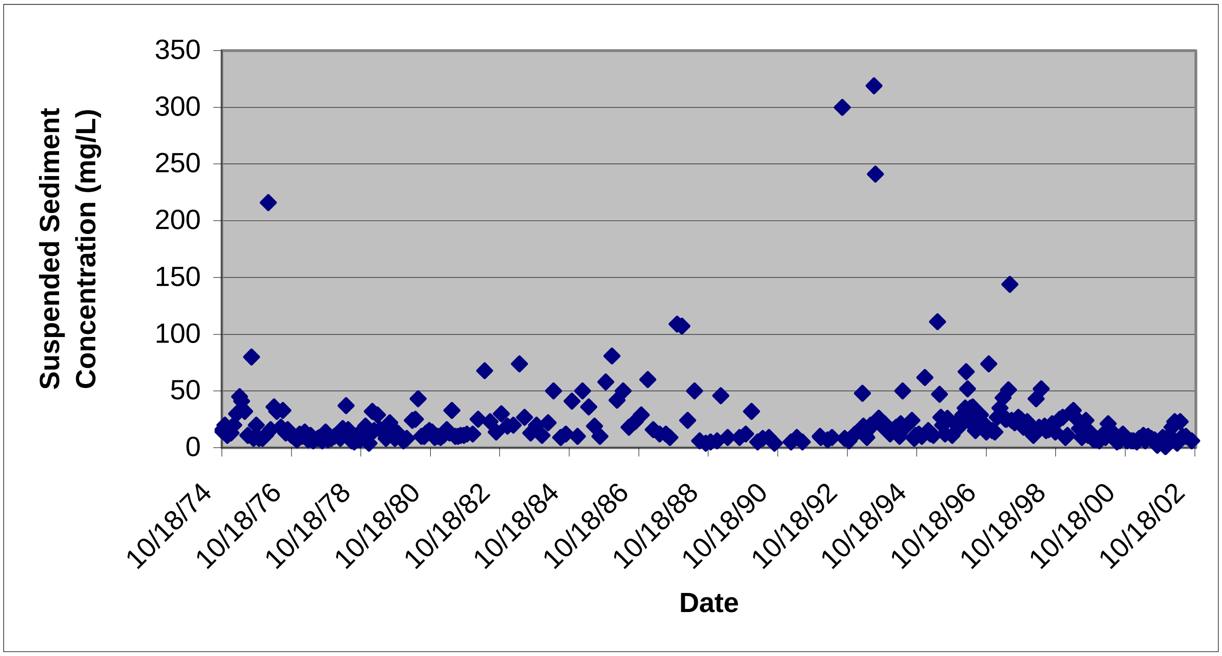


Figure 21. SSC concentrations in the Snake River at King Hill, 1974-2002 data, all seasons.

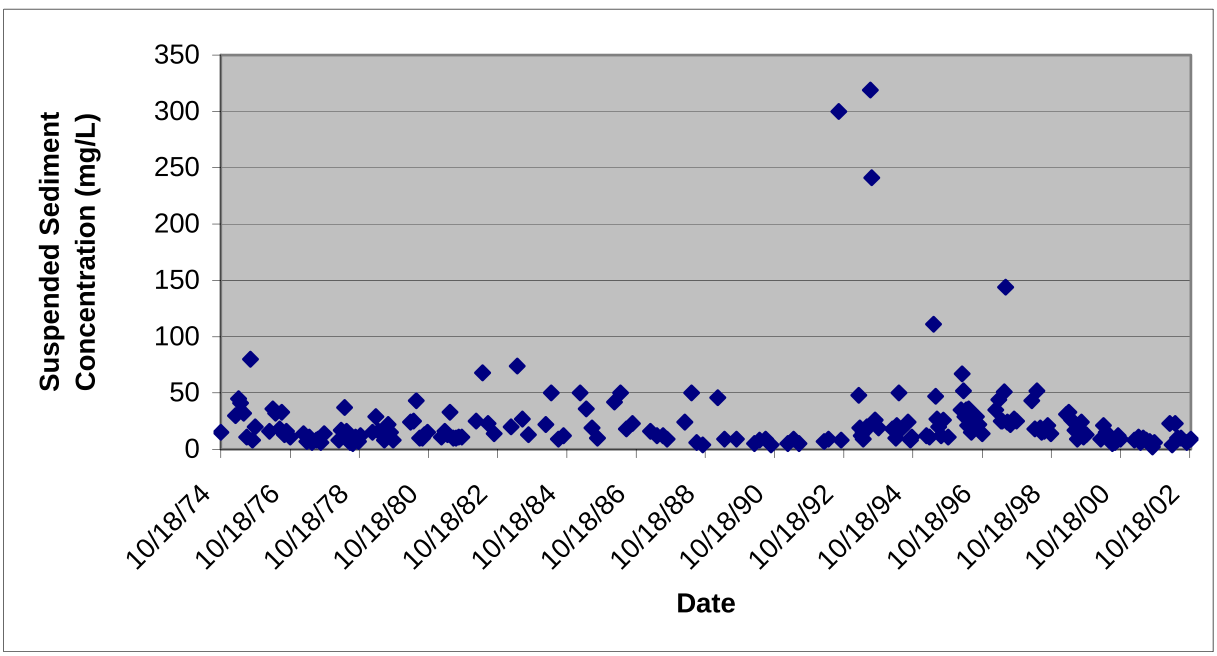


Figure 22. SSC concentrations in the Snake River at King Hill, 1974-2002 data, growing seasons.

Figure 21 shows that SSC in the Snake River at Kings Hill largely remains below 50 mg/L except in extremely high flow years, such as 1986 and 1997. While excursions above 50 mg/L do occur, they appear to be somewhat flow related. The mean SSC over the 1974-2002 period is 24 mg/L.

A comparison of Figures 21 and 22 illustrate that there is little difference in SSC concentration between the growing season and all seasons. The growing season mean SSC between 1974 and 2002 is 25 mg/L, the non-growing season SSC is 22 mg/L, and the mean of all data is 24 mg/L. These differences in concentration are negligible, indicating that there is no seasonal variability in SSC at King Hill.

Recognizing that there is no seasonal variability in SSC at King Hill, the 1997-2002 data from all seasons were evaluated against the SSC targets discussed above. Again, the 1997-2002 data were chosen because those years represent the full range of flows (high through low) expected to occur within the King Hill to Indian Cove reach. The durational nature of the targets makes a true comparison to the targets impossible because SSC data were not collected daily. To account for this data gap it is assumed that the concentration between sampling days remains static unless there is an excursion that can be explained by an acute event, such as the 1997 flood. Figure 23 shows the 1997-2002 SSC data at King Hill. The data show that concentrations remain well below 50 mg/L. The concentration of 144 mg/L that occurred on June 23, 1997, was due to events related to the 1997 flood and does not represent normal SSC conditions in the river. Based on 1997-2002 data, the mean SSC at King Hill is 18 mg/L. This level is below the targets of 50 and 80 mg/L. Thus, suspended sediment concentrations in the Snake River at King Hill do not exceed the targets.

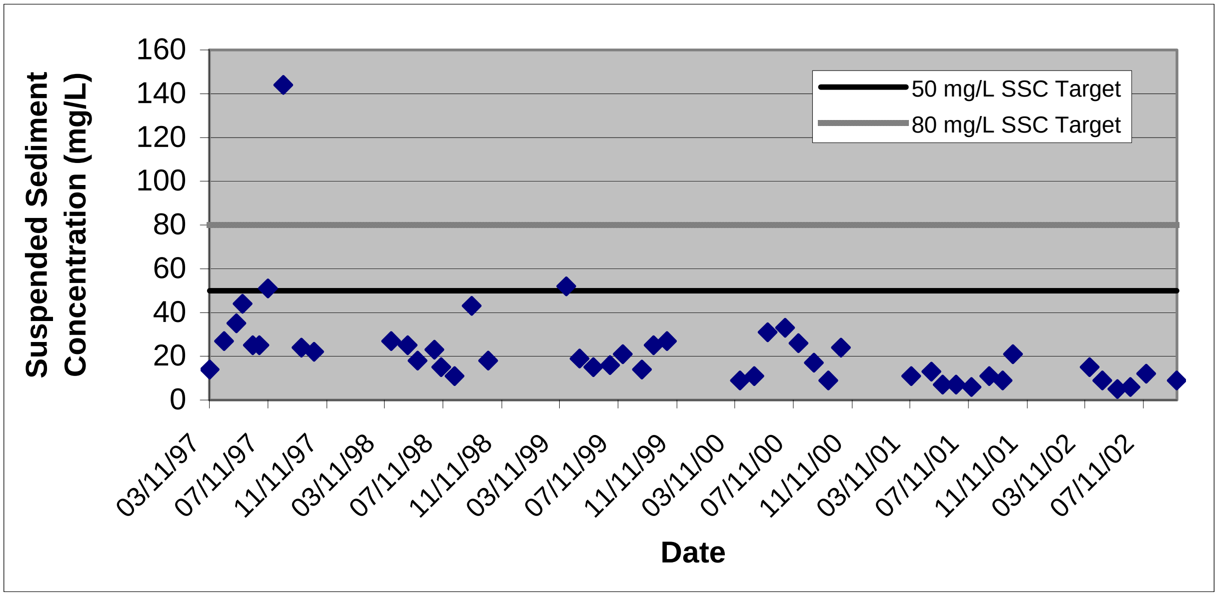


Figure 23. SSC concentrations in the Snake River at King Hill, 1997-2002 data, all seasons.

The Department of Environmental Quality (DEQ) has collected monthly SSC data at King Hill and Indian Cove since April 2003. These data are used to determine whether there is a net increase in SSC between the two sites, and, if so, whether SSC exceeds the water quality targets.

Unfortunately, the DEQ data represent the only available SSC data with which a comparison between King Hill and Indian Cove can be made. Because the tributary concentrations between King Hill and Indian Cove are typically below 10 mg/L and there are no other major sources of sediment to the river, the DEQ data likely represent the typical change in SSC between King Hill and Indian Cove. Figure 24 shows the change in SSC concentration between King Hill and Indian Cove. Based on the mean of these data, the net gain in SSC between King Hill and Indian Cove is 3 mg/L. The mean at King Hill is 22 mg/L, relatively consistent with the USGS data, while the mean at Indian Cove is 25 mg/L. Not shown on Figure 24 is the mean concentration in the river just below the city of Glenns Ferry, which was also 22 mg/L. This indicates that the SSC contributions from King Hill and Little Canyon Creeks, two of the largest volume tributaries in the basin, have no measurable change on river concentration.

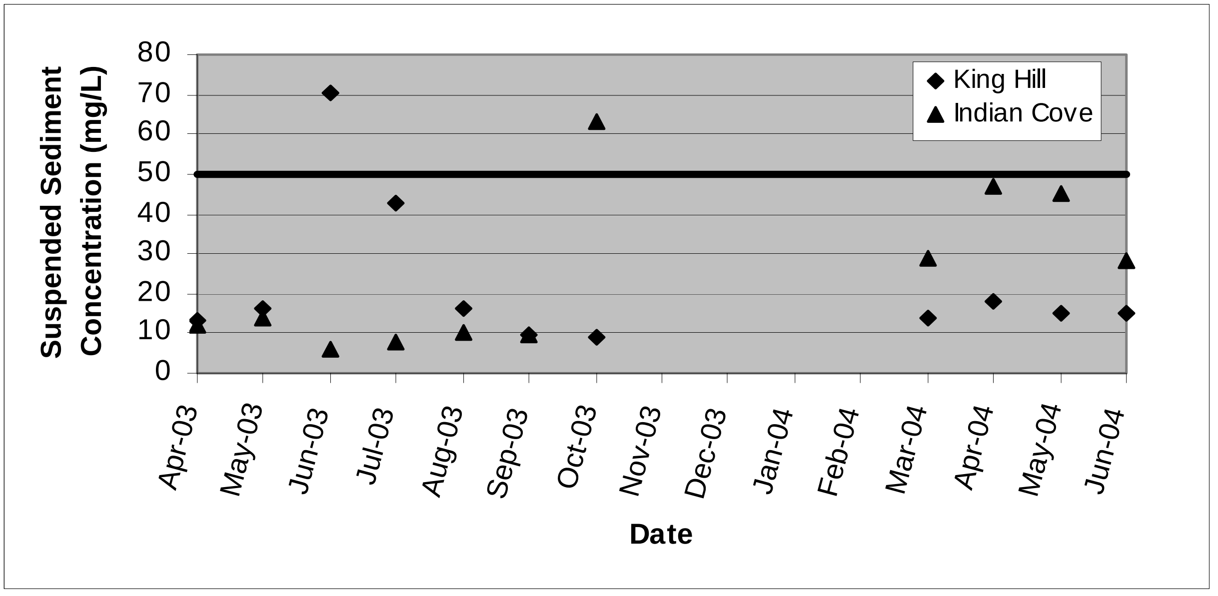


Figure 24. Comparison of SSC at King Hill to Indian Cove, 2003-2004 data, all seasons.

Figure 24 and the narrative above show that SSC between King Hill and Indian Cove does not increase substantially. The figure also suggests that concentrations do not exceed the durational targets of 50 mg/L for 60 consecutive days and 80 mg/L for 14 consecutive days. The target of 80 mg/L is never exceeded. The target of 50 mg/L was exceeded at King Hill in June 2003 and at Indian Cove in October 2003, but the duration does not appear to ever exceed 60 days. Based on these analyses, SSC in the Snake River between King Hill and Indian Cove is typically below the water quality targets. As such, SSC does not appear to be impairing the designated use of cold water aquatic life or the potentially existing use of salmonid spawning.

Analysis of Turbidity Data

Before beginning the analysis of the turbidity data, it should be noted that turbidity is not as desirable as SSC in terms of measuring water column sediment as it relates to aquatic life health. While turbidity is accepted as a surrogate to the state's narrative sediment standards (EPA 1999), it must be used with some level of caution or in conjunction with another sediment surrogate.

The reason for using caution is, in part, based on the laboratory methods by which turbidity is measured. Turbidity is expressed as the ratio of the amount of light transmitted through a sample of water to the amount of light scattered by debris in the sample. However, since the debris is nearly always composed of both organic (algae) and inorganic (sediment) material, the turbidity measurement takes into account material that is not readily harmful to aquatic life. In fact, it is possible to see elevated turbidity without any sediment in the water at all, such as is the case when the sample of water contains a significant amount of debris (that scatters light) and very little or no sediment. With that said, low turbidity levels typically also indicate low sediment levels.

Idaho Power Company has collected turbidity data at King Hill and Indian Cove since 1991. The data were collected monthly or bi-monthly and are available from 1991-1999 and 2002-early 2003. Turbidity data were not continuously collected during the years 1999-2001. As a result of this data gap, the data are evaluated based on 1995-1998 and 2002-early 2003.

Using data from the entire POR (1991-1999 and 2002-early 2003) at King Hill, the mean turbidity for all seasons is 13 NTU. The growing season mean turbidity is 14 NTU, while the non-growing season mean turbidity is 12 NTU. These means suggest that there is essentially no seasonal variability in turbidity. Thus, the data will be further evaluated on an annual basis.

Figures 25 and 26 show the turbidity levels at King Hill and Indian Cove for the years 1995-1998 and 2002-early 2003. As compared to the turbidity standard of *not to exceed 25 NTU for more than 10 consecutive days*, 11% (13 of 119) of the values exceed at King Hill while 7% (8 of 119) exceed at Indian Cove. The mean turbidity at King Hill is 15 NTU, while the mean turbidity at Indian Cove is 14 mg/L. The median turbidities at King Hill and Indian Cove are both 10 mg/L, which may actually be a better representation of the data since the values are not normally distributed.

Since the data were not collected for 10 consecutive days, a true comparison to the durational standard is again not possible. However, the means suggest that levels are typically below 25 NTU at both King Hill and Indian Cove.

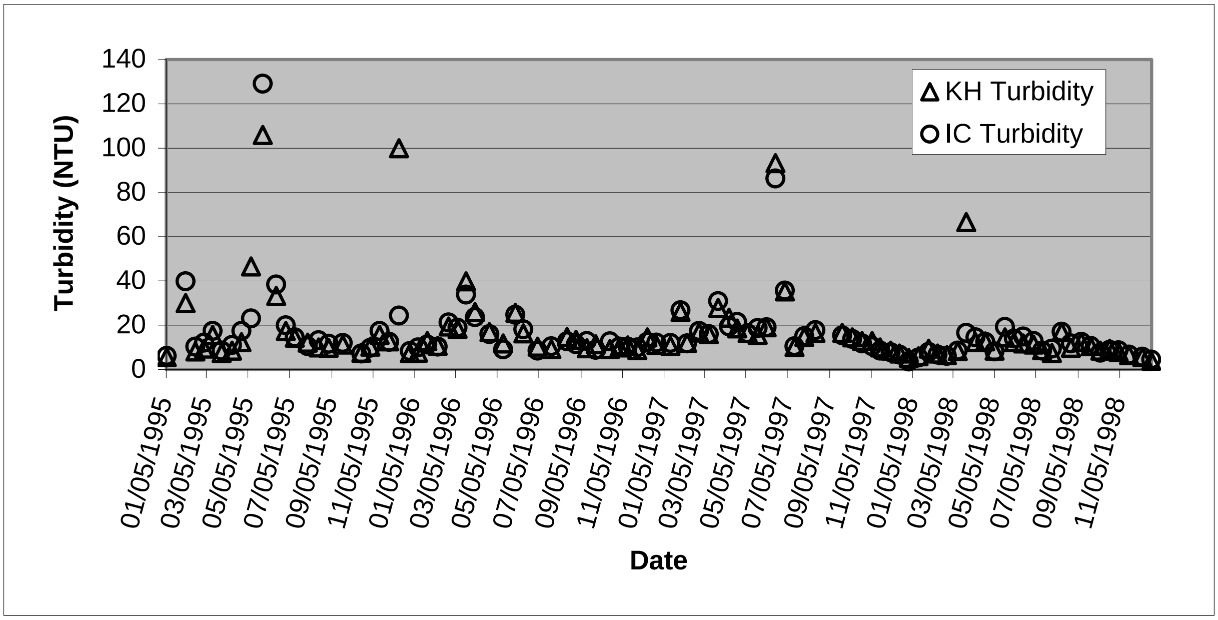


Figure 25. Turbidity levels at King Hill and Indian Cove for the years 1995-1998

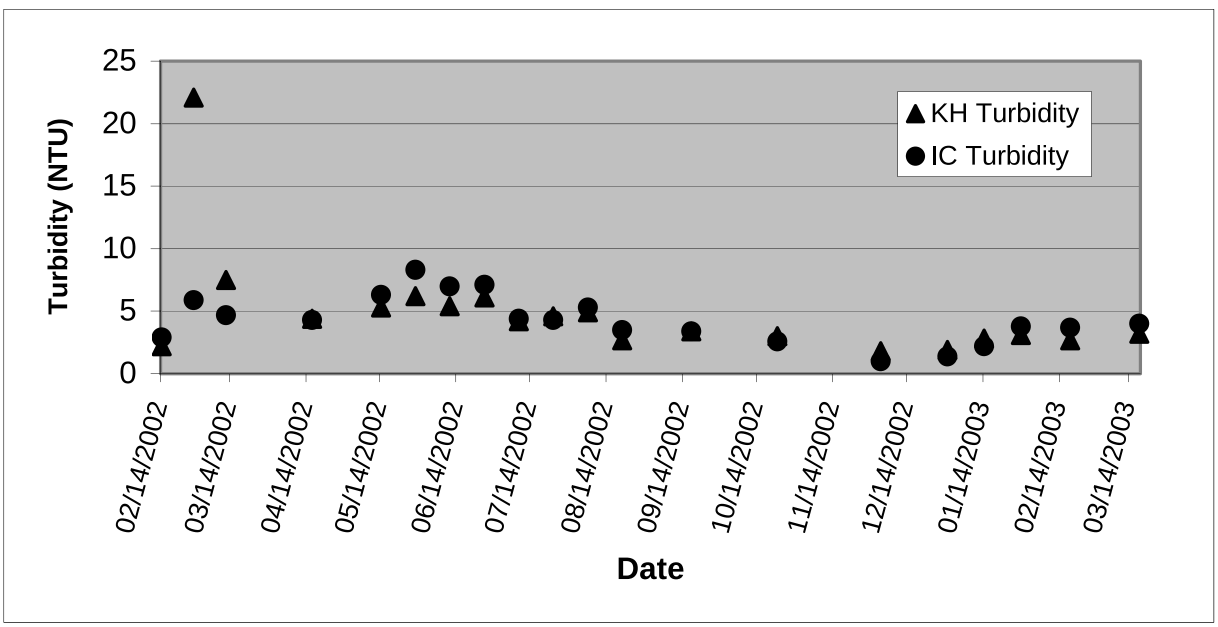


Figure 26. Turbidity levels at King Hill and Indian Cove for the years 2002-early 2003

Figures 27 and 28 show the change in turbidity between King Hill and Indian Cove. These figures are not effective in evaluating the data on a duration basis, but offer a better view of the data as they compare to 25 NTU and 50 NTU above background. As the standards relate to this analysis, the “background” condition is considered the concentration at King Hill. Thus, the change in turbidity between King Hill and Indian Cove should be less than 25 and 50 NTU.

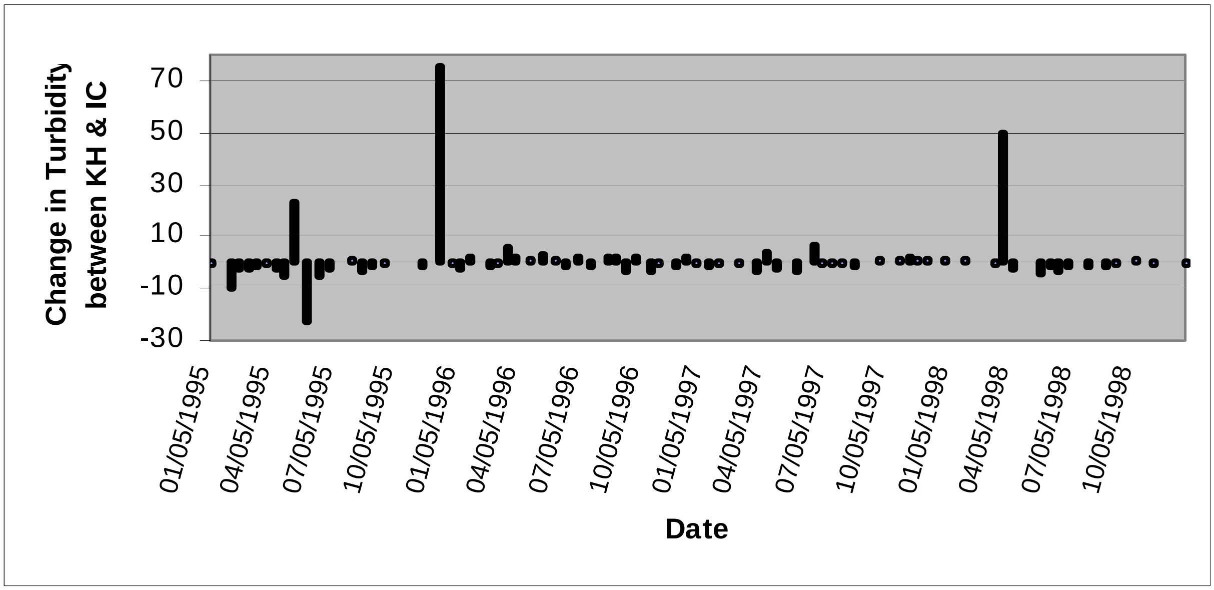


Figure 27. Change in turbidity between King Hill (KH) and Indian Cove (IC) for the years 1995-1998

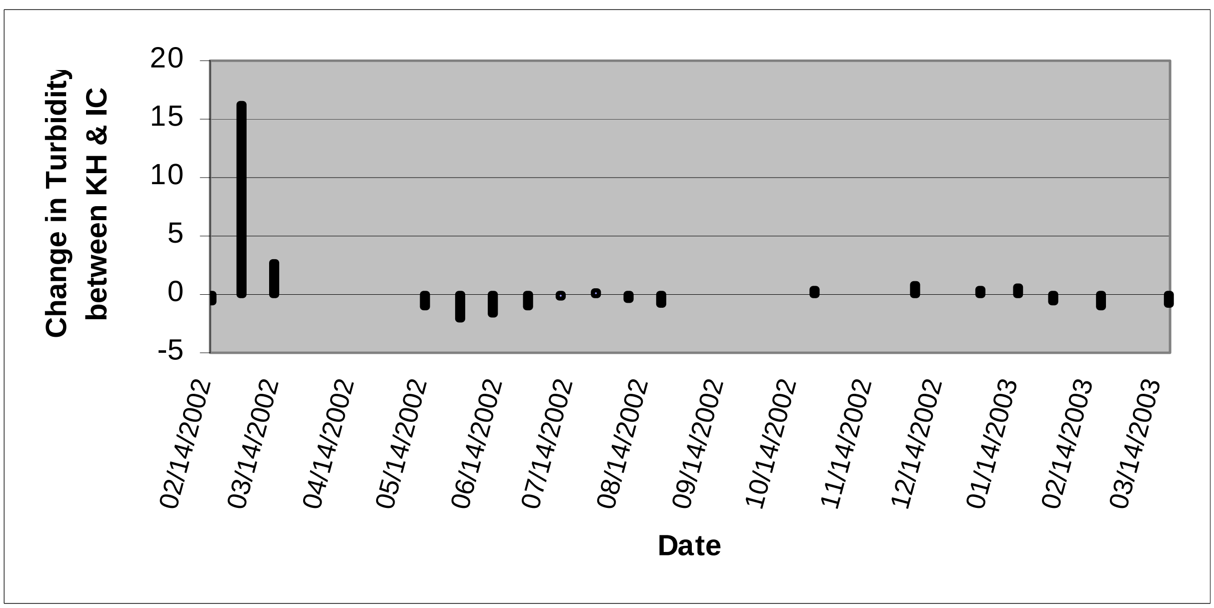


Figure 28. Change in turbidity between King Hill (KH) and Indian Cove (IC) for the years 2002-early 2003

Figures 27 and 28 show that the increase in turbidity between King Hill and Indian Cove is nearly always less than 25 NTU. Excursions above 25 and 50 NTU occurred in December 1995 and March 1998, but these increases are rare. Figures 27 and 28 are also effective in further showing that turbidity levels fluctuate very little between King Hill and Indian Cove. The mean change in turbidity between the two locations is an increase of 0.85 NTU.

Based on these analyses, turbidity levels in the Snake River between King Hill and Indian Cove are typically below the water quality standards. As such, turbidity does not appear to be impairing the designated use of cold water aquatic life or the potentially existing use of salmonid spawning.

Substrate Sediment Considerations/Macrophytes

While the SSC and turbidity data show that water column sediment is not impairing cold water aquatic life and salmonid spawning, there is an indication by Falter and Burris (1994) and a general agreement by the King Hill-C.J. Strike Reservoir Watershed Advisory Group (WAG) that there is excess sediment in the river bottom. The impetus for these findings is the resultant mass of aquatic plants that get their nutrients from the river bottom sediments. In recent years, the macrophytes have impaired recreation and aesthetics, primarily by impeding navigation. Falter and Burris (1994) found that macrophytic biomass in the river was strongly correlated to sediment total phosphorus levels, and that sediment total phosphorus levels were high. This is not surprising given the findings of other authors such as Carignan and Kalff (1980) and Barko and Smart (1981), who found that aquatic macrophytes predominantly grow with the substrate sediment as the primary source of nutrients. The authors went on to find that in the case of phosphorus, 90-100% of the uptake can be derived from root transport.

The excess amount of fine substrate sediment on the river bottom is the decisive factor in the production of excess macrophytes in the Mid-Snake River (Falter and Burris 1994). In recent years (2001-2004), the macrophytic biomass in the river has been very high. Idaho Power Company has tracked the number of truckloads of macrophytes removed from the trash racks at Upper Salmon Falls dam (~RM 580) since 1991. The data show that the number of truckloads removed in 2001-2003 are 419, 669, and 759, respectively. These numbers are notably higher than the average number of truckloads removed per year since 1991, which is 361. Correspondingly, 2001-2003 are three of the lowest flow years on record for the Snake River (see Figure 17). The lack of flushing flows to scour the substrate sediment in 2001-2003 and into 2004 appears to be one of the primary reasons aquatic macrophyte biomass is elevating. This can be further confirmed by the findings of Falter and Burris (1994) in which they noted that macrophyte biomass tends to decline when water velocities increase.

Appendix I shows the macrophyte beds on the Snake River between King Hill and Indian Cove during September 2004. According to some members of the King Hill-C.J. Strike WAG, the macrophytes were worse in 2004 than in recent memory. The macrophytes species identified by Falter and Burris (1994) in the Snake River were primarily *Potamogeton crispus, Potamogeton pectinatus,* and *Ceratophyllum demersum*. Epiphytic filamentous green algae were also identified. The species were primarily *Cladophora* and

Hydrodictyon. In terms of succession, the rooted macrophytes, epiphytes, and some non-rooted macrophytes were co-dominant through August; epiphytes were dominant through October.

The overabundance of sediment bound aquatic macrophytes in the Snake River appears to be in part due to an excess of organically rich fine sediment. While some level of aquatic macrophytes is very important to the river ecosystem, the macrophytes become a nuisance when they become excessive. As noted above, positive relationships have been developed between macrophytic biomass in the river and sediment total phosphorus levels. However, there exists very little information regarding the quantity of organic rich sediment required to generate excessive levels. As a result of this critical data gap, DEQ recommends initiating substrate sampling in the years immediately following high flow years. The expectation is that in the year(s) following high velocity flushing flows, the macrophytic biomass levels will be significantly reduced. Figure 29 shows a comparison of truckloads of macrophytes removed at Upper Salmon Falls dam to the average annual flow at King Hill. Note that in the years following the 1997 high flows, the macrophytes were significantly decreased, but in recent years when flows have been very low, the macrophytes were significantly increased.

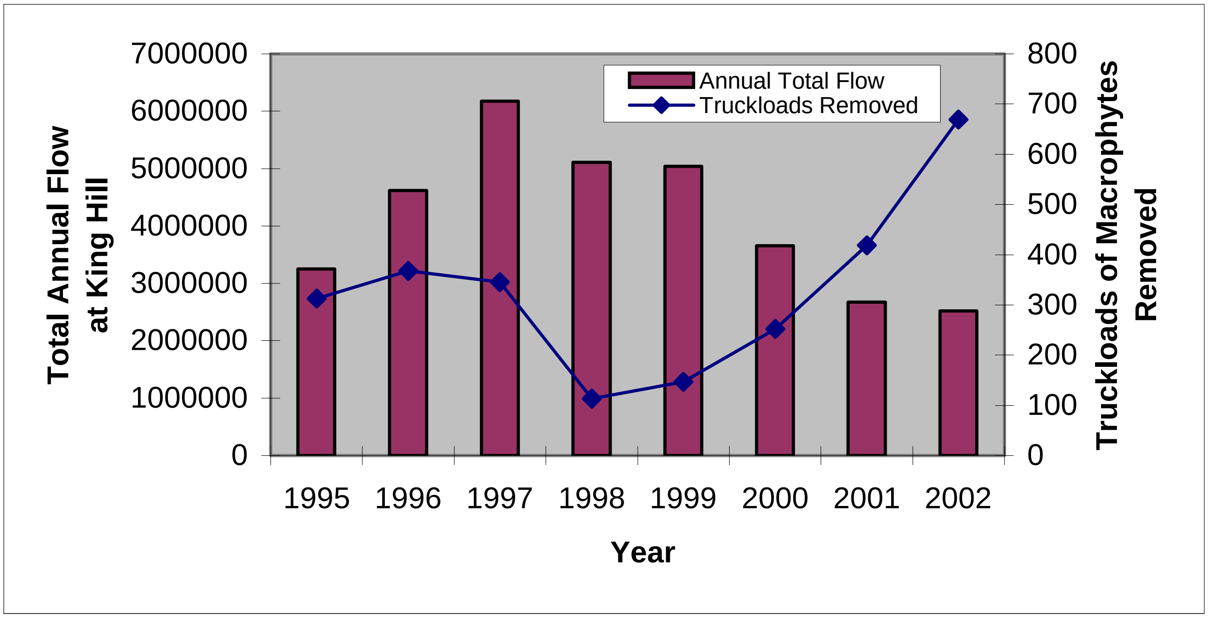


Figure 29. Number of truckloads of macrophytes removed from Upper Salmon Falls dam as compared to average annual flow at King Hill.

The intent of the additional sampling would be to characterize a "baseline" condition for which a potential substrate sediment TMDL can be developed. The intent of the TMDL would be to identify the amount of substrate sediment the river can assimilate before nuisance macrophytes begin to accumulate. Sediment levels beyond that assimilative capacity would be considered inappropriate. The details of this sampling will not be drafted as part of this assessment, but rather will be part of the TMDL implementation plan to follow.

Summary of Sediment Analysis

While the SSC and turbidity data show that water column sediment is not impairing cold water aquatic life and salmonid spawning, the overabundance of sediment-bound macrophytes indicates that substrate sediment may be in excess. As a result, DEQ does not recommend removing sediment from the §303(d) list. Rather, DEQ recommends preparing a water column sediment TMDL based on existing conditions to help manage any additional sediment that might be discharged to the river. The TMDL will not require reductions, but it will serve as a benchmark above which water column sediment levels in the river should not exceed. Chapter 5 outlines the TMDL in more detail.

Nutrient Loading Analysis

In determining whether excess nutrients are impairing aquatic life and contact recreation beneficial uses in a water body, the analysis of information must consider the effects of excess nutrients on nutrient related water quality parameters, such as dissolved oxygen levels, chlorophyll-a concentrations and aquatic plant masses. These secondary measures are considered numeric surrogates to the narrative water quality standard for nutrients. Rarely do excess nutrients themselves pose a threat to beneficial uses; it is the secondary effects that create impairment.

Defining the Limiting Nutrient

The goal when identifying a waters response to nutrient flux is to define which of the primary nutrients (nitrogen or phosphorus) is limiting the growth of aquatic plants. The nutrient that is in the shortest supply is typically defined as the limiting nutrient because its relative quantity can affect the rate of production of aquatic biomass. In fresh water, phosphorus tends to be the limiting nutrient. A general rule, often applied to determine which nutrient is limiting, is the nitrogen:phosphorus (N:P) ratio. If N:P is greater than ten, the limiting agent is typically phosphorus, and excessive algal growth will usually not occur if phosphorus is reduced appropriately. Conversely, if the N:P is less than 10, the limiting nutrient is typically nitrogen. It should also be noted that, in some systems, neither nutrient is limiting. This often occurs when the water is extremely enriched and both nutrients are in excess. Figure 30 shows the TN:TP ratios at King Hill on a monthly average basis for the years 1995-2002. To increase the robustness of this analysis, only paired data were used. That is, the samples used to calculate the TN and the TP sample were collected on the same day at the same time.

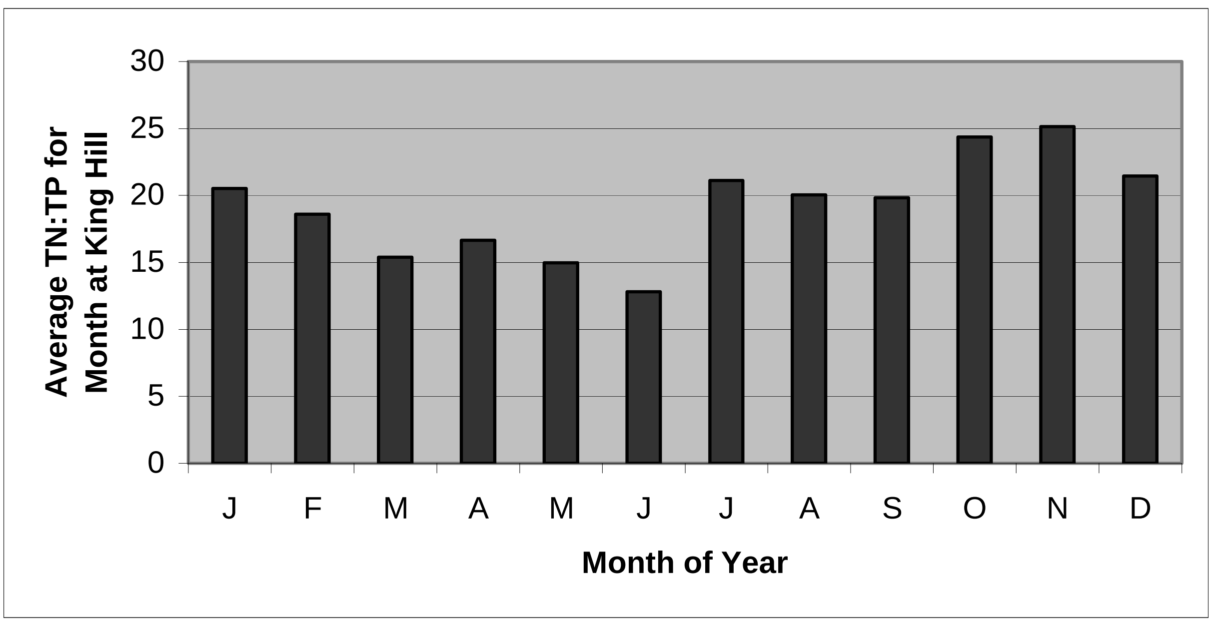


Figure 30. 1995-2002 monthly average TN:TP ratios at King Hill.

The data presented in Figure 30 shows that the TN:TP ratio exceeds 10 at all times of year thereby indicating that the Snake River is phosphorus limited. As such, the assessment of nutrients in the Snake River and any potential nutrient TMDL will be based on total phosphorus.

It is widely recognized that ortho-phosphate (OP) represents the readily bio-available fraction of total phosphorus. For this reason, it may seem to make sense to base phosphorus TMDL targets on ortho-phosphate rather than TP. However, ortho-phosphate is not a conservative constituent in terms of nutrient cycling through river and streams. Ortho-phosphate concentrations can change dramatically in a short distance or time due to growth or die-off of algae variations in dissolved oxygen concentrations. Ortho-phosphate can also convert between forms under favorable water column conditions and may not always be an accurate representation of the phosphorus available for biological consumption.

Total Phosphorus Target

As shown in Table 12, the standard for nutrients is narrative. The standard says, *"surface waters shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses."* Since the level of TP that will help preclude the development of nuisance aquatic growth in the Snake River between King Hill and Indian Cove is unknown, DEQ evaluated and chose to use the water column TP TMDL target of 0.075 mg/L TP developed for the adjacent upstream segment of the Snake River (DEQ 1997). As it applies to the Snake River between King Hill and Indian Cove, this target is applied as follows:

- **less than or equal to 0.075 mg/L (75 µg/L) total phosphorus at all locations in the river**

The rationale and justification for applying this TP target to the King Hill and Indian Cove segment of the Snake River is two tiered:

1. The derivation of the original target, as part of the Middle Snake River TMDL (DEQ 1997), accounted for EPA's (1986) recommended standards for free-flowing waters bodies (0.100 mg/L), lake tributaries (0.050 mg/L), and lakes and reservoirs (0.025 mg/L). It was concluded by the Middle Snake River Technical Advisory Committee (TAC) that the Middle Snake River was characterized by all three water types. As such, the TAC felt that 0.075 mg/L TP was a reasonable, preliminary target for water column TP. To help substantiate this target, the Middle Snake River TMDL also employed the RBM10 water quality model to verify whether the target of 0.075 mg/L TP was achievable (due to TMDL implementation) and protective of beneficial uses. The final model simulation showed that within ten years of TMDL implementation, proposed nutrient reductions should reach a concentration of 0.0728 mg/L TP at Gridley Bridge, which serves as the compliance point for the Middle Snake River TMDL. Thus, the target was achievable.

   Another aspect of the 0.075 mg/L TP target derived from the RBM10 model simulations was that plant biomass (macrophytes and epiphytes) responded somewhat to TP reductions. The simulations showed that after implementation of the targets, the plant biomass was reduced by 20-30%, thereby reducing the impacts of excess aquatic vegetation on beneficial uses in the Middle Snake River.

2. For the analysis of nutrient data (TP) as it relates to beneficial use support status, EPA (2000d) guidance suggests identifying three concentration ranges based on a frequency of distribution as a starting point for determining reference conditions, at risk conditions, and impaired condition. This analysis was performed as part of the Snake River-Hells Canyon TMDL (DEQ 2004) for three reaches of the Snake River: river miles greater than 600, river miles 400-600, and river miles 409-335. In order to ensure representative ranges, and minimize the potential that outliers in the data would create a bias, the lowest and highest measured values (5%) were eliminated from consideration. The assessment was accomplished using the data distributed between the 5th and 95th percentiles. This data distribution was then divided evenly into three categories, with the 35th percentile concentration defining the threshold below which reference conditions would be defined, and the 65th percentile defining the threshold above which impairment was projected to occur. The concentration range described between the 35th and the 65th percentiles was recommended as a definition of allowable conditions, with lower values tending toward better water quality conditions and higher concentration values being defined as more at risk for impairment. Table 15 shows the results of the analysis for river miles 400-600, the segment in which the King Hill (546) to Indian Cove (525) reach is located.

Table 15. Distribution of all available total phosphorus data within Snake River miles 400-600

Snake River Reach	Data Range	35th Percentile	65th Percentile
Snake River between (RM 400 and 600)	0.022 to 0.411	0.065 mg/L	0.077 mg/L

Using the general guidance from the EPA (2000d), the 35th percentile data from the section of the Snake River between river miles 400 and 600 was used to identify concentration values appropriate to reference conditions for the Snake River system. Within this data set, total phosphorus concentrations equal to or less than 0.065 mg/L would represent high quality “reference” conditions. Applying the 65th percentile concentration value as the threshold concentration above which impairment would be projected to occur would establish an upper concentration limit of 0.077 mg/L for total phosphorus. This correlates well with the proposed target of 0.075 mg/L for the support of designated beneficial uses.

Analysis of Total Phosphorus Data

Total phosphorus concentration data have been collected at King Hill by the USGS and at King Hill and Indian Cove by Idaho Power Company since 1967 and 1992, respectively. Data were typically collected on a monthly or bi-monthly basis. While the USGS data are more robust in terms of the years represented, the Idaho Power Company data are used for the TP analysis because, as opposed to the USGS data, they were collected at multiple locations along the segment. Using the Idaho Power Company data ensures better precision in terms of King Hill and Indian Cove data comparability. As with the SSC analysis, 1997-

2002 data are the years for which the analysis is focused. These years were chosen because they represent the variance in flows and concentrations expected to occur over the long-term, and the data that were collected during these years is more robust than previous years.

Figure 31 shows the annual mean and growing season mean TP concentrations at King Hill for the 1997-2002 POR. As illustrated by the similarity in the values, there appears to be very little seasonal variability in concentrations. The annual mean TP concentration is 0.084 mg/L while the growing season mean TP concentration is 0.088 mg/L. Since there is nominal seasonal variability, the 1997-2002 data from all seasons are used in further analysis and are the basis for evaluating current conditions against the TP target discussed above.

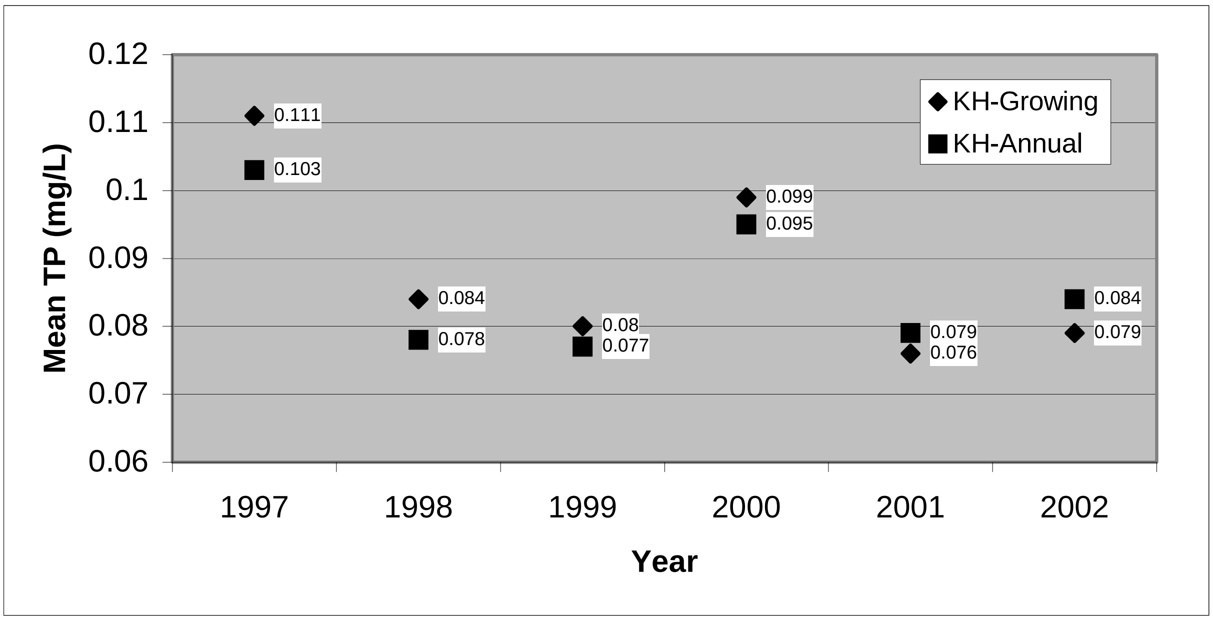


Figure 31. Annual mean and growing season TP concentrations at King Hill, 1997-2002 data.

Figure 32 shows the mean monthly TP concentrations by year at King Hill as compared to the 0.075 mg/L target. Figure 32 shows the mean monthly TP concentration by month. The data shown in figure 32 show that the mean monthly TP concentrations are slightly above or slightly below the target, depending on the year. The yearly variation is likely due to the annual differences in flows and the availability of biomass to consume the phosphorus. Significant excursions above the target occurred in March and April 1997 (flood year) and in June 1998, but these are anomalies and do not represent normal conditions. Figure 33 shows that on a monthly basis over the POR the concentrations are nearly always above the target. Only in October and November do concentrations fall below the target.

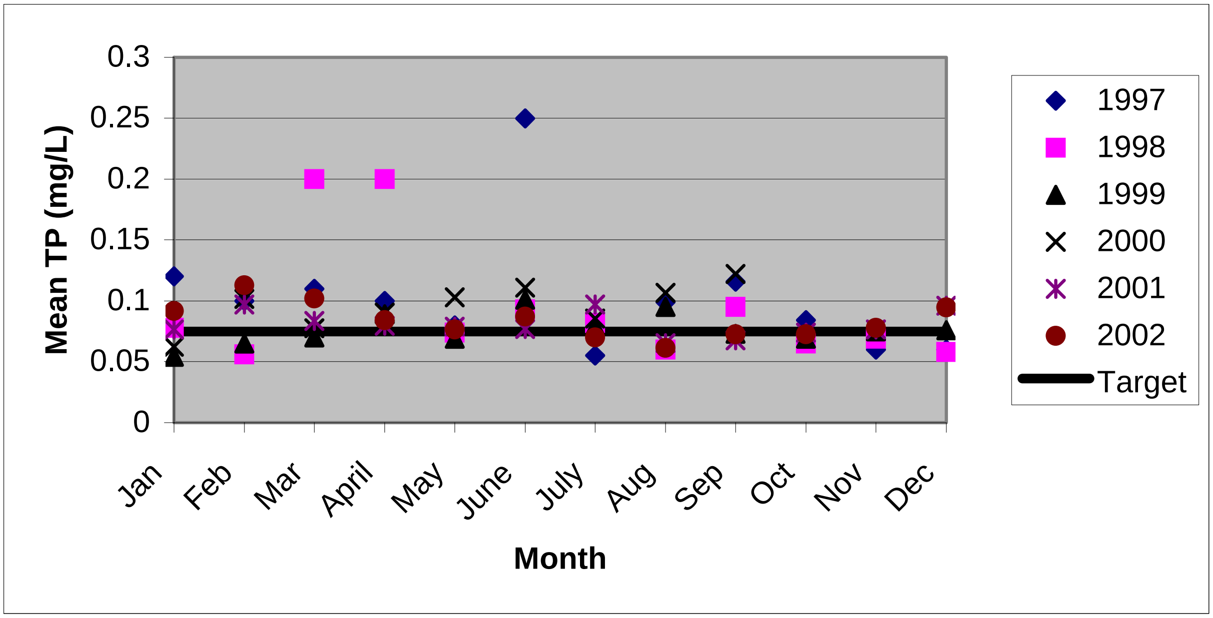


Figure 32. Monthly mean TP concentrations by year at King Hill, 1997-2002 data.

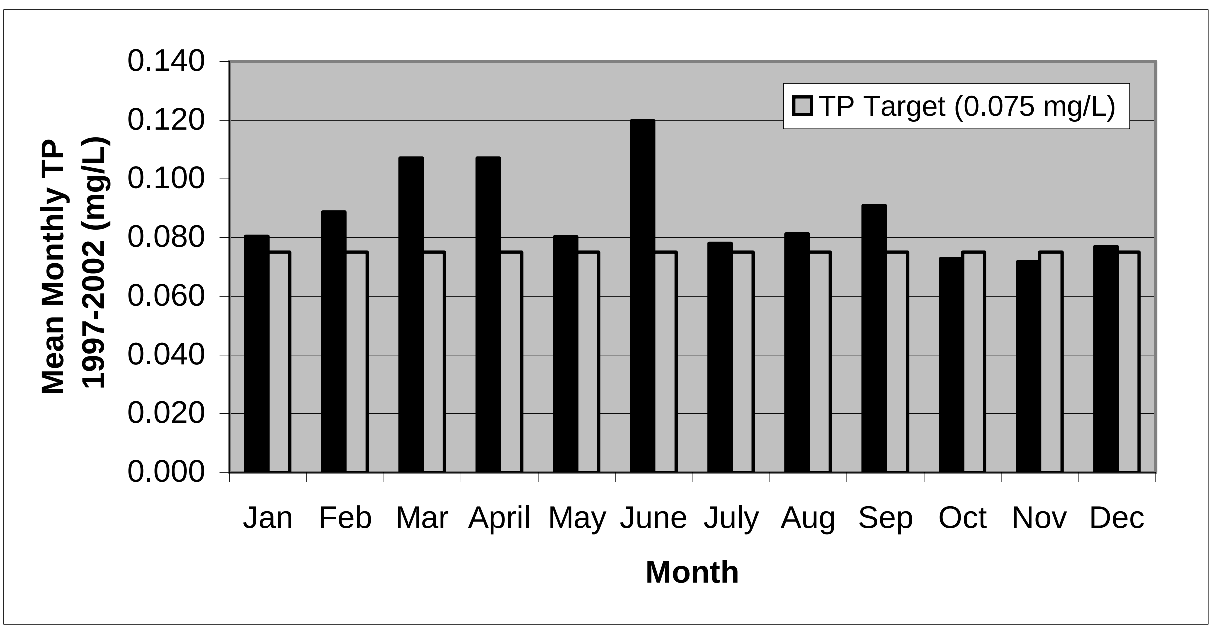


Figure 33. Monthly mean TP concentrations by month at King Hill, 1997-2002 data.

Figures 31-33 show that under current conditions, TP concentrations at King Hill exceed the target concentration of 0.075 mg/L. Using the data for all seasons, the calculated mean concentration at King Hill is 0.084 mg/L. This is the concentration that will be used as the current boundary condition for this assessment. As such, the target is exceeded and reductions are is necessary from the upstream segment of the Snake River to meet the target concentration at King Hill. In terms of concentration, this is quite a small reduction. However, the load associated with the concentration is somewhat larger. The load reduction associated with the concentration reduction is discussed in Chapter 5. It should be noted that while a TMDL is necessary, the Upper Snake Rock TMDL established TP target of 0.075 mg/L. The intent of the Upper Snake Rock TMDL is to meet 0.075 mg/L TP at King Hill.

As mentioned above, Idaho Power Company has collected water quality data at King Hill and Indian Cove. Monitoring at Indian Cove was discontinued in 2003, but monitoring continues on a voluntary basis at King Hill. The data from 1997-2002 are used to determine whether there is a net increase in TP concentration between the two monitoring sites. King Hill serves as the upstream boundary condition, while Indian Cove serves as the downstream compliance point. However, the expectation is that the Snake River must meet the 0.075 m/L target of at all locations between the two sites.

Figure 34 shows the annual mean TP concentrations at King Hill and Indian Cove. The data show that in most years the concentration at Indian Cove is nearly identical or slightly lower than King Hill. The year 2001 is the only exception. Figure 35 shows the mean monthly comparisons. As with the annual comparison, the monthly comparisons show that concentrations at Indian Cove are nearly always lower than King Hill. Using the data for all seasons, the calculated mean concentration at Indian Cove is 0.083 mg/L, further suggesting there is a slight decrease in concentration between the two sites.

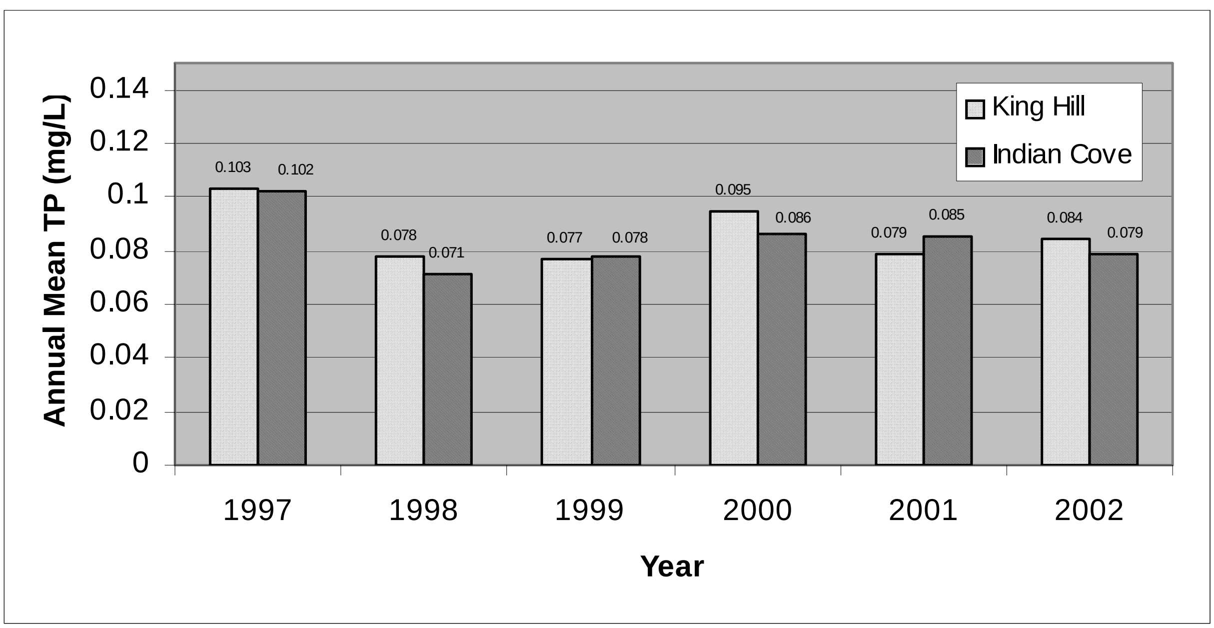


Figure 34. Annual mean TP concentrations in the Snake River at King Hill and Indian Cove, 1997-2002 data.

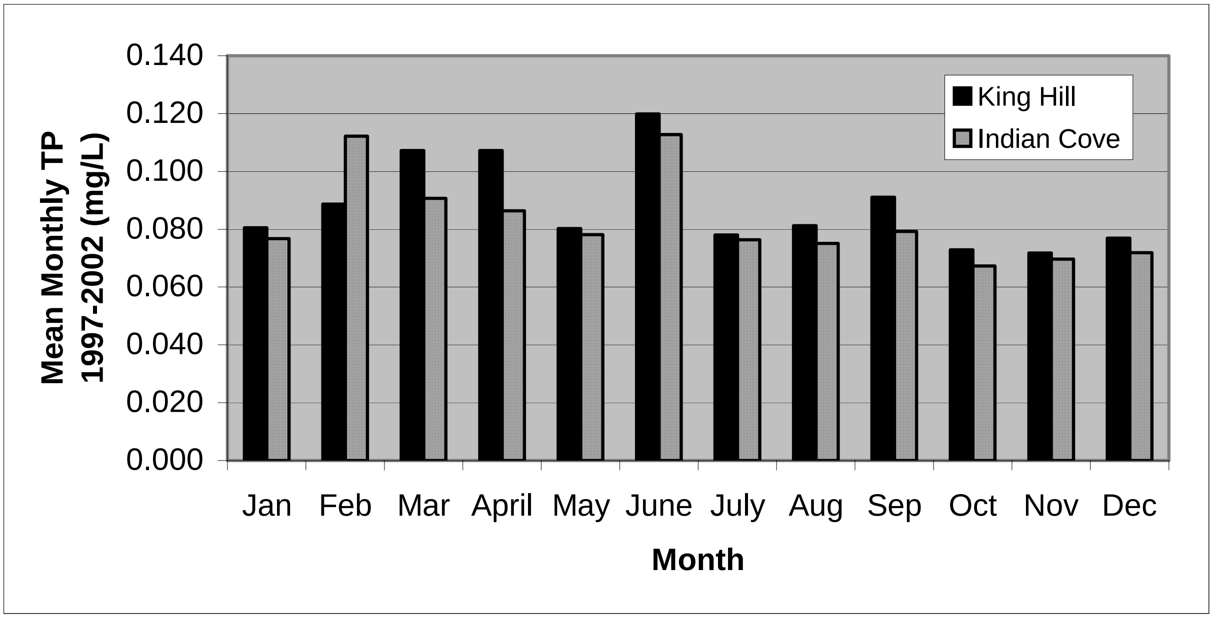


Figure 35. Mean monthly TP concentrations in the Snake River at King Hill and Indian Cove, 1997-2002 data.

Table 16 summarizes the current TP concentrations in the river at King Hill and Indian Cove as well as the current conditions as compared to the 0.075 mg/L target. Total phosphorus reductions are necessary at King Hill in order to meet the target.

Table 16. Summary of TP concentrations at King Hill and Indian Cove

River Location	Current TP Concentration (based on 1997-2002) data	TP Target
King Hill	0.084 mg/L	0.075 mg/L
Indian Cove	0.083 mg/L	0.075 mg/L

Figures 34 and 35 show that in most years TP concentrations in the water column decrease between King Hill and Indian Cove. An evaluation of the algal growth dynamics and the surface water TP sources between the two locations reveals that this phenomenon is not unexpected. Figure 36 shows annual mean TP concentrations at King Hill and Indian Cove as compared to the mean annual chlorophyll-a concentration at each site. Chlorophyll-a is a measure of algal biomass. The figure shows that in any given year the chlorophyll-a concentrations increase between King Hill and Indian Cove whereas the TP concentrations decrease. This dynamic likely occurs because the rate of TP loading between King Hill and Indian Cove does not exceed the rate at which algae and other aquatic plants consume the phosphorus.

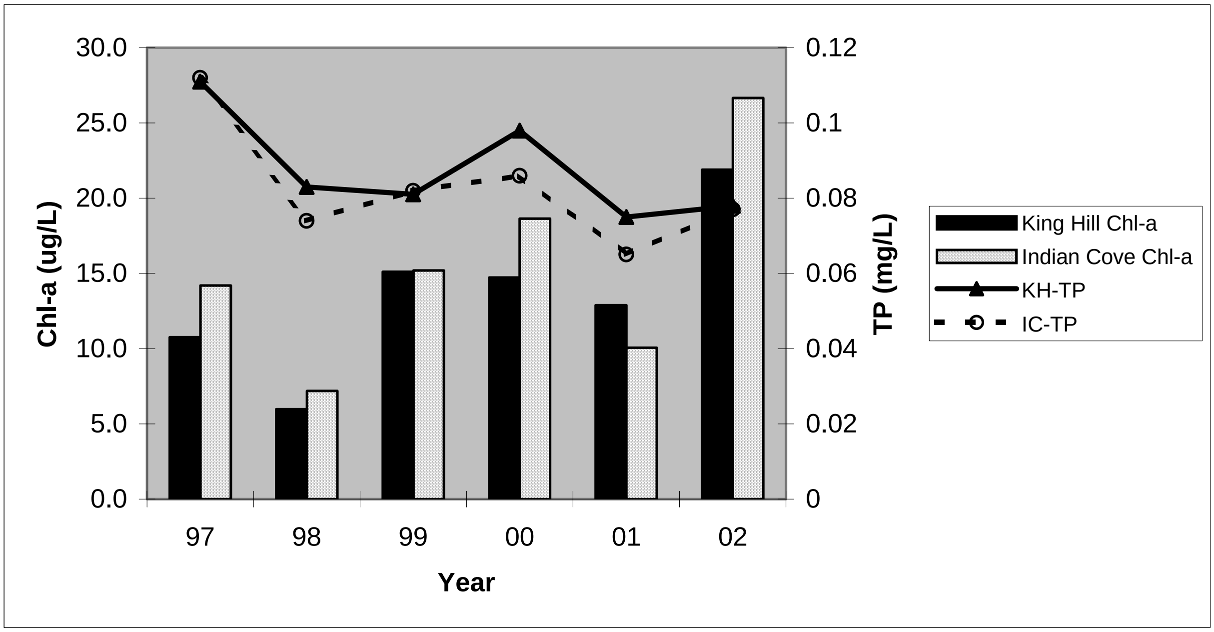


Figure 36. Annual mean TP concentrations at King Hill and Indian Cove as compared to the mean annual chlorophyll-a concentrations.

The "current TP concentrations" column in Table 16 and the data shown in Figure 36 suggest that TP loading between King Hill and Indian Cove is miniscule, is balanced by the consumption of the nutrients by algae, or a combination of both. It is likely a combination of both. To further investigate source loading between King Hill and Indian Cove, the loading potentials of King Hill, Little Canyon, Alkali, Cold Springs, and Bennett Creeks (the only tributary sources in the river segment) as well as the Glenns Ferry wastewater treatment plant (WWTP) were evaluated.

Figure 37 shows a very conservative estimate of the current TP loads from King Hill, Little Canyon, Alkali, Cold Springs, and Bennett Creeks as compared to the load in the Snake River (assuming the 0.075 target is met) and the resultant mixed concentration due to the sum of the tributary loads. The estimate is conservative because it is based on an in-river flow of 4717 cfs, which is the lowest minimum of the daily mean flows at King Hill. The figure shows that at no time does the in-river concentration increase beyond 0.075 mg/L. This is the case because of dilution. There simply is not a large enough TP load in the tributaries to make a noticeable difference in the river even using very conservative assumptions. Based on a river load of 1,910 lbs/day, the actual increase in river load due to the tributaries (total of 48 lbs/day) is approximately 2.5%. Using a typical (and more realistic) load of 4,619 lbs/day, the approximate increase would fall to 1.0% of the river load.

Stream Name	Measured Mean Flow	TP Conc.*	TP Load in Trib (lbs/day)	Snake River Flow**	Snake River Load (.075 mg/L)	Mixed Conc. in River
Cold Springs Creek	6.1	0.127	4.18	4717	1910.39	0.0751
Little Canyon Creek	18	0.207	20.12	4717	1910.39	0.0755
Bennett Creek	4.5	*0.207*	5.03	4717	1910.39	0.0751
Alkali Creek	0.85	*0.207*	0.95	4717	1910.39	0.0750
King Hill Creek	16	*0.207*	17.88	4717	1910.39	0.0754
*Bennett, Alkali, and King Hill Creek concentrations based on Little Canyon Creek concentration						***0.0754***
**Estimated lowest minimum of the daily mean flows for the POR at King Hill = 4717 cfs						

Figure 37. Estimated tributary TP loads as compared to in-river load and change in concentration.

The Glenns Ferry WWTP is authorized to discharge to the Snake River under National Pollutant Discharge Elimination System (NPDES) number ID-002200-04. The current permit, which was issued on November 24, 2003, does not include effluent limits for total phosphorus. Additionally, the city of Glenns Ferry does not currently monitor the effluent concentrations for total phosphorus. This requirement is scheduled to begin in January 2006.

To evaluate how the Glenns Ferry WWTP total phosphorus load affects the Snake River, a site specific mass balance for the river between King Hill and the Glenns Ferry discharge point was developed. The intent of the mass balance was to determine the expected TP load in the river directly above the discharge point. The river load was then mixed with the WWTP load to determine the concentration and load increase attributable to the WWTP. Appendix J shows the mass balance spreadsheet, which illustrates that concentration and load increases in the Snake River, as a result of the WWTP discharge, are 0.0006 mg/L and 25.7 lbs/day, respectively. The percent increases above Snake River concentration and load conditions are both around 0.90%. Table 17 summarizes the results of the spreadsheet. The TP concentration in the river after the Glenns Ferry WWTP is added increases diminimusly to 0.076 mg/L.

Table 17. Increase in TP concentration and load in the Snake River due to the Glenns Ferry WWTP

Change	Increase in the Snake River	Percent Increase
TP concentration increase due to WWTP	0.0006 mg/L	0.85%
TP load increase due to WWTP	25.7 lbs/day	0.86%

As illustrated in Figure 37, Appendix J and Table 17, the increase in TP concentration in the river as a result of the tributaries and the Glenns Ferry WWTP are negligible. Again, the reason for this negligible increase is due to the dilution factor of the Snake River. Neither the tributaries nor the WWTP increase the in-river TP concentration to a level significantly above the 0.075 mg/L target even using very conservative assumptions.

Even though the above analysis shows that TP levels in the river do not increase significantly due to the tributaries and the Glenns Ferry WWTP, load and wasteload allocations will still be developed for the sources. Since the river is currently exceeding the TP target, allocations must be established to set a baseline loading level, beyond which the sources should not exceed. The load allocations for the tributaries will be based on current conditions, as described in Figure 37. The wasteload allocation for the WWTP will be based on the plants current design capacity. The intent of the wasteload allocation will be to protect water quality in the river in the event that the facility grows beyond its current design capacity. The details of the load and wasteload allocations are outlined further in Chapter 5.

Biological and Other Surrogate Nutrient Parameters

Surrogate measures are particularly useful in determining beneficial use support status as it relates to nutrient enrichment because nutrient enrichment itself typically does not impair uses: the *side effects* of enrichment cause impairment. These side effects include elevated algae growth (chlorophyll-a), low (or extremely high) dissolved oxygen (DO) concentration, and pH shifts. Excessive aquatic plant growth (macrophytes and epiphytes) can also be enhanced by nutrient enrichment, but recent literature specific to the Snake River found that substrate bound nutrients are more of an issue than water column nutrients. The following section describes the analysis of the chlorophyll-a , DO, and pH surrogate parameters as they relate to phosphorus enrichment in the river and the water quality standards.

Chlorophyll-a

The evaluation of chlorophyll-a concentrations as they related to nutrient enrichment and contact recreation beneficial use support status often takes into account both water column (suspended) and benthic (substrate attached) chlorophyll-a. In large rivers, such as the Snake River, benthic chlorophyll-a is typically not evaluated because poor river clarity often precludes the development of benthic algae. Additionally, benthic chlorophyll-a is difficult to sample in large rivers. For this assessment, only water column chlorophyll-a was be evaluated.

Chlorophyll-a is the essential photosynthetic pigment found in aquatic plants. The amount of chlorophyll-a in suspended algae is commonly used to measure algal productivity. While chlorophyll-a concentrations vary from species to species, it remains a viable surrogate for algae biomass (Carlson, 1980, Watson et al., 1992). The EPA also suggests that chlorophyll-a is a desirable endpoint because it can usually be correlated to loading conditions (EPA, 1999). While the state of Idaho does not have a numeric criterion for chlorophyll-a, several other states and authors have developed targets based on a variety of conditions. The state of Oregon's threshold is 15 µg/L. When the Oregon threshold is exceeded in an average of three samples at a representative location, a follow-up is made to ascertain if a beneficial use is adversely impacted. The state of North Carolina has a chlorophyll-a criterion of 40 µg/L, which indicates impairment. Raschke (1993) proposed a level of 25 µg/L for surface waters used for viewing pleasure, boating, safe swimming, and fishing and also developed discoloration ratings based on corresponding concentration. Table 18 shows Raschke's (1993) discoloration ratings.

Table 18. Water discoloration linked to chlorophyll-a concentrations for waters in the southeastern United States.

Chlorophyll-a (µg/L)	Degree of Water Discoloration
Less than 10	No water discoloration
10 to 15	Some discoloration, some development of algae scums
20-30	Deep discoloration, frequent algal scum formation
Greater than 30	Very deep discoloration, intense matting of algal scums

The ranges identified above as being protective of designated beneficial uses extend from less than 10 µg/L to 40 µg/L. Using these ranges as a starting point, the downstream Snake River-Hells Canyon TMDL (DEQ 2004) further evaluated the numbers to determine concentrations protective of aesthetics, recreation, and domestic water supply. The results of the analysis yielded a chlorophyll-a target of 14 µg/L.

The allowable level of exceedance for this target is recognized as a critical factor in the support of designated beneficial uses. Frequency exceedance levels of up to 25% were found to be protective for recreational uses by Smeltzer and Heiskary (1990) and have been applied in this assessment. Given the existing data set at King Hill and Indian Cove, based on summer growing season chlorophyll-a concentrations, this 25% exceedance level, combined with the 14 µg/L mean growing season concentration target results in a nuisance threshold of 30 µg/L chlorophyll-a. The chlorophyll-a targets as they apply to the Snake River between King Hill and Indian Cove can be written as follows:

- **14 µg/L mean growing season chlorophyll-*a* concentration**
- **No greater than 25% of the data shall exceed the nuisance threshold of 30 µg/L chlorophyll-*a***

Figure 38 shows the mean growing season chlorophyll-a concentrations at King Hill and Indian Cove for the years 1997-2002. Other than 2001, the chlorophyll-a at Indian Cove is essentially equal to or higher than King Hill. Table 19 shows the same data in table format. Interestingly, chlorophyll-a concentrations are very low at both locations in 1998, the year after the 1997 flood.

As the concentrations compare to the mean growing season target (14 µg/L), the target is exceeded at King Hill in 1999, 2000, and 2002 and at Indian Cove in 1997, 1999, 2000, and 2002. To account for the disparity in years exceeded and year not exceeded the mean concentration for all growing season during 1997-2002 POR was calculated. The values are 15 µg/L at King Hill and 17 µg/L at Indian Cove. Both are greater than the 14 µg/L target, indicating that chlorophyll-a is in excess and excessive aquatic plants are impairing contact recreational beneficial uses.

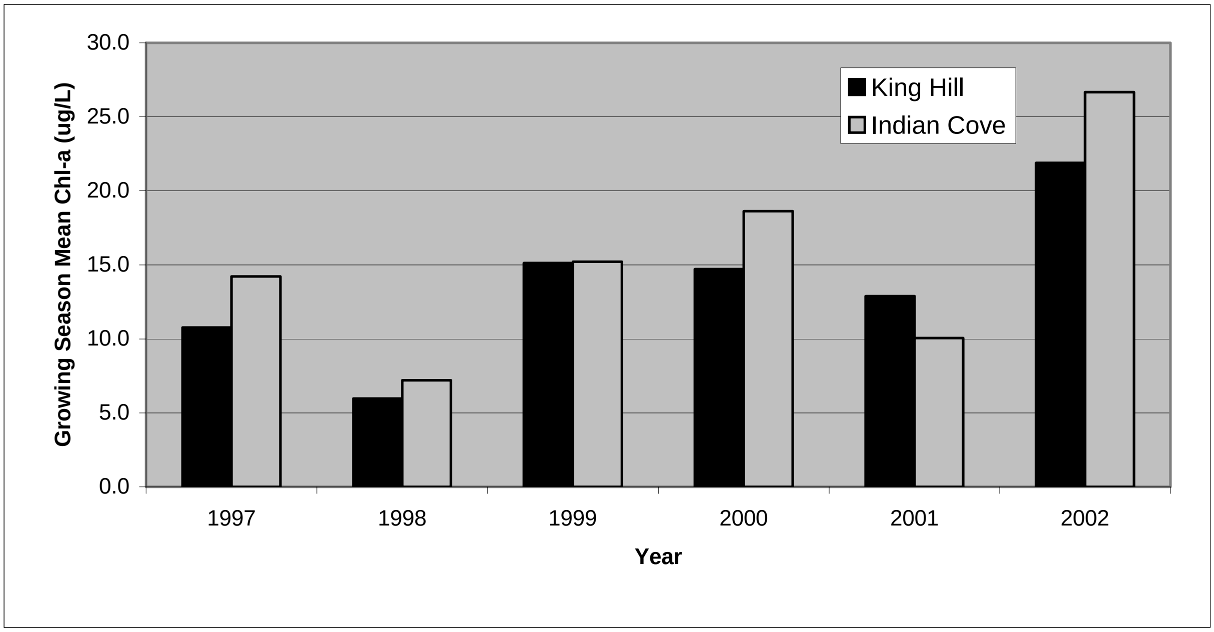


Figure 38. Mean growing season chlorophyll-a concentrations at King Hill and Indian Cove, 1997-2002 data.

Table 19. Mean growing season chlorophyll-a concentrations at King Hill and Indian Cove, 1997-2002 data.

Year	King Hill - Growing Season Mean Chl-a (µg/L)	Indian Cove - Growing Season Mean Chl-a (µg/L)
1997	10.8	14.2
1998	6.0	7.2
1999	15.1	15.2
2000	14.7	18.6
2001	12.9	10.1
2002	21.9	26.7

As the chlorophyll-a concentrations compare to the nuisance threshold target (less than 25% should exceed 30 µg/L), the target is not exceeded at King Hill or Indian Cove. Using the 1997-2002 data, 9.2% and 11.1% of the concentrations exceed 30 µg/L, respectively. This indicates that while the concentrations do reach levels that cause some discoloration (as indicated by the growing season means above), they rarely reach levels that cause deep discoloration and frequent algal scums.

Dissolved Oxygen

Dissolved oxygen concentrations can be a direct indicator of nuisance aquatic growth in that as aquatic algal biomass increases, the amount of nighttime respiration increases as well. As respiration increases, the volume of oxygen removed from the water increases. Thus, DO concentrations decrease. In excessive algae growth situations, the result is often low DO concentrations that stress or even kill sensitive species of fish and macroinvertebrates.

Opposite of DO decreases (sags) that occur during the night due to respiration, it is also common to observe DO over-saturation during the day. This occurs when excess algae photosynthesize and create elevated amounts of oxygen that over saturate the water column. This phenomenon is not as critical as oxygen sags in terms of tracking aquatic life support, but it is an indicator of aquatic plant enrichment.

As shown in Table 12, the state has numeric criteria for DO in surface waters. For lotic waters (flowing water such as rivers and streams), the standard says DO shall be "*greater than 6.0 mg/L at all times*." There are exemptions for some parts of lakes and reservoirs, which will be discussed later in the reservoir assessment.

Figure 39 shows the DO concentrations at King Hill and Indian Cove for all times of the year between 1997 and 2002. Concentrations never fall below 6.0 mg/L despite a clear abundance of macrophytes and epiphytes. The mean concentration at King Hill is 10.12 mg/L, while the mean concentration at Indian Cove is 10.50 mg/L. These concentrations equate to about 100% oxygen saturation. The slight increase in mean DO concentration appears to be due to the in-river increase between King Hill and Indian Cove in the years 2000-2002.

Unfortunately, the data shown in Figure 39 were all collected during the daytime hours. As mentioned above, DO sags are expected to occur during the night when respiration is occurring. These data do not allow for the investigation of nighttime sags. In an attempt to partially fill the data gap, King Hill samples collected before 9:00 a.m. were evaluated separately to determine the change in concentration. DO is expected to be at its lowest at dawn because algae have been respiring throughout the night. At 9:00 a.m. the sun has only been up for 2.5-3 hours. If DO levels were very low at dawn, they should still be relatively low at 9:00 A.M.

The King Hill DO data collected before 9:00 a.m. reveals a concentration of 9.09 mg/L. This value is 1.03 mg/L lower than the mean concentration for all data (10.12 mg/L) indicating that DO does sag at night. However, since the concentration is still well above 6.0 mg/L, DO sags significantly below the criteria probably do not occur.

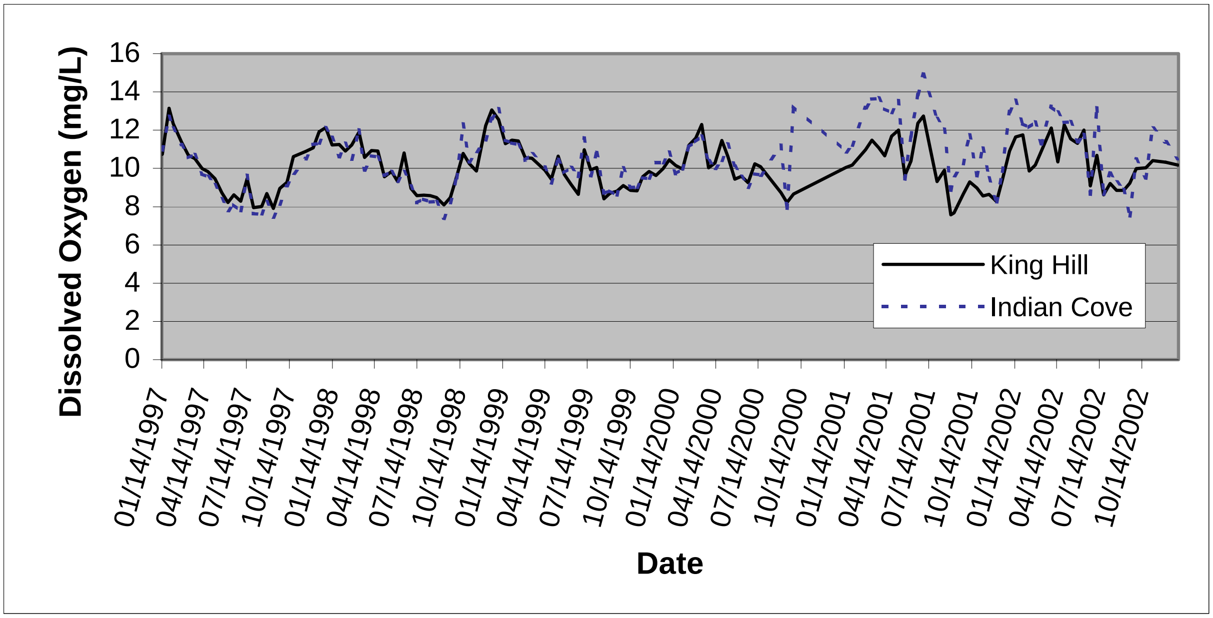


Figure 39. Dissolved oxygen concentrations at King Hill and Indian Cove, 1997-2002 data.

Figure 40 shows the DO concentration at King Hill and Indian Cove, separated by the growing season (March-October) and the non-growing season. As expected, DO concentrations are slightly lower during the growing season. Again, this is likely due to the respiratory activities of excess macrophytes and epiphytes at night. During the non-growing season, when aquatic plants are less abundant, the DO levels increase and stabilize.

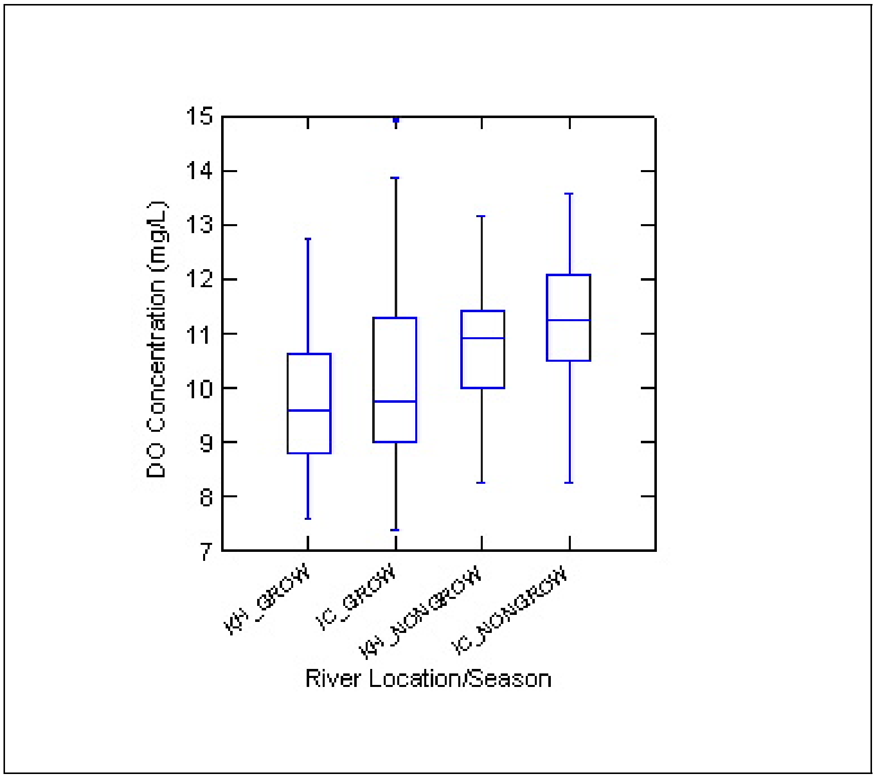


Figure 40. Growing and non-growing season DO concentrations at King Hill and Indian Cove, 1997-2002 data.

pH

pH is a measure of the concentration of hydrogen ions in water. Waters that display a very high or very low ionic concentration typically have restricted flora and fauna, in both species richness and abundance (Allan 1995). The effects of excess nutrients on pH levels in lotic waters such as the Snake River are in part a function of the nutrient-algae relationship and ultimately a function of the algal biomass in the system. When algal biomass conditions become very excessive, the water body typically experiences an increased volume of carbon dioxide in the water at night due to plant respiration. This increase in carbon dioxide beyond the normal range disrupts the stream's ability to buffer itself. When carbon dioxide levels increase, the pH typically drops. If the river has the ability to buffer itself, pH shifts may not be noticeable. However, the data should be evaluated to determine the rivers buffering ability.

As was shown in Table 12, the state has numeric criteria for pH in surface waters. For lotic waters (flowing water such as rivers and streams), the standard says *"hydrogen ion concentration (pH) values shall be within the range of 6.5 to 9.0."*

Figures 41 and 42 shows the range of pH values at King Hill and Indian Cove for the years 1997-2002. Figure 42 shows that the median, 70th and 90th quartiles at King Hill and Indian Cove are essentially the same. The median values are 8.27 and 8.26, respectively. The pH at

Indian Cove briefly exceeded nine in 2002 (Figure 40), but the exceedence does not appear to be chronic and do not represent typical conditions. Only 2.2% of the data for the 1997-2002 period exceed nine. These exceedances are likely due to the very low flow conditions that occurred in 2002.

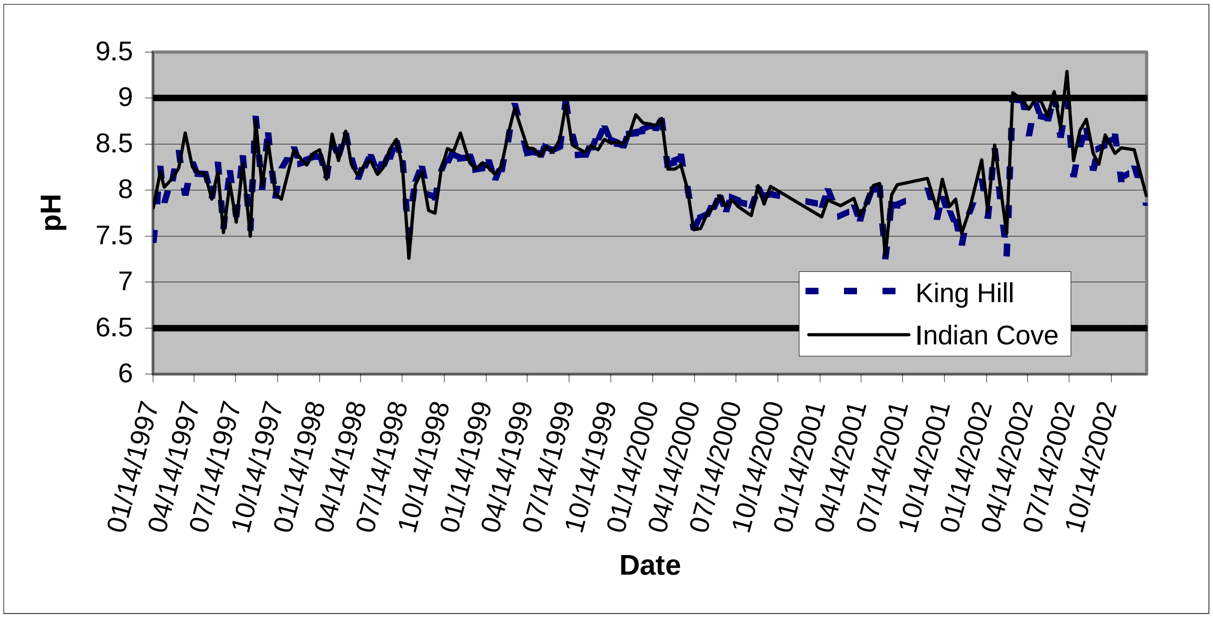


Figure 41. pH values at King Hill and Indian Cove, 1997-2002 all data.

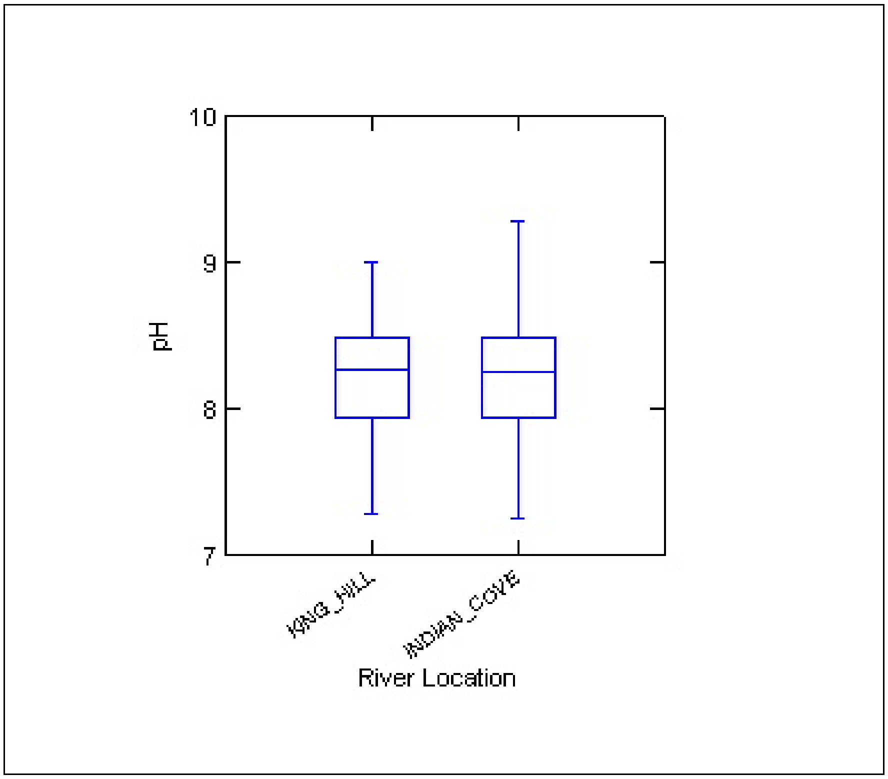


Figure 42. pH values at King Hill and Indian Cove, 1997-2002 all data.

Conclusions and Status of Beneficial Uses in the Snake River

The sediment data analysis shows that turbidity and suspended sediment levels in the Snake River between King Hill and Indian Cove are below the target concentrations and are at levels that would not be expected to impair cold water aquatic life beneficial uses. However, the presence of excess amounts of substrate-attached macrophytes indicates that substrate sediment is in excess. The macrophytes are impairing contact recreation and aesthetic beneficial uses. While no reductions will be necessary, DEQ will develop a suspended sediment TMDL with the intent of setting a benchmark that water column sediment levels in the river should not exceed. Additionally, DEQ recommends initiating substrate sampling in the years immediately following high flow years in the Snake River. The expectation is that in the year(s) following high velocity flushing flows, the macrophytic biomass levels will be significantly reduced. The intent of the additional sampling will be to characterize a "baseline" condition for which a potential substrate sediment TMDL can be developed. The intent of the TMDL would be to identify the amount of substrate sediment the river can assimilate before nuisance macrophytes begin to accumulate. Sediment levels beyond that assimilative capacity would be considered inappropriate.

The nutrient data analyses shows that TP concentrations exceed the target concentration at King Hill, but decrease between King Hill and Indian Cove. While the tributaries and the Glenns Ferry WWTP are sources of TP to the river, their relative contribution is diminutive when compared to the overall river load. Dissolved oxygen concentrations and pH values between King Hill and Indian Cove are within ranges established by the standards. However, suspended chlorophyll-a concentrations exceed the growing season mean target concentration. Again, this exceedance is impairing contact recreation beneficial uses. DEQ has developed a nutrient TMDL for the Snake River with the intent of decreasing TP concentrations at King Hill and reducing suspended chlorophyll-a concentrations to an acceptable level.

Table 20 summarizes the beneficial use support status throughout the Snake River between King Hill and Indian Cove as it relates to sediment and nutrients. Table 20 also outlines which TMDLs will be developed for the Snake River.

Table 20. Summary of Snake River water quality assessments for sediment and nutrients

Pollutant/Segment	Beneficial Uses Support Status	Impaired Use[1]	Comments
Sediment	--[2]	--	--
King Hill (RM 546.3) to Indian Cove (RM 525.3)	Impaired A sediment TMDL will be developed for the Snake River between King Hill and Indian Cove.	PCR, AES	Excess aquatic plant growth due to elevated levels of nutrient rich substrate sediment
Nutrients	--	--	--
King Hill (RM 546.3) to Indian Cove (RM 525.3)	Impaired A nutrient TMDL will be developed for the Snake River between King Hill and Indian Cove.	PCR, AES	Excess algae in the water column is causing development of algae scums

[1]CWAL: cold water aquatic life, SS: salmonid spawning, PCR: primary contact recreation, AES: aesthetics
[2]--: Cells left intentionally blank

Snake River Tributary Data Analysis

There are nine primary surface water tributaries that discharge to the Snake River between King Hill and Indian Cove. Of the nine tributaries, only King Hill Creek is not §303(d) listed. The remaining eight tributaries, as shown in Table 21, are §303(d) listed. The following sections describe each of the tributaries and assess the beneficial use support status as it relates to the §303(d) listed pollutant(s). Where the §303(d) pollutant is unknown, the assessment of beneficial use support status typically begins by evaluating sediment conditions. DEQ has determined that in Idaho, excess sediment is the pollutant that most often limits the full attainment of aquatic life beneficial uses.

Since no specific sediment criteria exist for the tributaries, surrogate targets to the narrative standard are used to assess sediment conditions in the tributaries. The targets are designed to account for both suspended sediment and substrate sediment and to be protective of cold water aquatic life. As opposed to the Snake River, the application of a substrate targets is possible. The targets are as follows:

Suspended Sediment Concentration

- **a geometric mean of 50 mg/L suspended sediment for no longer than 60 consecutive days**
- **a geometric mean of 80 mg/L suspended sediment for no longer than 14 consecutive days**

Substrate Material (Particle Size Distribution)

- **less than or equal to 30% fine material (particles less than 6.0 mm in diameter) in riffles**

The substrate material target is particularly useful in areas where bank erosion is the primary source of sediment. Eroding banks have the capability to contribute large amounts of multi-sized sediment particles to a stream in a short period. While the small, colloidal material will stay suspended and quickly disperse, the heavier material will settle to the bottom of the stream where it can adversely affect fish and macroinvertebrate communities, smothering fish nesting areas and fill pools—a critical habitat for rearing juveniles. Excess substrate sediment can also decrease intergravel dissolved oxygen concentrations by reducing the flow of water through the intergravel matrix. To prevent these adverse conditions from occurring, several researchers have recommended that riffles contain less than 30% fine material in order to protect trout spawning areas and macroinvertebrate communities (Bjorn and Reiser 1991, Rhodes et al. 1994, Witzell and MacCrimmon 1983).

It should also be noted that in assessing the upper, perennial segments of the streams only the substrate material target (30% fines) was applied. Human-induced elevated levels of suspended sediment are not expected in the upper segments because irrigated agriculture is not present.

Table 21. §303(d) tributaries to the Snake River between King Hill and Indian Cove

Stream Name	Boundary	§303(d) Pollutant	Designated Use(s)[1]
Alkali Creek	Headwaters to Snake River	Sediment	Undesignated
Bennett Creek	Headwaters to Snake River	Unknown	Undesignated
Browns Creek	Headwaters to Snake River	Sediment	Undesignated
Cold Springs Creek	Ryegrass Creek to Snake River	Unknown	Undesignated
Deadman Creek	Confluence of E. and W. Fork to Snake River	Sediment	Undesignated
Little Canyon Creek	Headwaters to Snake River	Sediment, Flow Alteration	Undesignated
Ryegrass Creek	Headwaters to Cold Springs Creek	Sediment	Undesignated
Sailor Creek	Headwaters to Snake River	Sediment	Undesignated

[1]For undesignated waters, the presumed uses are Coldwater Aquatic Life and Contact Recreation (Secondary for streams of this size)

None of the tributaries are designated for beneficial uses in the *Idaho Water Quality Standards and Wastewater Treatment Requirements*. IDAPA 58.01.01.101.01a says that undesignated waters should be protected for cold water aquatic life and contact recreation (primary or secondary, whichever is appropriate). Thus, the following assessments are based on the protection of cold water aquatic life and secondary contact recreation.

Sailor Creek, Deadman Creek and Browns Creek

Sailor, Deadman, and Browns Creeks are located on the south side of the Snake River. All three streams join the river in the Indian Cove area, as shown in Figure 43. For purposes of this assessment, Sailor, Deadman, and Browns Creeks are grouped together because from a water quality assessment standpoint there is very little to discuss. Appendix F illustrates that these streams are nearly always dry from their headwaters to the Snake River. The streams were visited in 1995, 1996, 1998, 2003, and 2004 and were found to be dry in all of those years. As a result, DEQ did not assess the streams any further from a water quality standpoint.

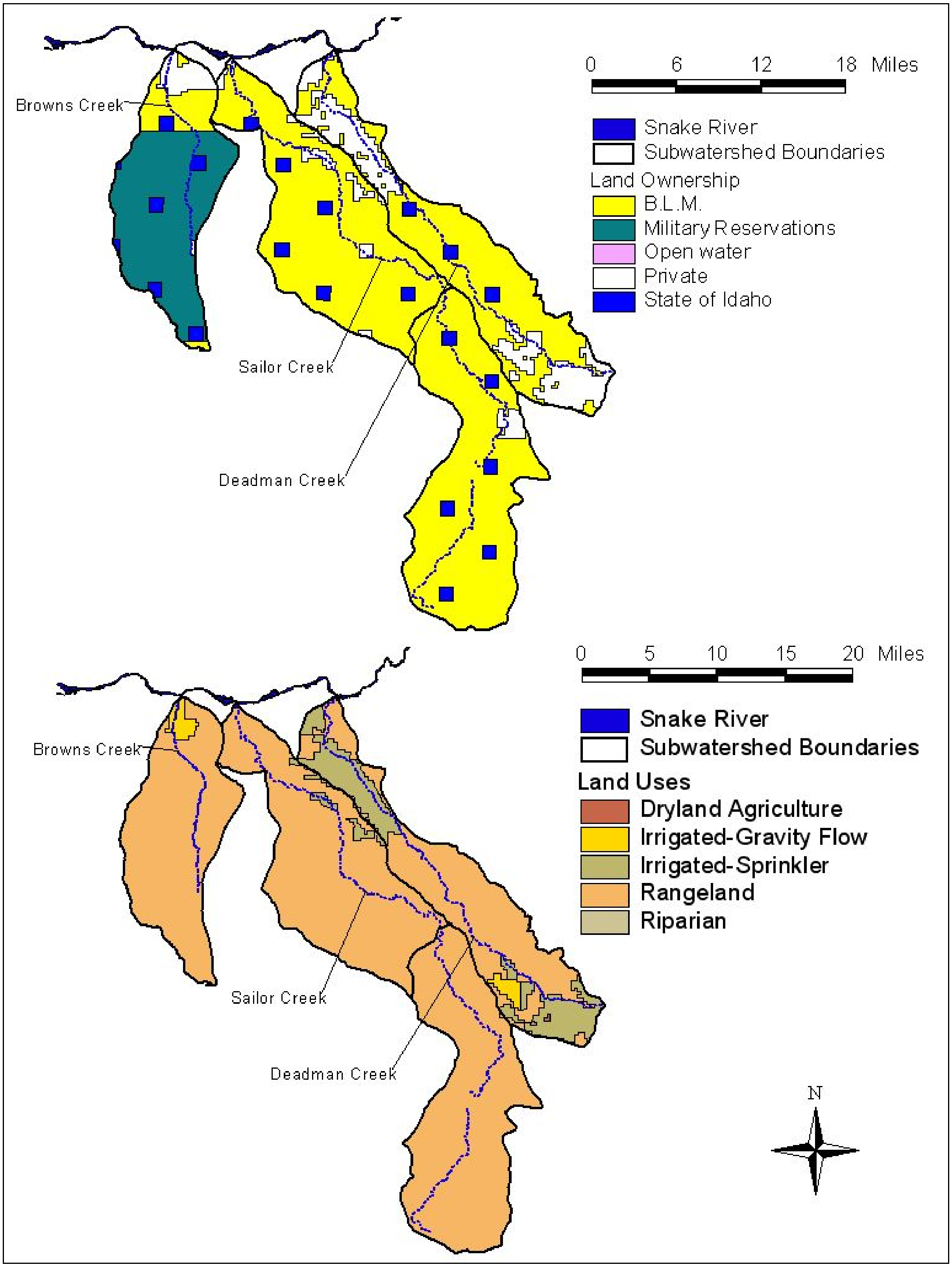


Figure 43. Sailor, Deadman, and Browns Creek watershed characteristics

Bennett Creek

Bennett Creek is a 32.41-mile long stream that drains a 94 square mile (60,601 acre) watershed. Figure 44 shows the major characteristics of Bennett Creek. The elevation change in the watershed is approximately 3,377 feet with the elevation of the headwaters at about 5,870 feet and the mouth at about 2,493 feet. The headwaters of Bennett Creek are located in the Bennett Hills along U.S. Highway 20 about 2 miles south and 4 miles west of Little Camas Reservoir. After briefly flowing in a southwesterly direction along the highway, the stream turns and flows in a southeasterly direction through the Bennett Hills. The topography in this area is steep, as it often flows through narrow canyons. This segment typically flows year-around due to natural springs that feed the stream.

After exiting the Bennett Hills, the stream trends nearly due south through the valley above the Snake River Canyon (upper valley), over the steep terrace that overlooks the Snake River Canyon and eventually into the Snake River. As illustrated in Appendix F, this segment of stream is intermittent. From where the stream exits the Bennett Hills to where it enters the Snake River, Bennett Creek encounters several changes in land ownership, land use, and water quantity management. Within the upper valley area, the stream is primarily located on privately held rangeland, although parcels of irrigated cropland are common. The quantity of water in Bennett Creek is managed heavily by the local stakeholders in cooperation with the Idaho Department of Water Resource (IDWR). Water is withdrawn for irrigation purposes, stock water, and flood storage. Four dams exist on Bennett Creek in the upper valley area. Two of the dams are off-channel, while the other two are in-channel. Local stakeholders, in cooperation with IDWR, built the dams.

Once in the Snake River canyon, Bennett Creek is nearly all on private land. The land use also begins to transition from rangeland to irrigated cropland. Additionally, the King Hill Canal bisects the stream a few hundred meters south of Interstate 84. The King Hill Canal provides water to Bennett Creek as needed during the irrigation season. When the canal is not charging the stream, it is dry.

The segment of Bennett Creek that extends from the headwaters to the upper valley is the only portion that contains water year around. The lower segments contain water intermittently for irrigation purposes, but not long enough for a suitable aquatic life community to establish. Since the lower segments do not provide a significant pollutant load to the Snake River (see Snake River assessment above), only the upper segment is evaluated for beneficial use support status.

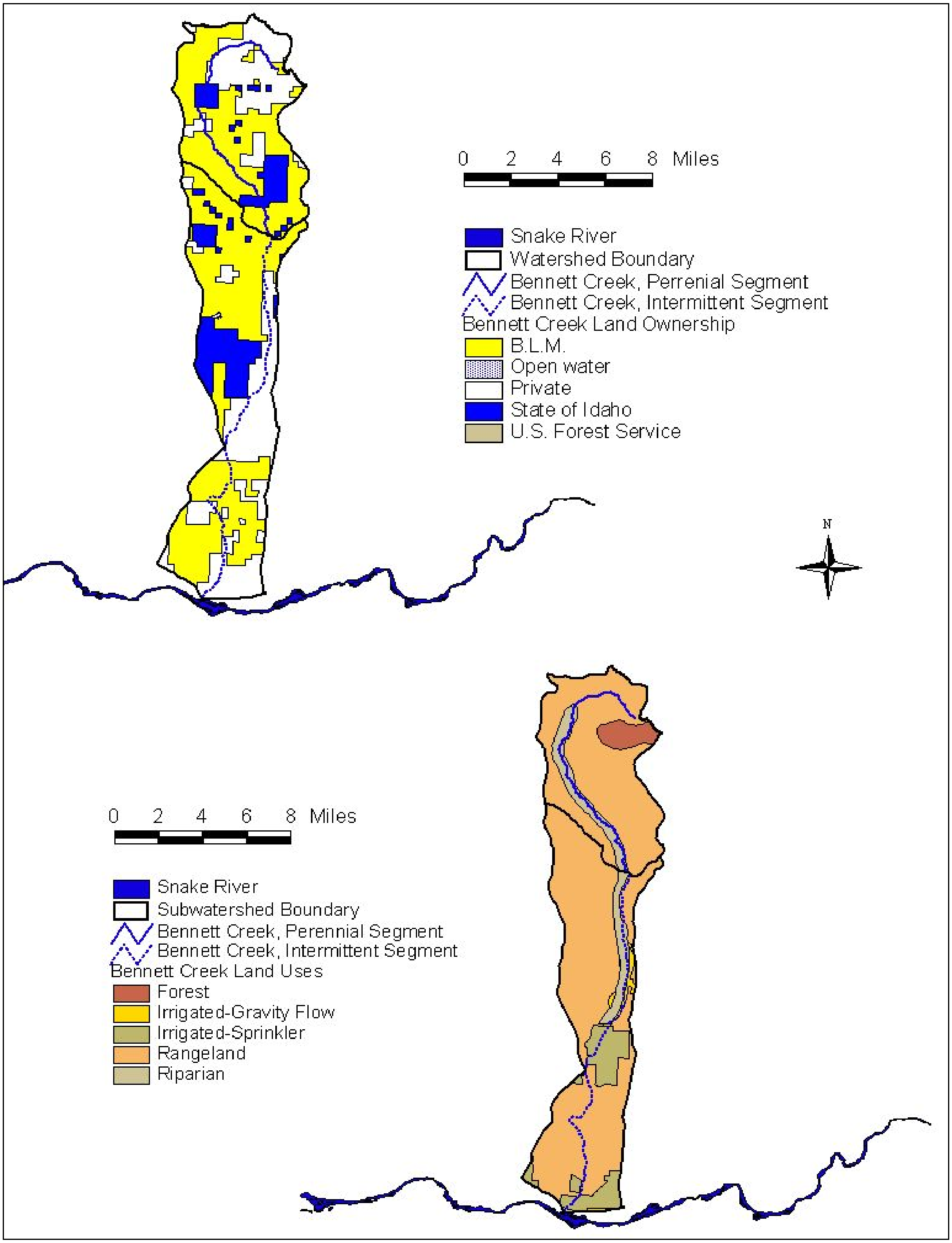


Figure 44. Bennett Creek watershed characteristics

Sediment Analysis

As shown in Table 21, Bennett Creek is §303(d) listed for "unknown" pollutants and there are no designated beneficial uses meaning the stream is, by default, protected for cold water aquatic life. The §303(d) listing is based on the results of DEQ's 2003 Beneficial Use Reconnaissance Project (BURP) survey of the stream, which showed that in the upper, perennial segment the stream contained excessive amounts of fine material (particles <6.0 mm in diameter) on the stream bottom. The percentage of fine material was 51%, but a review of the BURP field form showed that the monitoring site was inadvertently located directly above a series of beaver complexes. As a result, these data are not used in this analysis in terms of comparing current conditions to the 30% fines target.

Using the Wolman (1954) pebble count procedure, DEQ re-measured the substrate material in the upper, perennial segment of Bennett Creek in July 2004. Particle size measurements were performed in a riffle approximately three miles above where the stream enters the upper valley. The segment of stream in which the measurements were performed is more representative of actual substrate conditions than the sample collected in 2003. The percentage of fine material was 18%, meaning that the target of 30% was not exceeded.

Aquatic Life (Fish) Distribution

Fish distribution data are very useful in determining the support status of cold water aquatic life. Different fish species and age classes have different ranges of tolerance to pollutants. Salmonid species (trout) are typically less tolerant to pollutants (such as excess sediment) than non-salmonids. Additionally, adult fish are more tolerant than juvenile fish. The presence of juveniles typically indicates that water quality is suitable for young fish to survive, and they indicate spawning success.

The Idaho Department of Fish and Game (IDFG) collected fish distribution data at four locations in Bennett Creek in July and August of 2002. Several age classes of redband trout were found in the upper, perennial segment of the stream. The lower segments were not sampled due to a lack of water. Figure 45 shows the number of fish and their respective size classes at each of the four locations. Figure 46 shows the location of each monitoring site.

The presence of three age classes of redband trout, including juveniles at all four sampling locations, further indicates that excess sediment is not impairing cold water aquatic life. The use appears to be fully supported.

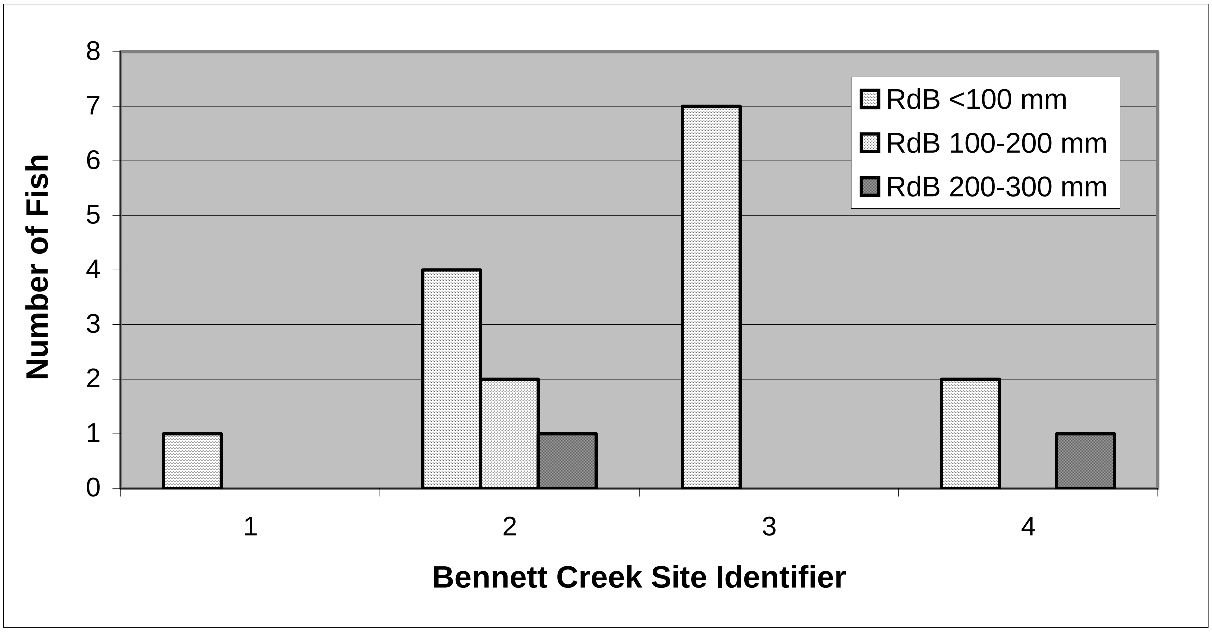


Figure 45. Redband trout (RdB) distribution by size (length in mm) in the upper, perennial segment of Bennett Creek, IDFG 2002 data.

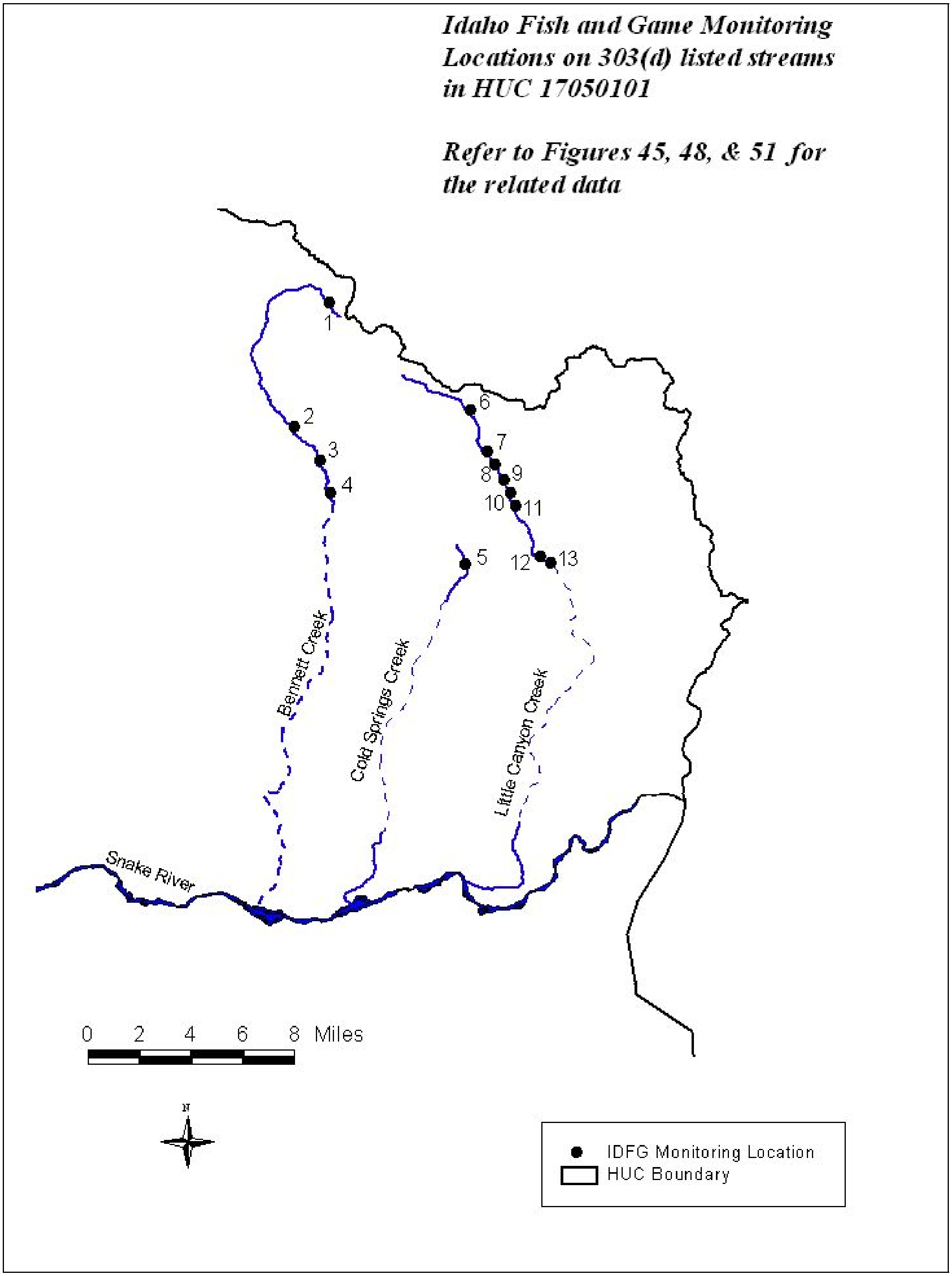


Figure 46. Location of IDFG fish distribution data in HUC 17050101

Cold Springs Creek

Cold Springs Creek (Figure 47) is a 16.8-mile long stream that drains a 43.7 square mile (27,978 acre) watershed. The elevation change in the watershed is approximately 1,608 feet, with the elevation of the west fork and east fork confluence (headwaters) at about 4,101 feet and mouth at about 2,493 feet. The headwaters of the west fork are located in the Bennett Hills near Bennett Mountain, from which it flows for approximately 9.1 miles before it joins the east fork to form Cold Springs Creek. The topography in this area is steep, as the stream often flows through narrow canyons, and this segment typically flows year-around due to natural springs that feed the stream.

After exiting the Bennett Hills, the stream trends in a south to southwesterly direction through the upper valley above the Snake River canyon, over the steep terrace that overlooks the Snake River canyon and eventually into the Snake River. As illustrated in Appendix F, the segment of stream between the Bennett Hills and the Snake River Canyon is intermittent.

From where the stream exits the Bennett Hills to where it enters the Snake River, Cold Springs Creek is similar to Bennett Creek, encountering changes in land ownership, land use, and water quantity management. Within the upper valley area, the stream is primarily located on privately held rangeland, although parcels of irrigated cropland are common. The quantity of water in the stream is managed by the local stakeholders in cooperation with the Idaho Department of Water Resources, although not as heavily as Bennett Creek. Water is withdrawn for irrigation purposes, stock water, and flood storage. Once in the Snake River canyon, Cold Springs Creek is nearly all on private land. The land use also begins to transition from rangeland to irrigated cropland.

Two segments of Cold Springs Creek contain water all year around: the upper segment (headwaters to exit from Bennett Hills) and the lower segment (exit from upper valley to Snake River). The segment of stream in the upper valley is largely intermittent. The hydrology of these segments is better defined in Appendix F.

The upper and lower segments of Cold Springs Creek contain water year-around; the middle segment does not. Due to the intermittence of the middle segment, this segment will not be assessed for beneficial use support status. However, since the potential for the middle segment to contribute pollutants to the lower segment exists, pollutant reductions may be necessary. The application of these reductions will be discussed further in the TMDL section (Chapter 5).

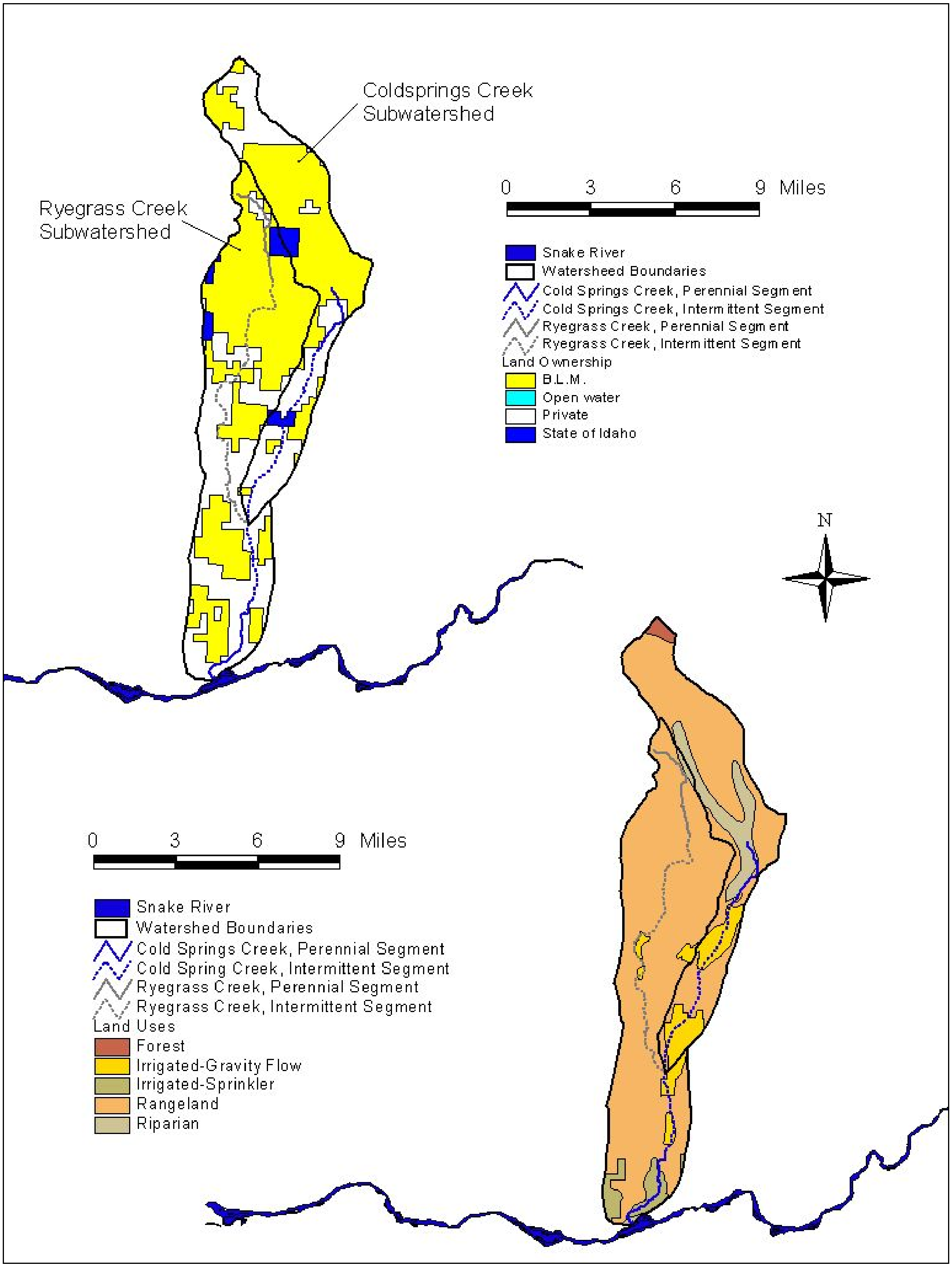


Figure 47. Cold Springs Creek and Ryegrass Creek watershed characteristics

Sediment Analysis

As was shown in Table 21, Cold Springs Creek is §303(d) listed for "unknown" pollutants, and there are no designated beneficial uses, meaning the stream is, by default, protected for cold water aquatic life. As described above, there are two perennial segments of Cold Springs Creek. Land uses in the upper segment are rangeland and riparian areas. Since the typical type of sediment loading associated with these land uses is bank erosion, the sediment condition analysis for this segment is based on meeting the 30% substrate fines target.

Using the Wolman (1954) pebble count procedure, DEQ measured the substrate material in the upper segment of Cold Springs Creek in July 2004. Particle size measurements were performed approximately 1.5 miles below where the stream exits the upper canyon, so the stream was nearly dry. Unfortunately, access was not gained above this location, so it is not certain that the measured segment is entirely representative of the upper segment. However, it is likely that the particle size distribution above the sampling point contains even less fine material due to the limited access to the stream banks. The percentage of fine substrate material was 26%, meaning that the target of 30% was not exceeded.

Land uses in the lower segment of Cold Springs Creek are a mix of rangeland and irrigated cropland. As such, the sediment condition analysis for this segment is based on meeting the 30% substrate fines target and the durational water column targets of 50 mg/L and 80 mg/L SSC.

Wolman pebble counts were performed in two locations in the lower segment of Cold Springs Creek in March and April of 2004. In March, counts were performed directly above where the stream crosses Interstate 84 (0.5 mile from the river). In April, counts were performed approximately 1.5 miles upstream from the Snake River. The percentage of fine substrate material at each site was 35% and 33%, respectively, meaning that the target of 30% is slightly exceeded. A survey of the stream correspondingly showed that the stream banks are eroding in several locations, such that less than 80% of the banks are stable.

The Data Assessment Methods section of this document describes the linkage that has been developed between 80% bank stability and maintaining less than 30% fine substrate material in riffles. This linkage was used to develop TMDLs for the lower segment of Cold Springs Creek. The TMDL portion (Chapter 5) will identify the reductions necessary to meet the 30% fines substrate target.

In addition to assessing the particle size distribution in the lower segment of Cold Springs Creek, DEQ also collected SSC samples to compare to the water column targets. Samples were collected in the same locations as the pebble counts at the end of March 2003. The concentration at the site 0.5 miles from the river was 31 mg/L while the concentration at the site 1.5 miles above the river was 19 mg/L. Both are below the most stringent durational target of 50 mg/L.

Aquatic Life (Fish) Distribution
Fish distribution data are very useful in determining the support status of cold water aquatic life. Different fish species and age classes have different ranges of tolerance to pollutants. Salmonid species (trout) are typically less tolerant to pollutants (such as excess sediment) than non-salmonids. Additionally, adult fish are more tolerant than juvenile fish. The presence of juveniles typically indicates that water quality is suitable for young fish to survive and also indicates spawning success.

Idaho Fish and Game collected fish distribution data at a single location in the upper, perennial segment of Cold Springs Creek in July 2002. Several age classes of redband trout were found in the stream. The lower segment of the stream was not sampled. Figure 48 shows the number of fish within each size class. Figure 46 (above) shows the location of each monitoring site.

The presence of three age classes of redband trout, including several juveniles further indicates that excess sediment is not impairing cold water aquatic life in the upper segments. Since there are hydrologic boundaries between the upper and lower site, these fish data are not used to determine support status in the lower segment. The lack of aquatic life information in the lower segment remains a data gap.

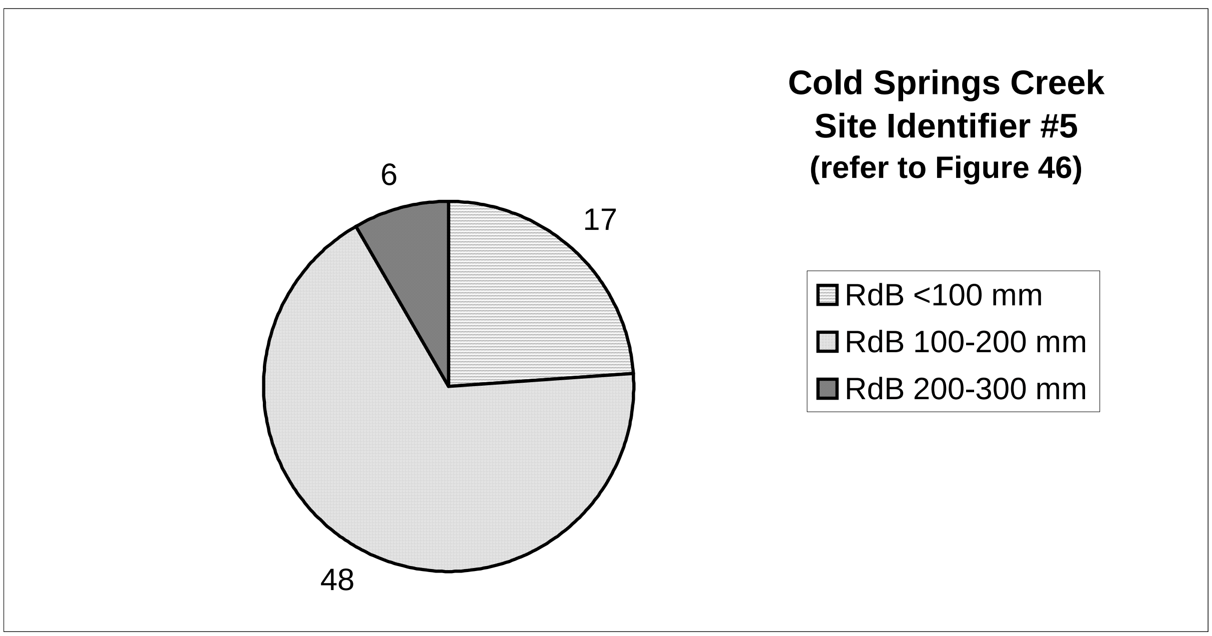


Figure 48. Redband trout (RdB) size distribution (length in mm) in the upper, perennial segment of Cold Springs Creek, IDFG 2002 data.

Ryegrass Creek

Ryegrass Creek is a 15.7-mile long stream that drains a 28.7 square mile (18,386 acre) watershed. Figure 47 (above) shows the major characteristics of Ryegrass Creek. The elevation change in the watershed is approximately 1,755 feet, with the elevation headwaters at about 4,822 feet and the confluence with Cold Springs Creek at about 3,067 feet. The headwaters of Ryegrass Creek are located in the Bennett Hills approximately six miles south of Bennett Mountain. The stream meanders in a southerly direction for its entirety until it joins Cold Springs Creek. The topography in the headwaters and for the first two miles of the stream is steep. This segment typically flows year-round due to the natural springs that feed the stream.

After exiting the Bennett Hills, the stream moves through the upper valley above the Snake River canyon until it joins Cold Springs Creek. As illustrated in Appendix F, the segment of stream between the Bennett Hills and Cold Springs Creek is intermittent.

From where the stream exits the Bennett Hills to where it enters Cold Springs Creek, some changes in land ownership, land use, and water quantity management are encountered. The stream is primarily located on privately held rangeland, but parcels of irrigated cropland are common. The quantity of water in the stream is managed by the local stakeholders in cooperation with the Idaho Department of Water Resource. Water is withdrawn for irrigation purposes, stock water, and flood storage.

Only the upper segment of Ryegrass Creek (in the Bennett Hills) contains water all year-around. This segment is defined as the upper (headwaters to exit from Bennett Hills) segment. The lower, intermittent segment extends from where the stream exits the Bennett Hills to Cold Springs Creek. The hydrology of these segments is better defined in Appendix F.

The upper segment of Ryegrass Creek contains water all year around; the lower segment does not. Due to the intermittence of the lower segment, this segment will not be assessed for beneficial use support status. However, since the potential for the lower segment to contribute pollutants to Cold Springs Creek exists, pollutant reductions may be necessary. The application of these reductions will be discussed further in the TMDL section (Chapter 5).

Sediment Analysis

As shown in Table 21, Ryegrass Creek is §303(d) listed for sediment and there are no designated beneficial uses meaning the stream is, by default, protected for cold water aquatic life. As described above, only the upper segment of the stream is perennial. Land uses in the upper segment are primarily rangeland. Since the typical type of sediment loading associated with this land use is bank erosion, the sediment condition analysis for this segment is based on meeting the 30% substrate fines target.

Using the Wolman (1954) pebble count procedure DEQ measured the substrate material in the upper segment of Ryegrass Creek in September 2004. Particle size measurements were performed approximately one mile below where the stream exits the upper canyon. Unfortunately, access was not gained above this location. Thus, it is not certain that the measured segment is entirely representative of the upper segment. However, it is likely that the particle size distribution above the sampling point contains even less fine material due to less access to the stream banks. The percentage of fine substrate material was 19%, meaning that the target of 30% was not exceeded.

Aquatic Life (Fish) Distribution
Fish distribution data are not available for Ryegrass Creek. This remains a data gap that needs to be filled when additional resources become available.

Alkali Creek

Alkali Creek is a 16.4-mile long stream that drains a 35.8 square mile (22,945 acre) watershed. Figure 49 shows the major characteristics of Alkali Creek. The elevation change in the watershed is approximately 1,526 feet, with the elevation of the headwaters at about 4,019 feet and mouth at about 2,493 feet. The headwaters of Alkali Creek are located at the base of the Bennett Hills approximately three miles north of Blair Trail Reservoir. The stream trends in a southwesterly direction through the upper valley until it meets the terrace that borders the Snake River canyon. The topography in the headwaters is not as steep as the other tributaries because the headwaters do not extend as far into the Bennett Hills. After dropping into the Snake River canyon, Alkali Creek trends in a south to southeasterly direction until it enters the Snake River.

From where the stream exits the Bennett Hill to where it drops into the Snake River canyon, Alkali Creek is intermittent. The hydrology of these segments is better defined in Appendix F. Over the length of the stream, Alkali Creek encounters changes in land ownership, land use, and water quantity management. Within the upper valley area the stream is primarily located on rangeland held by the Bureau of Land Management, although parcels of irrigated privately held rangeland and cropland are present. The quantity of water in the stream is managed by the local stakeholders in cooperation with the Idaho Department of Water Resource. Water is withdrawn for irrigation purposes, stock water, and flood storage. Once in the Snake River canyon, Alkali Creek is on a mix of BLM and private land. There is also less irrigated cropland that some of the adjacent tributaries. Much of the stream below the canyon flows through a privately held elk farm.

As noted above, two segments of Alkali Creek contain water all year-around. These segments are defined as the upper (headwaters to exit from Bennett Hills) and lower (exit from upper valley to Snake River). The segment of stream in the upper valley is largely intermittent. The hydrology of these segments is better defined in Appendix F.

The upper and lower segments of Alkali Creek contain water all year-around; the middle segment does not. Due to the intermittence of the middle segment, this segment will not be assessed for beneficial use support status. However, since the potential for the middle segment to contribute pollutants to the lower segment exists, pollutant reductions may be necessary. If so, the application of these reductions will be discussed further in the TMDL section (Chapter 5).

Sediment Analysis

As shown in Table 21, Alkali Creek is §303(d) listed for sediment and there are no designated beneficial uses meaning the stream is, by default, protected for cold water aquatic life. As described above, only the upper and lower segments of the stream are perennial. The primary land use in both segments is rangeland. Since the typical type of sediment loading associated with this land use is bank erosion, the sediment condition analysis for this segment is based on meeting the 30% substrate fines target. However, due to the presence of the elk farm on the lower segment, SSC will also be evaluated to ensure that irrigated pasture related sediment is not in excess.

Using the Wolman (1954) pebble count procedure, DEQ measured the substrate material in the upper segment of Alkali Creek in September 2004 and the lower segment in March 2004. In the upper segment, pebble counts were performed approximately one-half mile below where the stream exits the upper canyon. Thus, it is not certain that the measured segment is entirely representative of the upper segment. However, it is likely that the particle size distribution above the sampling point contains even less fine material due to less access to the stream banks. The percentage of fine material in the upper segment was 30%, which is equal to the target of 30%.

In the lower segment, pebble counts were performed approximately one mile up from the Snake River (above the elk ranch) and approximately 200 meters up from the Snake River (below the elk ranch). The percentage of fine substrate material at the two sites on the lower segment were 10% and 6%, respectively. Both percentages are below the target of 30%.

In addition to assessing the particle size distribution in the lower segment of Alkali Creek, DEQ also collected SSC samples to compare to the water column targets. Samples were collected in the same locations as the pebble counts at the end of March 2003. The concentration at the site above the elk ranch was 7.4 mg/L, while the concentration at the site below the elk ranch was 9.1 mg/L. Both are below the most stringent durational target of 50 mg/L.

Aquatic Life (Fish) Distribution

Fish distribution data are not available for Alkali Creek. This remains a data gap that needs to be filled when additional resources become available.

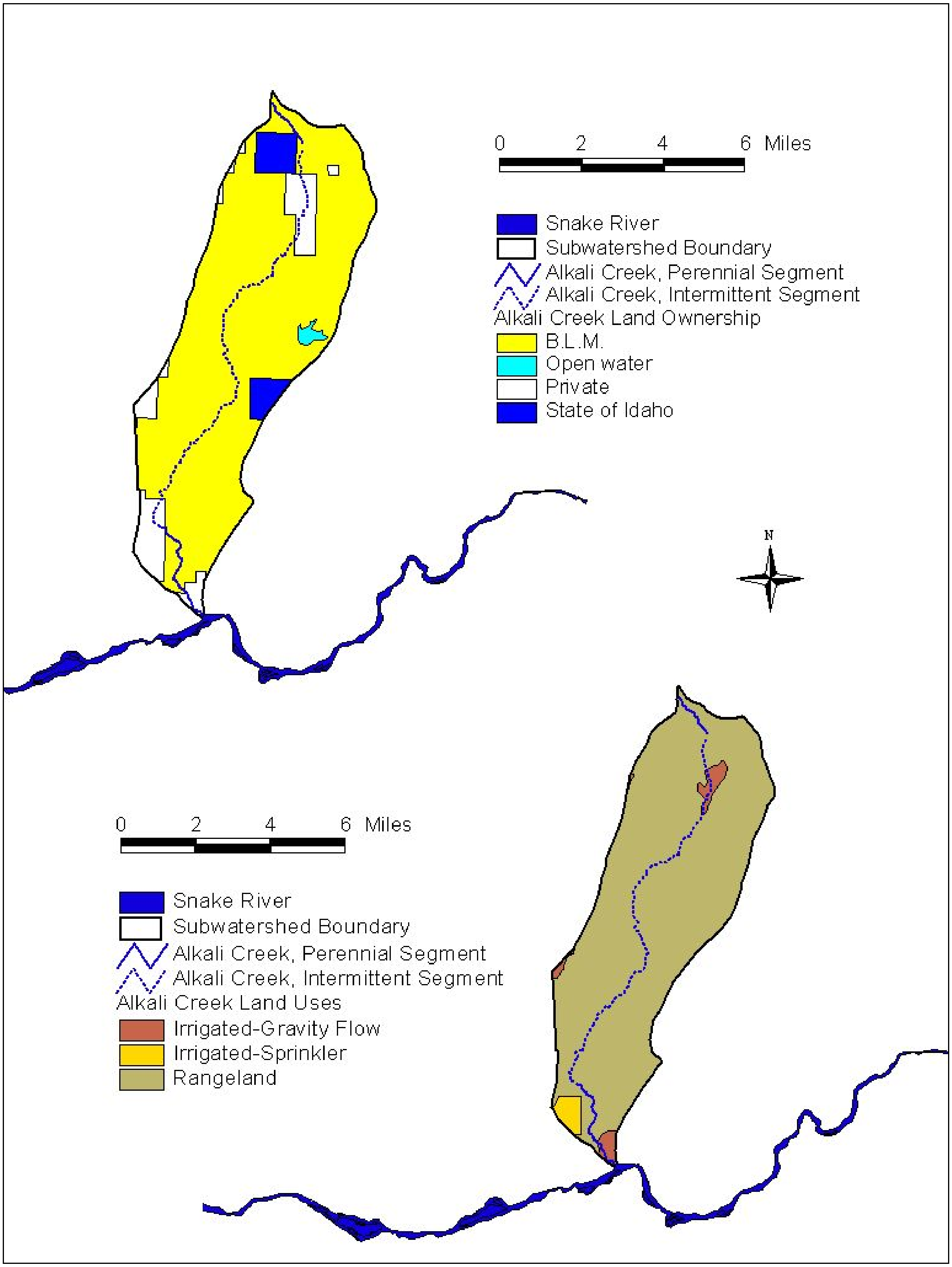


Figure 49. Alkali Creek watershed characteristics

Little Canyon Creek

Little Canyon Creek is a 28.8-mile long stream that drains a 55 square mile (35,513 acre) watershed. Figure 50 shows the major characteristics of Little Canyon Creek. The elevation change in the watershed is approximately 4,134 feet, with the elevation of the headwaters at about 6,627 feet and mouth at about 2,493 feet. The headwaters of Little Canyon Creek are located in the Bennett Hills near Bennett Mountain. Little Canyon Creek flows in a southeasterly direction from its headwaters to where the stream exits the Bennett Hills. The topography in this area is steep, as it often flows through narrow canyons. This segment typically flows year-around due to natural springs that feed the stream.

After exiting the Bennett Hills, the stream turns to the southwest and moves through the valley above the Snake River canyon (upper valley). As illustrated in Appendix F, this segment of stream is intermittent. From where the stream exits the Bennett Hill to where it meets the steep terrace above the Snake River canyon, Little Canyon Creek encounters several changes in land ownership, land use and water quantity management. Within the upper valley area the stream is primarily located on federally held rangeland, although parcels of privately held irrigated cropland are common. The quantity of water in Little Creek is managed by the local stakeholders in cooperation with the Idaho Department of Water Resource. Water is withdrawn for irrigation purposes, stock water, and flood storage.

Once in the Snake River canyon, Little Canyon Creek is nearly all on private land. The land use also begins to transition from rangeland to irrigated cropland and urban/suburban uses, although some rangeland is still available. In addition, the stream flows directly through the town of Glenns Ferry approximately three miles before it enters the Snake River. The entire segment of stream in the Snake River canyon is perennial.

The segment of Little Canyon Creek located in the upper valley is intermittent. Due to the intermittence of this segment, it will not be assessed for beneficial use support status. However, since the potential for this segment to contribute pollutants the lower portion of Little Canyon Creek exists, pollutant reductions may be necessary. The application of these reductions will be discussed further in the TMDL section (Chapter 5).

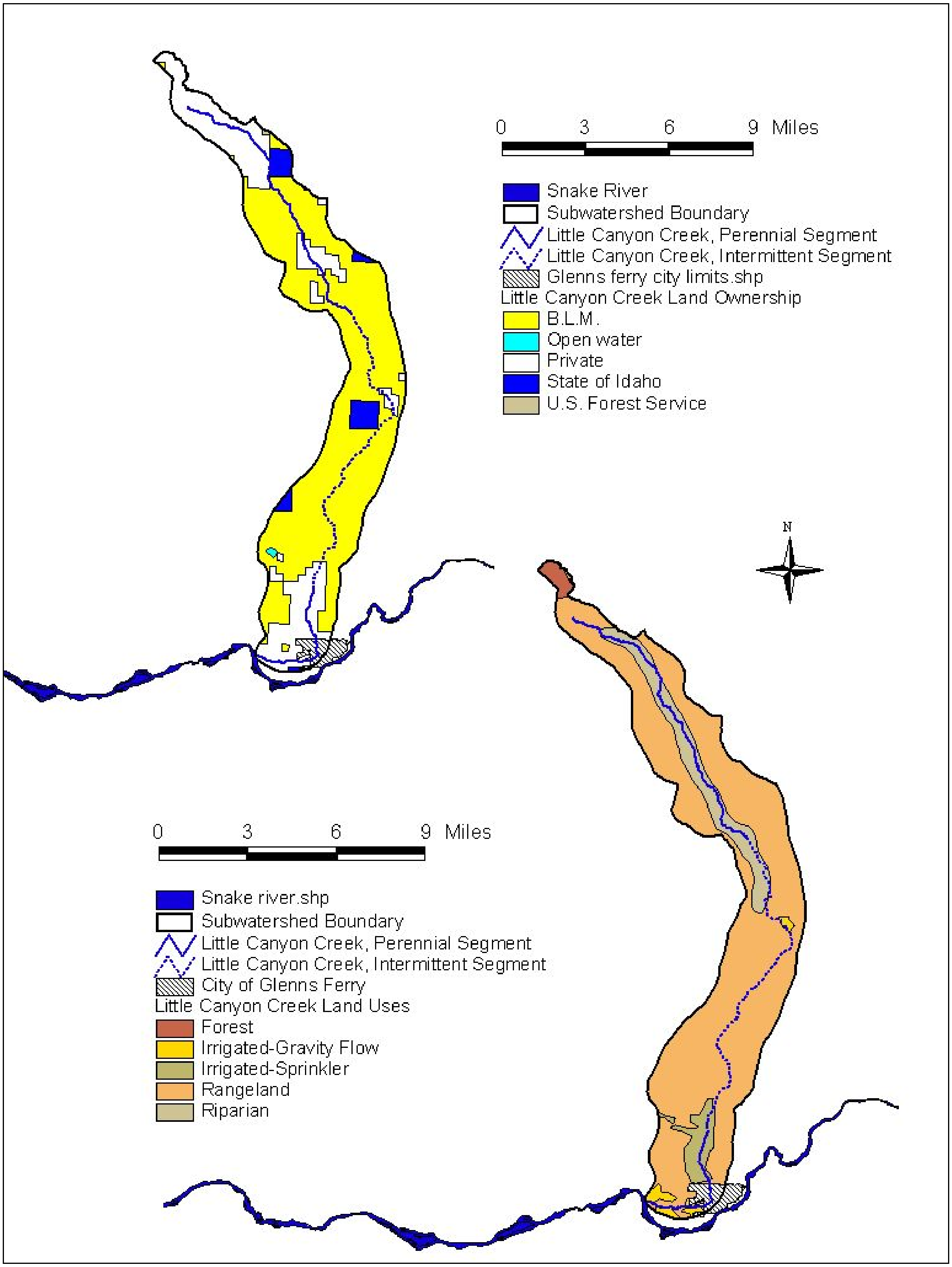


Figure 50. Little Canyon Creek watershed characteristics

Sediment Analysis

As shown in Table 21, Little Canyon Creek is §303(d) listed for sediment and there are no designated beneficial uses meaning the stream is, by default, protected for cold water aquatic life. As described above, there are two perennial segments of Little Canyon Creek, the upper and lower segments. Land uses in the upper segment are rangeland and riparian areas. Since the typical type of sediment loading associated with these land uses is bank erosion, the sediment condition analysis for this segment is based on meeting the 30% substrate fines target.

Using the Wolman (1954) pebble count procedure, DEQ measured the substrate material at two locations in the upper segment of Little Canyon Creek in March 2004. Particle size measurements were performed approximately 2.0 and 3.0 miles above where the stream exits the upper canyon. The percentage of fine substrate material was 14% and 22%, respectively, meaning that the target of 30% was not exceeded.

Land uses in the lower segment of Cold Springs Creek are a mix of rangeland and irrigated cropland and urban/suburban uses. As such, the sediment condition analysis for this segment is based on meeting the 30% substrate fines target and the durational water column targets of 50 mg/L and 80 mg/L SSC.

Wolman pebble counts were performed in two locations in the lower segment of Little Canyon Springs Creek in March and May of 2004. In March, counts were performed approximately 1.5 miles above Glenns Ferry in a rangeland area. In May, the counts were performed approximately 2 miles above Glenns Ferry in a rangeland/irrigated cropland area. The percentage of fine substrate material at each site was 85% and 34%, respectively, meaning that the target of 30% is exceeded. A survey of the stream correspondingly showed that the stream banks are eroding in several locations such that less than 80% of the banks are stable. This is especially the case in the segment where the percentage of fine material is 85%. Attempts were also made to access the stream below the city of Glenns Ferry, but access was denied. Thus, it is conservatively assumed that that fine substrate material also exceeds 30% in the segment of stream below Glenns Ferry.

The Data Assessment Methods section of this document describes the linkage that has been developed between 80% bank stability and maintaining less than 30% fine substrate material in riffles. This linkage was used to develop TMDLs for the lower segment of Little Canyon Creek. The TMDL portion (Chapter 5) identifies the reductions necessary to meet the 30% fines substrate target.

In addition to assessing the particle size distribution in the lower segment of Little Canyon Creek, DEQ also collected an SSC sample to compare to the water column targets. A sample was collected approximately 1.5 miles above Glenns Ferry (in the same location as the pebble count) in March 2004. The SSC concentration at the site was 15 mg/L, which is below the most stringent durational target of 50 mg/L.

Aquatic Life (Fish) Distribution
Fish distribution data are very useful in determining the support status of cold water aquatic life. Different fish species and age classes have different ranges of tolerance to pollutants. Salmonid species (trout) are typically less tolerant to pollutants (such as excess sediment) than non-salmonids. Additionally, adult fish are more tolerant than juvenile fish. The presence of juveniles typically indicates that water quality is suitable for young fish to survive and they indicate spawning success.

IDFG collected fish distribution data at eight locations in the upper, perennial segment of Little Canyon Creek in June and July of 2002. Several age classes of redband trout were found in the stream. Young-of-the-year (born that year) rainbow trout were located as well. The lower segment of the stream was not sampled. Figure 51 shows the number of fish within each size class. Figure 46 (above) shows the location of each monitoring site.

The presence of three age classes of redband trout, including several juveniles, as well as the presence of juvenile rainbow trout further indicates that excess sediment is not impairing cold water aquatic life in the upper segments. Since there are hydrologic boundaries between the upper and lower site, these fish data were not used to determine support status in the lower segment. The lack of aquatic life information in the lower segment remains a data gap.

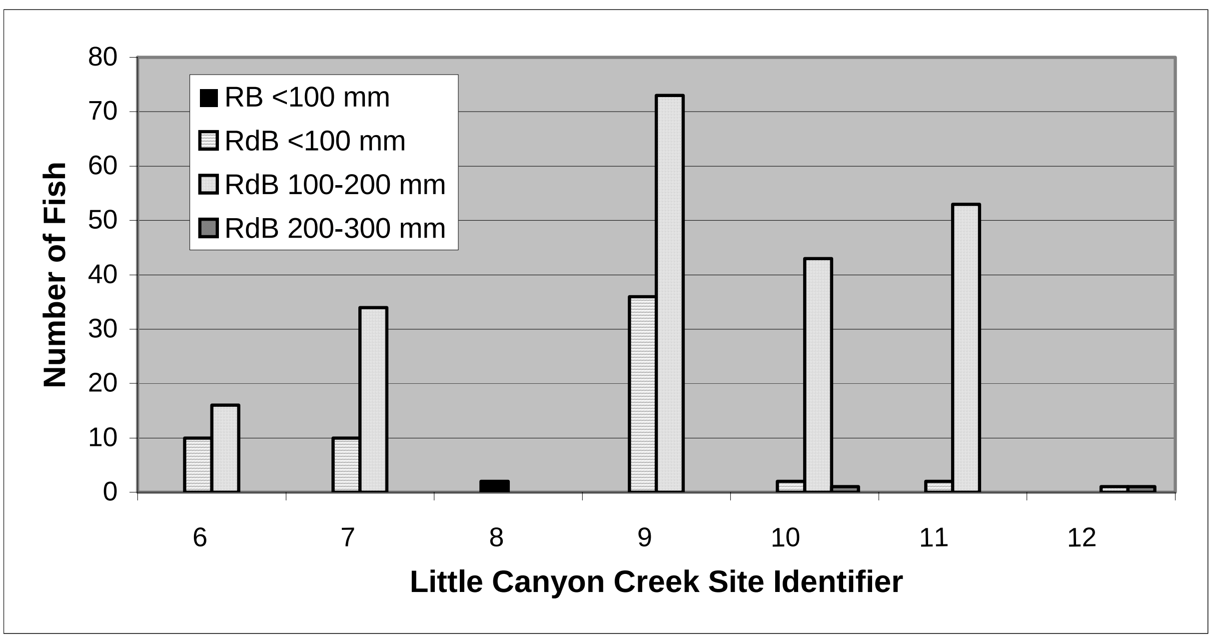


Figure 51. Fish distribution (length in mm) in the upper, perennial segment of Little Canyon Creek, IDFG 2002 data.

Conclusions and Status of Beneficial Uses in Tributaries

The combination of sediment and aquatic life data for the Cold Springs and Little Canyon Creeks show that excess substrate sediment is impairing cold water aquatic life in the lower segments. As a result, TMDLs are necessary for these segments. The data also shows that the middle segments of Cold Springs and Little Canyon Creeks are intermittent. As such, a beneficial use support status analysis was not performed (Appendix F). However, since these segments may provide sediment to the lower segments, TMDLs may be necessary. The data for the upper segments show that uses are not impaired.

Beneficial uses do not appear to be impaired in Bennett, Ryegrass, or Alkali Creeks. TMDLs are not recommended for these streams. The data also show that Deadman, Sailor, and Browns Creeks are dry essentially all of the time. Thus, no further assessments were made on these streams.

Table 22 summarizes the beneficial use support status for the §303(d) listed tributaries in HUC 17050101. Table 22 also outlines where TMDLs will be developed on the tributaries.

Table 22. Summary of the water quality assessments for 303(d) tributaries in HUC 17050101

Pollutant / Segment	Beneficial Uses Support Status	Impaired Use[1]	Comments
Deadman Creek	Not Impaired	None	Intermittent Stream[2]
Sailor Creek	Not Impaired	None	Intermittent Stream[2]
Browns Creek	Not Impaired	None	Intermittent Stream[2]
Bennett Creek -Upper Segment	Not Impaired	None	Based on fish and particle size distribution data
-Lower Segment	Not Impaired	None	Intermittent Stream[2]
Ryegrass Creek -Upper	Not Impaired	None	Based on particle size distribution data
-Lower	Not Impaired	None	Intermittent Stream[2], a TMDL may be necessary to prevent sediment loading in Cold Springs Creek
Cold Springs Creek -Upper Segment	Not Impaired	None	Based on fish and particle size distribution data
-Middle Segment	Not Impaired	None	Intermittent Stream[2], a TMDL may be necessary to prevent sediment loading in the lower segment
-Lower Segment	Impaired	CWAL	Based on particle size distribution data, a TMDL to reduce bank erosion is necessary
Alkali Creek -Upper Segment	Not Impaired	None	Based on particle size distribution data
-Middle Segment	Not Impaired	None	Intermittent Stream
-Lower Segment	Not Impaired	None	Based on particle size distribution and SSC[3] data
Little Canyon Creek -Upper Segment	Not Impaired	None	Based on fish and particle size distribution data
-Middle Segment	Not Impaired	None	Intermittent Stream[2], a TMDL may be necessary to prevent sediment loading in the lower segment
-Lower Segment	Impaired	CWAL	Based on particle size distribution data, a TMDL to reduce bank erosion is necessary

[1]CWAL: cold water aquatic life, [2]See Appendix F for further explanation, SSC: suspended sediment concentration

C.J. Strike Reservoir Data Analysis

C.J. Strike Reservoir is located in the western end of the King Hill-C.J. Strike subbasin. The reservoir encompasses approximately 7,650 surface acres and a volume of about 226,800 acre-feet at full pool. Figure 52 shows a location overview of C.J Strike Reservoir within Idaho. The C.J. Strike Hydroelectric Project and the ensuing reservoir were constructed in 1952 to help meet the growing demand for electricity in southern Idaho (Idaho Power Company 1998). The project currently operates under a newly issued license from the Federal Energy Regulatory Commission. The previous license expired in the year 2000.

Reservoir Flow and Physical Characteristics

Unlike many reservoirs in southwestern Idaho, C.J Strike Reservoir does not store water for the irrigation season only. There is very little active storage. The mean daily flows entering and leaving the reservoir are nearly equal, meaning that the reservoir experiences very little daily water level fluctuations (Idaho Power Company 1998). C.J. Strike Reservoir receives water from two primary sources:

- Entering from the east, the Snake River is by far the largest source of water to the reservoir. The average annual discharge from the Snake River is 10,370 cfs resulting is a total annual flow of near 8 million acre-feet (Brennan et al. 1996b).
- Entering from the southeast, the Bruneau River has a mean annual discharge of 388 cfs contributing a total annual flow of 273,000 acre-feet (Brennan et al. 1996b).

As illustrated in Figure 52, C.J. Strike Reservoir has two distinct branches. Corresponding to its volumetric contribution, the Snake River branch is the largest, extending from Indian Cove (Snake River mile 525) to the C.J. Strike Dam (Snake River mile 494). The Bruneau River branch of the reservoir, extending from the confluence of the Bruneau River and the Snake River (Bruneau River mile 0) to about Bruneau River mile 6.5, fluctuates somewhat because of wetland conditions where the Bruneau River enters the reservoir. The confluence of the Bruneau River and the Snake River are within the body of the reservoir.

Steep basalt cliffs bind most segments of C.J. Strike Reservoir, with much of the reservoir canyon resembling a trench cut into the plain (Idaho Power Company 1998). Figure 53 gives an example of the typical topography surrounding C.J. Strike Reservoir. At about 2,164 acres, the Bruneau River arm consists of the Bruneau Pool and the Bruneau narrows. The Bruneau Pool has a maximum depth of about 10 meters, while the narrows are much deeper (Idaho Power Company 1998). The Snake River arm consists of a large open pool just east and northeast of the dam. Above the pool, the reservoir begins to constrict (see Figures 52 and 53) and becomes narrow and deep. In some locations, the reservoir reaches nearly 100 feet deep, although the mean depth for the entire Snake River arm is 33 feet (Idaho Power Company 1998).

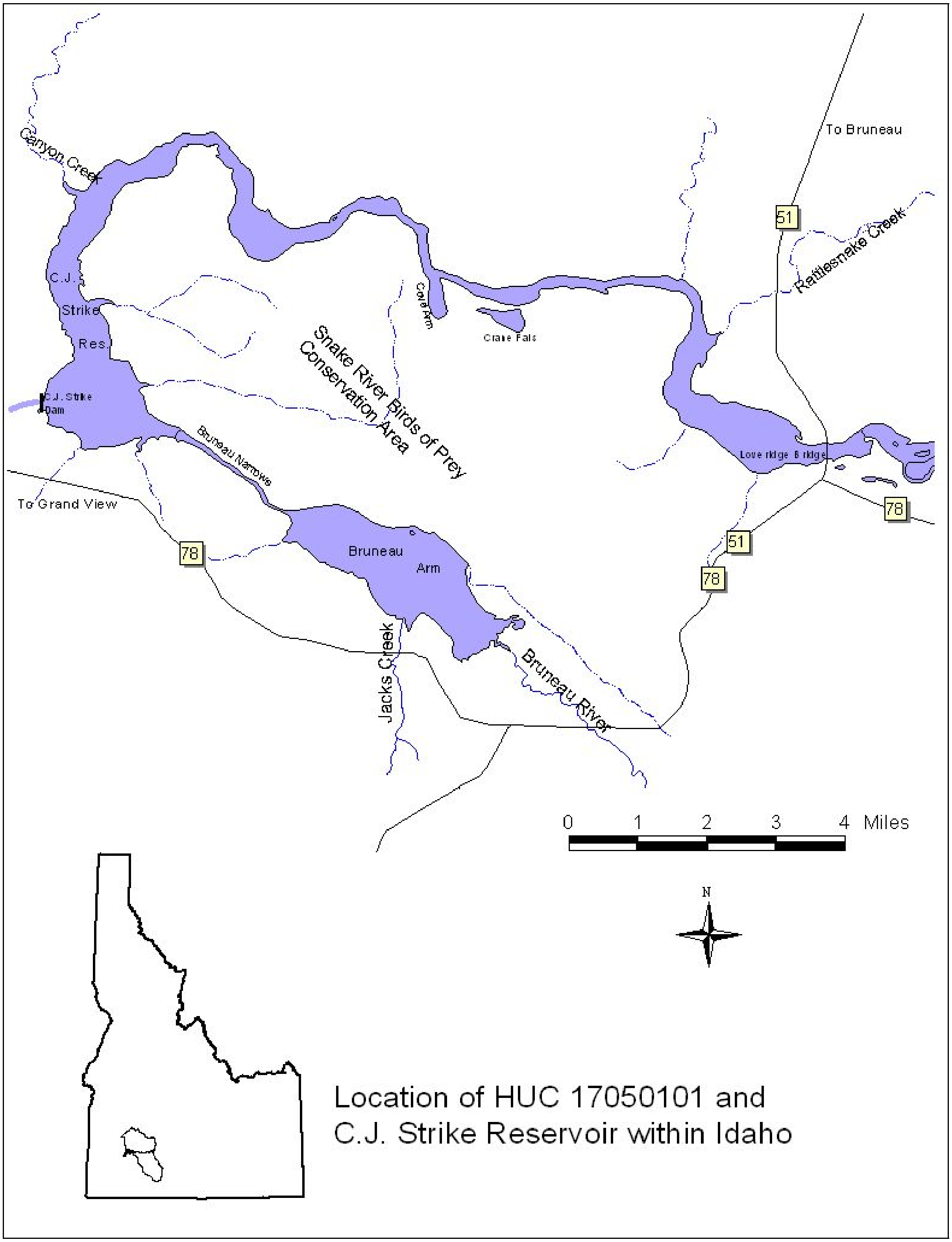


Figure 52. Location overview of C.J Strike Reservoir within Idaho

Figure 53. Typical topography surrounding C.J. Strike Reservoir

Pesticides Loading Analysis

C.J. Strike Reservoir (Snake River arm) is the only water body in HUC 17050101 listed for pesticides. The pesticides evaluated as part of this assessment focus on total-DDT (1,1,1-trichloro-2,2-bis(p-chlorophenyl) ethane, CAS #50-29-3) including its metabolites DDD (1,1-dichloro-2,2-bis(p-chlorophenyl) ethane, CAS #72-54-8) and DDE (1,1-dichloro-2,2-bis(chlorophenyl) ethylene, CAS #72-55-9) and dieldrin (1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo, exo-1,4:5,8-dimethanonaphthalene, CAS #60-57-1). The water quality standards/target values specific to these pesticides are described below. The values are based on a combination of standards and targets established by the downstream Snake River-Hells Canyon TMDL (17050115) (IDEQ 2004) and the *Idaho Water Quality Standards and Water Treatment Requirements* adoption of the U.S. EPA guidance (EPA 1992).

The water column targets that will be used for the C.J. Strike Reservoir assessment of pesticides are as follows:

- **total-DDT (t-DDT):**
  1. **Aquatic Life: less than 0.001µg/L water column concentration**
  2. **Domestic Water Supply: less than 0.00059 µg/L water column concentration**

- **Dieldrin**
  1. **Aquatic Life: less than 0.0019µg/L water column concentration**
  2. **Domestic Water Supply: less than 0.00014 µg/L water column concentration**

The domestic water supply targets are based on a carcinogenic risk of 10^{-6}. That is, given the concentration in the water, there is a 1 in 1,000,000 chance of developing t-DDT or dieldrin induced cancer.

In addition to the detailed DDT and dieldrin analysis, the King Hill-C.J. Strike Reservoir watershed advisory group also requested an evaluation of several other pesticides. This analysis was performed if two criteria were met: a) the water column concentration data were available, and b) a standard for that given pesticide existed within the *Idaho Water Quality Standards and Water Treatment Requirements.* Based on these criteria, additional analyses were performed for aldrin, endrin, heptachlor, heptachlor epoxide, lindane, alpha-HCH, and dacthal.

t-DDT and Dieldrin Characteristics

While neither t-DDT nor dieldrin are highly water-soluble; both compounds readily adsorb onto suspended and benthic particles within the water system. At some point, the suspended particles are typically deposited on a stream, lake, or reservoir bottom. The particle can then become resuspended and transported in a similar fashion to a downstream location—a process is called *pollutant cycling*. Aquatic organisms, especially bottom-feeding species such as suckers and carp, are vulnerable to the bioaccumulation of these compounds as they move through the system.

t-DDT and dieldrin are persistent, long-lived contaminants. As such, even though their use has been discontinued, they are expected to remain in the environment for the foreseeable future (US EPA 1992a). This problem is evident throughout the United States: in a national US EPA study (US EPA 1992a), over 90% of 388 sites sampled nationwide in 1986 and 1989 showed concentrations of p,p'DDE (a metabolite of DDT) and PCBs.

DDT

DDT is an anthropogenic chemical that was widely used pre-1973 to control insects on agricultural crops and insects that carry dangerous diseases, such as malaria and typhus. On a global scale, the use of DDT increased substantially after the Second World War. DDT appeared to be the ideal insecticide in that it was cheap to manufacture and of relatively low toxicity to mammals (oral Lethal Dose 50 is 300 to 500 mg/kg). However, concern over environmental effects began to appear in the late 1940s. Many species of insects were able to develop a resistance to DDT so that it was no longer as effective as a control mechanism. In addition, DDT was also discovered to be highly toxic to fish (ATSDR 2001, Harrison 2001). Due to the risk it presented to wildlife, and with potential human health concerns being raised, the use of DDT was banned in 1973 in the United States except for public health emergencies.

The chemical stability of DDT and its tendency to bioaccumulate in fatty tissues add to the complexity of the problem. DDT is not metabolized (broken down by cells) rapidly; rather it is stored in fatty tissues within the body. As an average, about eight years are required for an animal to metabolize half of the DDT it assimilates (this eight years is known as the biological half-life). Therefore, if an animal continues to ingest DDT at a steady rate, its tissue concentration will increase over time (Harrison 2001).

Dieldrin

Dieldrin is a man made chlorinated insecticide that was popular for crops, such as corn and cotton, from 1950 to 1970. Dieldrin does not occur naturally in the environment. Due to concerns about damage to the environment and the potential harm to human health, EPA banned all uses of dieldrin, except to control termites, in 1974. In 1987, EPA banned dieldrin for all uses.

As with DDT, dieldrin is a very stable chemical and tends to bioaccumulate in fatty tissues. Dieldrin is not metabolized rapidly and exits the body very slowly (ATSDR 2001). Because dieldrin is bioaccumulative, it does not break down easily in the environment and becomes increasingly concentrated as it moves up the food chain to humans and other wildlife. (US EPA PBT 2001).

Sources of DDT and Dieldrin

DDT and dieldrin compounds entered surface water systems primarily from agricultural nonpoint source runoff and atmospheric deposition. Because the compounds have been banned from use in the U.S. since 1973 and 1987, respectively, the primary sources of these compounds in surface waters are legacy deposition and continued agricultural runoff from previously treated areas. (This analysis was done under the assumption that there are no current sources of DDT and dieldrin to the system.) Additionally, organochlorine insecticides are man-made compounds; no natural sources for these compounds exist at any significant level.

Data Availability in the Snake River and C.J. Strike Reservoir

The United States Geologic Survey (USGS) extensively monitored pesticides and trace metals in the Snake River system from 1992 through 1997 (Maret and Ott 1997, Clark and Maret 1998). Total-DDT and dieldrin levels in fish tissues and sediment were evaluated. The data showed that concentrations of both t-DDT and organochlorine compounds increased in the distance downstream (over the entire Snake River study area). As expected, reservoir concentrations were somewhat higher overall than tributary concentrations, but the downstream increase was evident in both types of surface waters. None of the DDT fish tissue samples exceeded the EPA action level of 1000 µg/kg, and dieldrin levels were always below the 5.0 µg/kg detection limit. Table 23 shows the fish tissue data specific to the King Hill-C.J. Strike basin (HUC 17050101), as presented in Maret and Ott 1997 and Clark and Maret 1998.

Table 23. USGS data showing t-DDT and dieldrin fish tissue data for King Hill and C.J. Strike Reservoir

Location	Year	Species	Pesticide	Concentration (µg/kg)	NAS/NAE[1] Exceeded
C.J. Strike Reservoir[2]	1997	Yellow perch, fillet	t-DDT	11	No
C.J. Strike Reservoir	1997	Sucker	t-DDT	232	No
King Hill	1997	Sucker	t-DDT	187	No
C.J. Strike Reservoir	1997	Sucker	Dieldrin	< 5	No
C.J. Strike Reservoir	1997	Bass	Dieldrin	< 5	No
C.J. Strike Reservoir	1997	Yellow perch, fillet	Dieldrin	< 5	No
King Hill	1997	Sucker	Dieldrin	< 5	No
King Hill	1992	Sucker	Dieldrin	< 5	No
King Hill	1992	Sucker	Dieldrin	< 5	No
King Hill	1993	Sucker	Dieldrin	< 5	No
King Hill	1994	Sucker	Dieldrin	< 5	No
King Hill	1992	Sucker	t-DDT	171	No
King Hill	1992	Sucker	t-DDT	308	No
King Hill	1993	Sucker	t-DDT	177	No
King Hill	1994	Sucker	t-DDT	213	No

[1] NAS/NAE: National Academy of Sciences/National Academy of Engineering (1973) recommended maximum concentrations in whole-body fish for the protection of fish eating wildlife: 1000 µg/kg t-DDT, 100 µg/kg dieldrin.

[2] All C.J. Strike Data collected at Loveridge Bridge, which is the inflow for C.J. Strike Reservoir.

It should be noted that the C.J. Strike Reservoir DDT and dieldrin data presented in Table 23, and used from this point forward were collected at Loveridge Bridge, which represents the transitional zone (from river to reservoir) in C.J. Strike Reservoir. The Loveridge Bridge data are used to represent all of C.J. Strike Reservoir, because very little pesticides data exists for the lacustrine (deepest) portion of the reservoir (two data points). The concept of using Loveridge Bridge data to represent the entire reservoir from a pesticides standpoint was introduced by Clark and Maret (1998).

A general comparison between the King Hill and C.J. Strike fish tissue t-DDT concentrations suggests that the concentrations may be similar. The mean concentration in sucker tissues collected from King Hill is 211 µg/kg (n = 5), while the concentration of a single sucker sample collected from C.J. Strike is 232 µg/kg. While this interpretation suggests a similarity, the fish tissue t-DDT concentrations are not robust enough to conclude whether there is a substantive increase or decrease in tissue concentration between King Hill and C.J. Strike Reservoir. The dieldrin data offer little comparative insight as well. Fish tissue samples collected at both King Hill and C.J. Strike fall below the 5.0 µg/l detection limit, making a comparison difficult.

One conclusion that can be reached based on the data in Table 23 is that the reported t-DDT and dieldrin fish tissue concentrations are well below the National Academy of Sciences and National Academy of Engineering action levels for the protection of predatory wildlife. This conclusion will be further expanded upon in terms of beneficial use support status at the conclusion of this pesticides analysis.

The bed sediment t-DDT and dieldrin data offer little additional insight into the pesticide conditions in C.J. Strike Reservoir or a comparison between King Hill and C.J. Strike Reservoir, again primarily due to the lack of a robust data set. Table 24 shows the bed-sediment data as presented by Maret and Ott 1997 and Clark and Maret 1998.

Table 24. USGS data showing DDT and dieldrin bed-sediment data for King Hill and C.J. Strike Reservoir

Location	Year	Pesticide	Concentration (µg/kg)
C.J. Strike Reservoir[1]	1997	p,p'-DDT	1.1
C.J. Strike Reservoir	1997	Dieldrin	<1.0
King Hill	1997	p,p'-DDT	.40
King Hill	1997	Dieldrin	<1.0
King Hill	1992	t-DDT	ND[2]
King Hill	1992	t-DDT	ND
King Hill	1993	t-DDT	ND
King Hill	1994	t-DDT	13

[1] All C.J. Strike Data collected at Loveridge Bridge, which is the inflow for C.J. Strike Reservoir.
[2] Not Detected

The bed-sediment p,p'-DDT concentration at C.J. Strike Reservoir in 1997 is nearly three times the concentration at King Hill for the same year, remaining consistent with the findings of Clark and Maret 1998, which suggested that concentrations increase in the downstream direction. However, the 1992-1994 t-DDT data at King Hill show that the concentration ranges from “non-detect” in 1992 and 1993 to 13 µg/kg in 1994. This variation in concentration suggests that the difference between King Hill and C.J. Strike Reservoir in 1997 should be interpreted with caution.

The dieldrin concentrations at C.J. Strike Reservoir and King Hill in 1997 were both less than the detection limit of 1.0 µg/kg, again making a direct comparison difficult.

Water Column t-DDT and Dieldrin

As noted above, the fish tissue and bed sediment t-DDT and dieldrin data are not particularly robust. While the data do offer some insight into the relative levels of each pesticide in the fish tissue and sediment, they do not offer an explicit linkage to the beneficial use support status of aquatic life and domestic water supply in C.J. Strike Reservoir. To create this critical linkage, a method to estimate the water column concentration in C.J. Strike Reservoir was developed. The intent was to compare the estimated concentration to the water quality targets outlined above to determine beneficial use support status.

Over the past several years, the USGS has collected t-DDT and dieldrin water column data from King Hill. These data are used to develop bioaccumulation factors (BAF) for t-DDT and dieldrin, which provide a means to estimate the water column concentration of each pesticide. Bioaccumulation is described as the process by which an organism accumulates a substance in its body as a result of uptake from all environmental sources (water, food, sediment, etc.). A bioaccumulation factor is described as the ratio of the concentration of a substance in tissue to its concentration in ambient water. The concept of bioaccumulation and the use of bioaccumulation factors applies well to persistent pesticides, such as t-DDT and dieldrin, because their chemical structure does not rapidly breakdown in the environment. Figure 54 shows a hypothetical example of how DDT, an organochlorine, can bioaccumulate in the environment.

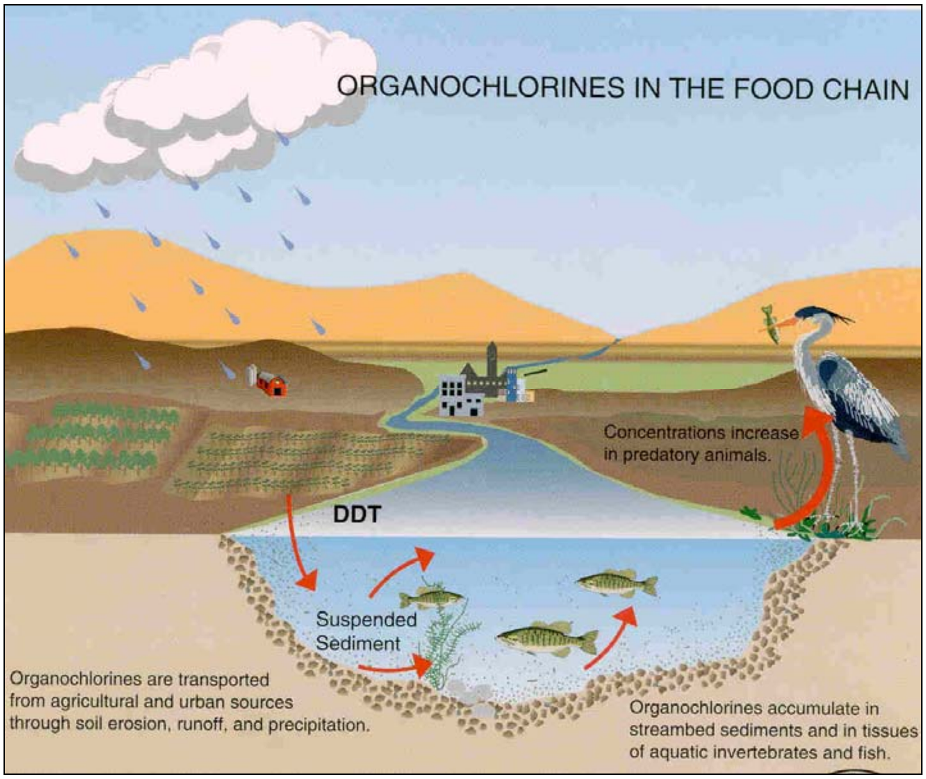


Figure 54. **Diagram illustrating the concept of bioaccumulation in the environment (Marret and Ott 1997)**

Using the concept of bioaccumulation as a starting point, BAFs specific to the dynamics of the King Hill-C.J. Strike Snake River segment were developed. The King Hill-C.J. Strike BAFs were developed following the methods outlined in the EPA 2000 publication entitled "Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health." Appendix G describes the process by which the bioaccumulation factors for t-DDT and dieldrin were developed.

Using the derived bioaccumulation factors (Appendix G) for t-DDT and dieldrin as the basis, the calculated water column concentrations of t-DDT and dieldrin at C.J. Strike Reservoir are 0.0004 µg/L and 0.0001µg/L, respectively. Table 25 shows the calculated concentrations in comparison to the aquatic life and contact recreation water column targets outlined above.

Table 25. Calculated t-DDT and dieldrin water column concentrations in C.J. Strike Reservoir

Pesticide	Beneficial Use[1]	Calculated Concentration (µg/L)	Target Concentration (µg/L)
t-DDT	CWAL	0.00044	0.001
t-DDT	DWS	0.00044	0.00059
Dieldrin	CWAL	0.00011	0.0019
Dieldrin	DWS	0.00011	0.00014

[1] CWAL: cold water aquatic life, DWS: domestic water supply

In addition to the calculated values shown above, Idaho Power Company and DEQ collected follow-up DDT and dieldrin samples during the summer of 2004:

- Idaho Power Company collected samples from the Snake River at King Hill and Loveridge Bridge. Both samples were none detect for both constituents.
- DEQ collected samples from the Snake River at King Hill and Loveridge Bridge and from C.J. Strike Reservoir at river miles 497 (lacustrine zone), 506 (transitional zone), and river mile 4.0 of the Bruneau Arm. Again, all samples were non-detect for both constituents.

The intent of these sampling efforts was two-fold. First, both entities wanted to verify that DDT and dieldrin were no longer detectable in the water column. Second, since the BAF analysis described earlier uses Loveridge Bridge as the surrogate location for the entire reservoir, DEQ wanted to ensure that DDT and dieldrin were indeed undetectable in the reservoir.

Recommendations for DDT and Dieldrin

The data presented in Table 25 and recently collected data show that the calculated t-DDT and dieldrin water column concentrations do not exceed the target concentrations for cold water aquatic life or domestic water supply beneficial uses. DEQ does not recommend developing a TMDL for these pesticides. However, the data presented in Table 23 and in Appendix G do show that recently collected fish tissue samples still contain measurable levels of DDT. These fish pose a potential health threat to predatory wildlife. Most at risk are predators of larger fish that have lived for several years, such as bald and golden eagles, both of which inhabit areas of the C.J. Strike Reservoir vicinity (Idaho Power Company 1998.)

Since DDT and dieldrin were banned from use in 1973 and 1987, respectively, there should be no new discharges of either compound. However, as shown above, the compounds are still detectable in a variety of media, particularly DDT. Again, this is likely due to their biopersistence (long half-life).

Assuming that no new discharges of DDT and dieldrin are occurring, other measures can be taken to decrease the transport potential of sediment bound legacy pesticides into the Snake River and C.J. Strike Reservoir. Unfortunately, the direct removal of pesticides deposited in sediments is not feasible in the watershed. Any potential sources of legacy pesticides in the area are likely to be diffuse in nature and do not stem from a discrete source but, rather, from historical application on agricultural lands or deposition from surface water transport. Removal of the sediments and organic material associated with these compounds would potentially result in degradation of other habitat parameters through sediment removal and disturbance.

However, while direct removal of pesticide pollutants is not feasible, management practices targeted to reduce further sediment transport to surface water systems will also have the side effect of reducing any sediment bound pesticides. Pesticide transport and deposition are, in most cases, directly correlated with the transport and deposition of sediment and organic matter (Clark and Maret, 1998; Maret, 1995; Maret and Ott, 1997; Rinella et al., 1994). Reductions in the amount of these materials entering the system will likely result in reduction of pesticide pollutant transport and loading to the system. Reduction of such transport will be directly linked to the sediment reduction measures identified within this and other related TMDLs in the Snake River Basin.

Additional Pesticides Analysis
At the request of the King Hill-C.J. Strike watershed advisory group, an evaluation of several additional pesticides was performed. This analysis was performed if two criteria were met:

- water column concentration data were available
- a standard for that given pesticide existed within the *Idaho Water Quality Standards and Water Treatment Requirements*

Based on meeting both of these criteria, additional analyses were performed for aldrin, endrin, heptachlor, heptachlor epoxide, lindane, alpha-HCH, and dacthal. After compiling the data, two distinct data sets were identified. Aldrin, endrin, heptachlor, heptachlor epoxide, and lindane data were available for the period 1965-1971, and alpha-HCH, dacthal, and lindane data were available for the period 1994-2002. Unfortunately, no data were available for the period between 1971 and 1994.

Tables 26 and 27 show the results of comparing the mean concentration for each pesticide for the period of record to the applicable water quality standard for the protection of cold water aquatic life and domestic water supply. It should be noted that these data were collected at King Hill. As such, they do not represent the most desirable data for determining beneficial use support status in C.J. Strike Reservoir. However, the data do allow for the best available analysis of Snake River conditions within the King Hill area and offer the additional insight requested by the watershed advisory group.

Table 26. Mean pesticide concentration at King Hill for the period of record as compared to the applicable water quality standard, 1965-1971 data

Pesticide	Beneficial Use[1]	Calculated Mean Concentration (µg/L)	Target Concentration (µg/L)
Aldrin	CWAL	0.00063	None Available
Aldrin	DWS	0.00063	0.00013
Endrin	CWAL	0.00048	0.0023
Endrin	DWS	0.00048	0.76
Heptachlor	CWAL	0.0014	0.0038
Heptachlor	DWS	0.0014	0.00021
Heptachlor epoxide[2]	CWAL	0.00016	0.0038
Heptachlor epoxide[2]	DWS	0.00016	0.0001
Lindane	CWAL	0.0027	0.08
Lindane	DWS	0.0027	0.019

[1] CWAL: cold water aquatic life, DWS: domestic water supply
[2] Oxidized form of Heptachlor

Table 27. Mean pesticide concentration at King Hill for the period of record as compared to the applicable water quality standard, 1994-2002 data

Pesticide	Beneficial Use[1]	Calculated Mean Concentration (µg/L)	Target Concentration (µg/L)
Alpha-HCH[2]	CWAL	0.0014	None Available
Alpha-HCH[2]	DWS	0.0014	0.0039
Dacthal	CWAL	0.0011	None Available
Dacthal	DWS	0.0011	70
Lindane	CWAL	0.0020	0.08
Lindane	DWS	0.0020	0.019

[1] CWAL: cold water aquatic life, DWS: domestic water supply
[2] Photochlorinated form of Benzene

The data presented in Table 26 show that the mean aldrin, heptachlor, and heptachlor epoxide concentrations for the 1965-1971 POR exceed the current standards for domestic water supply. The aquatic life standard is not exceeded with these or any of the other pesticides (endrin or lindane). While not shown in Table 26, it is important to note that the values causing the mean concentrations to exceed the aldrin, heptachlor, and heptachlor epoxide standards all occurred in 1966 and 1967. There were no exceedances in 1965 or 1968-1971. Apparently, some factor or combination of factors caused an acute spike in the concentrations during 1966 and 1967 because from 1968 to 1971 there were no exceedances.

Table 27 shows that the mean alpha-HCH, dacthal, and lindane concentrations for the 1994-2002 POR are all below the current standards for domestic water supply and/or cold water aquatic life.

Recommendations for the Additional Pesticides

Of the available data for all years, only the aldrin, heptachlor and heptachlor epoxide data for the period 1966 and 1967 show exceedances of the current standards. Since the 1968-1971 data do not show exceedances because aldrin has since been banned from use and because heptachlor is no longer used for agricultural purposes, DEQ does not recommend developing a TMDL for these pesticides.

Pesticides Loading Analysis Summary

The data presented in Tables 24 and 25 and recently collected data show that the t-DDT and dieldrin concentrations in C.J. Strike Reservoir do not exceed the target concentrations for cold water aquatic life or domestic water supply beneficial uses. In addition, Tables 26 and 27 show that aldrin, endrin, heptachlor, heptachlor epoxide, lindane, alpha-HCH, and dacthal do not exceed current standards in the Snake River near King Hill. Based on these analyses, DEQ does not recommend developing a TMDL for pesticides and recommends de-listing pesticides as a pollutant of concern from the next available §303(d) list.

Nutrient Loading Analysis

C.J. Strike Reservoir is §303(d) listed for excess nutrient. The *Idaho Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02) designate beneficial uses for the C.J. Strike Reservoir, which include cold water aquatic life. To determine impairment of water quality by excess nutrients, this analysis uses levels of dissolved oxygen as an indicator of water quality. Excess nutrients and dissolved oxygen are inversely correlated: when excess nutrients are high, dissolved oxygen is low. Data from the Idaho Power Company show that Idaho’s water quality standard for dissolved oxygen is violated. An analysis of the Idaho Power Company data will demonstrate the water quality issues in the reservoir relating to excess nutrients.

The presence of a reservoir is a human disturbance, so water quality cannot be completely restored to the condition of the river before impoundment. However, the symptoms of water quality impairment can be managed. Reservoirs need management and protection because they are subject to the same effects of silt, organic matter, and nutrient loading as lakes. On the average, nutrient and sediment loads are much higher for reservoirs than lakes. In general, reservoirs are at the bottom of a watershed receiving the inflow of more tributaries than lakes, which are generally central in a watershed and in a symmetrical drainage. Nutrient and sediment loads are, on the average, much higher for reservoirs and this material may have undergone a far longer period of in-stream processing than for material loaded to natural lakes. In addition, reservoir watersheds are generally nearly an order of magnitude greater than the average watershed of a lake, which accounts for the higher areal load of reservoirs. Water often enters lakes via smaller streams that are likely to traverse wetland or littoral areas, which filter pollutants, whereas reservoir inflows often have characteristics of a major river for large distances into the reservoir, allowing little opportunity for pollutant filtration (Thornton 1990).

Characteristics of Reservoir Zonation

Reservoirs combine qualities of both rivers and lakes, separating into zones called riverine, transitional, and lacustrine (lake-like), according to shape of the basin and velocity of streamflow (Figure 55). Table 28 lists the main differences between the reservoir zones (Kimmel and Groeger 1984).

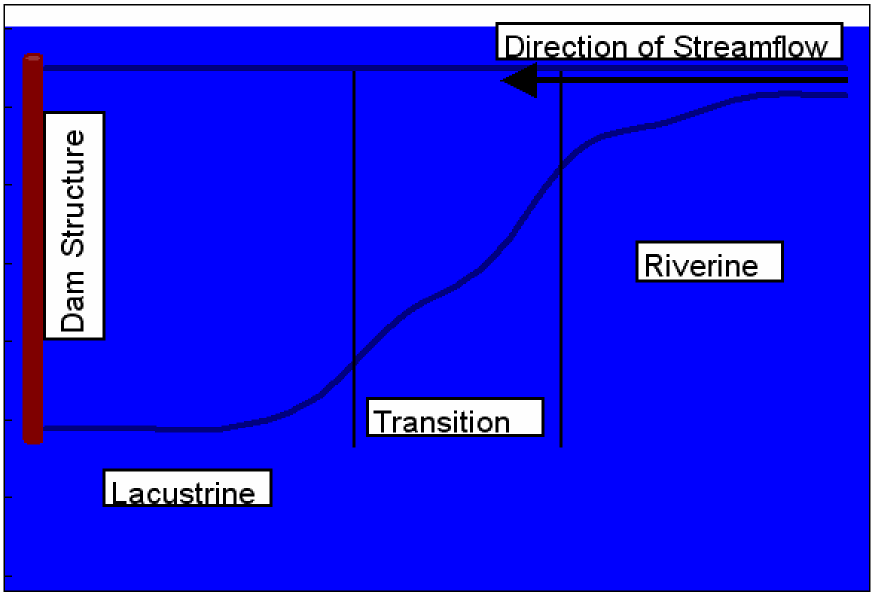


Figure 55. Example reservoir zones

Table 28. Defining characteristics of reservoir zones

Riverine Zone	Transitional Zone	Lacustrine Zone
Narrow -basin	Broader, deeper basin	Broad, deep, lake-like
High streamflow	Reduced streamflow	Little streamflow
High suspended solids, low light	Lower suspended solids, more light	Clearer
High nutrients, advective supply	Advective nutrient supply reduced	Internal nutrient recycling, low nutrients
Light limited photosynthesis	High photosynthesis	Nutrient limited photosynthesis
Algal cell loss by sedimentation	Algal cell loss by sedimentation, grazing	Algal cell loss by grazing
Organic matter supply allochthonous	Intermediate	Organic matter supply autochthonous
More eutrophic	Intermediate	More oligotrophic

The zones control the abundance and metabolism of algae and the way the system processes nutrients. The riverine zone is dominated by flow and mixing. In the rapid flushing conditions of the riverine zone, algal abundance is more dependent on flushing than on nutrient concentrations. In the transitional zone, the inflow velocity slows, rapid sedimentation begins, and water clarity increases. The lacustrine zone has thermal stratification and a higher probability of nutrient limitation of algal growth (Wetzel 2001).

Characteristics of Reservoir Stratification

In the lacustrine zone of deep reservoirs, surface waters warm in the summer while bottom waters remain cool. Cold water is denser than warm water, so the surface waters and bottom waters do not mix. The surface waters (epilimnion) continue to be mixed by wind, while the bottom waters (hypolimnion) do not mix with the upper layers of water (Figure 56). The middle layer (*metalimnion* or *thermocline*) is the area with the most rapid temperature change.

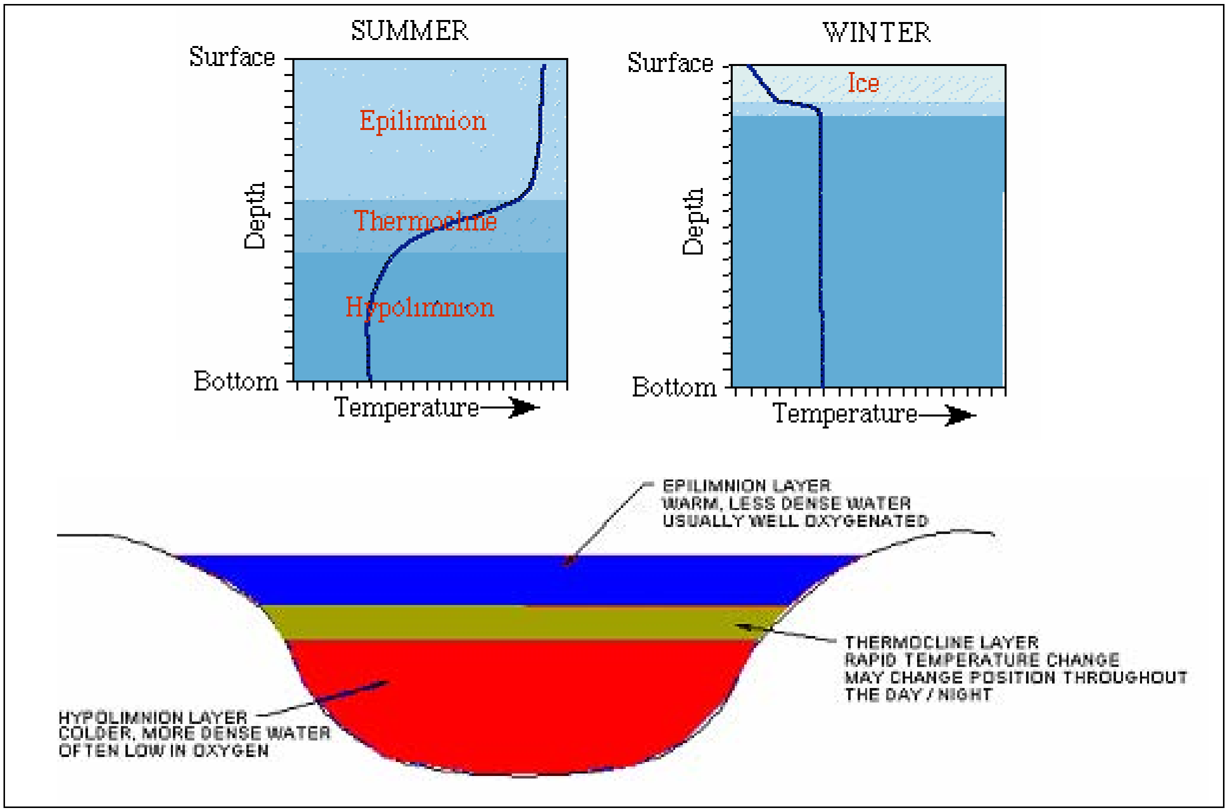


Figure 56. Depictions of a stratified lacustrine zone

This thermal stratification generally remains in the lacustrine zone until cooler air temperatures in the fall cool the surface waters sufficiently to cause the stratified layers to turn over and mix thoroughly. Stratification is the main driver of the physical, chemical, and biological interactions of a lake. Features of strata are given in Table 29 (Wetzel 2001).

Table 29. Defining characteristics of reservoir stratification layers

Epilimnion	Metalimnion	Hypolimnion
Warm isothermic	Warm to cold thermal discontinuity	Cold isothermic
Abundant Oxygen	Variable oxygen	Oxygen low or absent, increased concentrations of soluble forms of contaminants and nutrients
Warm water fishery	Mixed fishery	Coldwater fishery if oxygen adequate

Effects of Excess Nutrients in Reservoirs

Nutrients, including nitrogen and phosphorus, support plant growth and the food web. Although nutrients are necessary to support life in aquatic ecosystems, excess nutrients are detrimental to water quality, causing more algal and plant growth than can be consumed in the food web of the reservoir. Excess algal growth, causing slime and choked plant growth, creates problems for many beneficial uses of water resources, including the following:

Aquatic life

- Increased pH, changing the animal community composition
- Depleted dissolved oxygen, adversely affecting animal populations and ultimately causing fish kills

Drinking water

- Gives an unpleasant taste and smell to the water
- Increases costs of treating drinking water

Recreation and aesthetic enjoyment

- Reduces water clarity
- Makes swimming conditions unpleasant
- Causes objectionable odors
- Interferes with boating
- Creates a polluted appearance

Trophic state refers to the overall level of nutrients and related algal and plant growth in the system. *Eutrophication* is the artificial increase in the trophic state of a system caused by human activities, such as overuse of fertilizers and wastewater input to surface waters. The four major trophic classes include (Natural Resources Conservation Service 1999) the following:

- Oligotrophic – systems that have low supplies of nutrients; poorly nourished
- Mesotrophic – systems with intermediate nutrient supplies
- Eutrophic – systems that have a large supply of nutrients; well nourished
- Hypertrophic – systems that have excessively large supplies of nutrients.

The shape of a basin greatly influences the effectiveness of excess nutrients. Shallow and broad stream channels allow more margins for rooted plants, which creates more leaf and sediment surfaces to harbor algae; all of the biological activities in these areas create internal nutrient loading. Productivity is negatively correlated with mean depth so deeper reservoirs have a greater capacity to receive excess nutrients without increasing the biomass of plants and algae (Cooke 1993).

C.J. Strike Reservoir Nutrient Assessment

For the C.J. Strike Reservoir, DEQ assessed water quality from river mile 510 downstream to river mile 494 at the dam (Figure 57). Since 1995 is the year with the most extensive Idaho Power Company data, and the Snake River stream flow was near average, data from March through September 1995 is used in this reservoir water quality assessment.

The size and shape of C.J. Strike Reservoir, and the extent of water quality data, are important to this assessment. Data for the reservoir from river mile (RM) 510 to 494 exists at monitoring stations, including RM 494.5, 495.3, 498, 500, 502, 504, 506, 508, and 510. Water quality data, including temperature, conductivity, pH, dissolved oxygen, phosphorus, nitrogen, and chlorophyll-a were measured at depths of 0.3, 3, 5, 10, 15, 20, and 25 meters. Most frequently, temperature, conductivity, pH, and dissolved oxygen were monitored every two weeks, and the other components were monitored every four weeks.

Monitoring at various depths throughout the reservoir, from March through September, reveals the variability of the water quality at different locations, depths, and times of the year. Figure 58 is a grid representing the bathymetry of the reservoir; each grid cell is two meters deep, the number inside each grid cell is the width of the reservoir at that point, and the length of each grid cell is listed on the fourth row down the table. In this assessment, all of the dimensions of surface area, volume, and depth are calculated from this grid. This is also the grid used by Idaho Power Company consultants to model water quality in the reservoir with the CE-QUAL-W2 (Cole and Wells 2003) model.

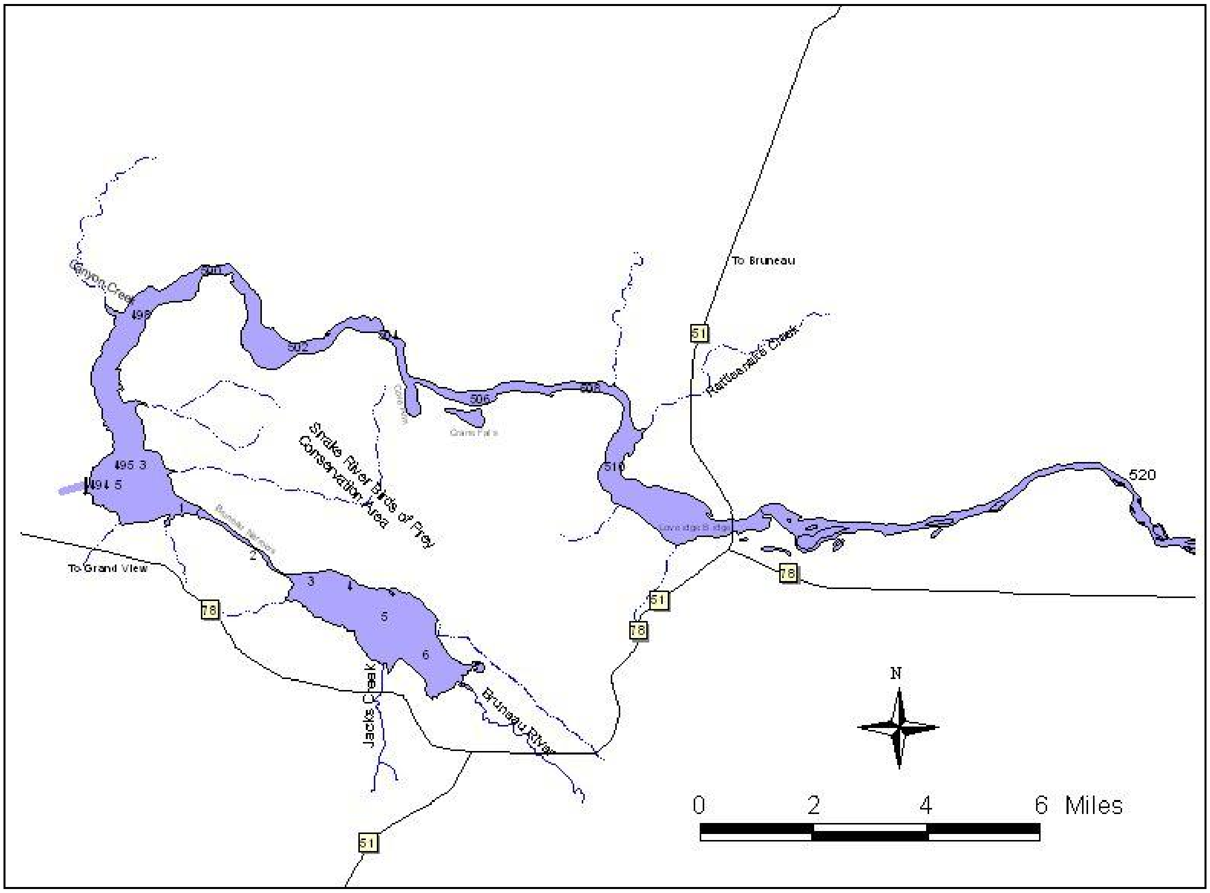


Figure 57. C.J. Strike Reservoir river miles

From RM		494	495	496	497	498	499	499	500	500	501	501	502	503	504	505	506	506	507	508	509
To RM		495	496	497	498	499	499	500	500	501	501	502	503	504	505	506	506	507	508	509	510
Segment	30	29	28	24	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10
Length	0.0	2414.0	1609.3	1609.3	841.2	847.3	911.4	992.1	681.2	940.3	1040.9	1152.1	1444.8	1281.7	1249.7	1543.8	752.9	888.5	1609.3	1609.3	1609.3
Depth (m)	Width (m)																				
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	875	885	598	751	622	488	473	263	229	383	1002	335	310	198	172	285	388	269	204	264
4	0	853	856	594	698	618	482	461	256	221	375	977	308	303	195	168	273	377	231	185	223
6	0	819	803	584	640	607	465	432	245	208	353	951	273	291	185	158	252	342	192	153	177
8	0	789	746	571	558	586	448	393	233	194	326	921	243	277	172	145	210	223	151	90	20
10	0	763	684	557	491	563	433	351	220	181	298	890	219	250	156	132	127	50	50	20	0
12	0	735	623	537	442	535	415	304	203	168	267	852	198	188	134	118	90	30	20	0	0
14	0	701	553	509	392	499	381	251	183	110	225	749	175	150	116	98	50	20	0	0	0
16	0	662	469	475	248	461	305	201	164	90	193	314	150	110	100	73	30	0	0	0	0
18	0	610	401	432	294	429	237	169	146	70	173	204	112	50	20	30	0	0	0	0	0
20	0	541	336	375	227	388	177	145	90	50	50	50	50	20	0	0	0	0	0	0	0
22	0	448	273	313	168	276	134	121	70	40	30	20	20	0	0	0	0	0	0	0	0
24	0	305	217	256	128	130	100	87	50	30	20	0	0	0	0	0	0	0	0	0	0
25	0	203	185	155	96	90	50	50	30	20	0	0	0	0	0	0	0	0	0	0	0
26	0	124	90	90	50	50	30	30	20	0	0	0	0	0	0	0	0	0	0	0	0
28	0	50	50	50	30	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Layer thickness = 2 meters																					

Figure 58. Lateral view of C.J. Strike Reservoir widths and depths

C.J. Strike Reservoir Stratification

The *Osgood Index* is a screening level indicator of the overall mixing capacity of a reservoir or lake. The Osgood Index equals the mean depth (z) divided by the square root of the surface area (A) of the reservoir ($z/A^{0.5}$). A low number is a shallow, broad reservoir that is readily mixed by wind. Higher numbers indicate more resistance to mixing. The C.J. Strike Reservoir from river mile 502 to 494 has a surface area of 8,519,183 meters^2 and a mean depth of 27.82 meters. The Osgood Index of C.J. Strike Reservoir is therefore $27.82/8{,}519{,}183^{0.5}$ = 0.01. An Osgood Index of less than 6.0 would indicate that the system is a deep, stratified lake, but with some transfer of phosphorus from the hypolimnion to the upper waters (Natural Resources Conservation Center 1999).

A stratified deep lake with some hypolimnetic phosphorus transfer is moderately sensitive to increased phosphorus loading, but relatively insensitive to decreased phosphorus loading. That is, it will take a long time for such a system to show a response to a decreased phosphorus load. Large phosphorus concentrations build up in the hypolimnetic sediments and only a limited amount transfers up to the metalimnion (Natural Resources Conservation Center 1999). Although the Osgood index is a screening tool, plotting the temperature data for C.J. Strike Reservoir also shows a stratified system. Figure 59 shows how the temperature profile at RM 494.5 becomes increasingly stratified from May through September and then becomes more isothermal as the weather cools in October.

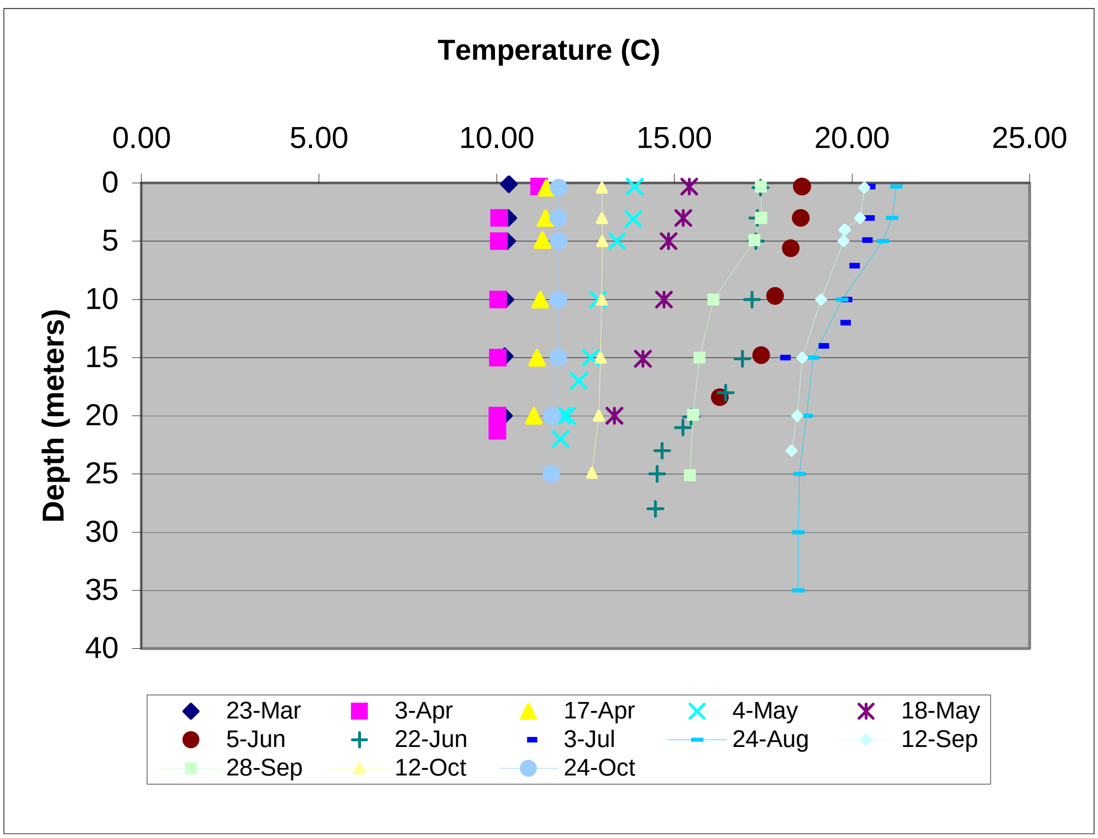


Figure 59. 1995 temperature profiles at river mile 494.5

Orthophosphorus (OP) is the biologically-available form of phosphorus that is dissolved and ready to be consumed and metabolized by algae. Therefore, it is a stronger indicator of eutrophication potential than evaluating total phosphorus for this purpose. The OP data shows that the reservoir is stratified and resistant to mixing because the deepest measurements consistently have the largest OP amounts. The OP is migrating out of the sediment to the hypolimion for a very high internal loading. However, it is trapped by the stratification, otherwise OP would mix vertically into the photic zone and have a greater effect on algal growth. This example shows how strongly water quality is interrelated with the physical structure of the reservoir. In this instance, stratification affects nutrient migration and availability for algal growth.

Plotting the orthophosporus data also somewhat supports the Osgood prediction of reservoir type but infers a stronger stratification (Figure 60).

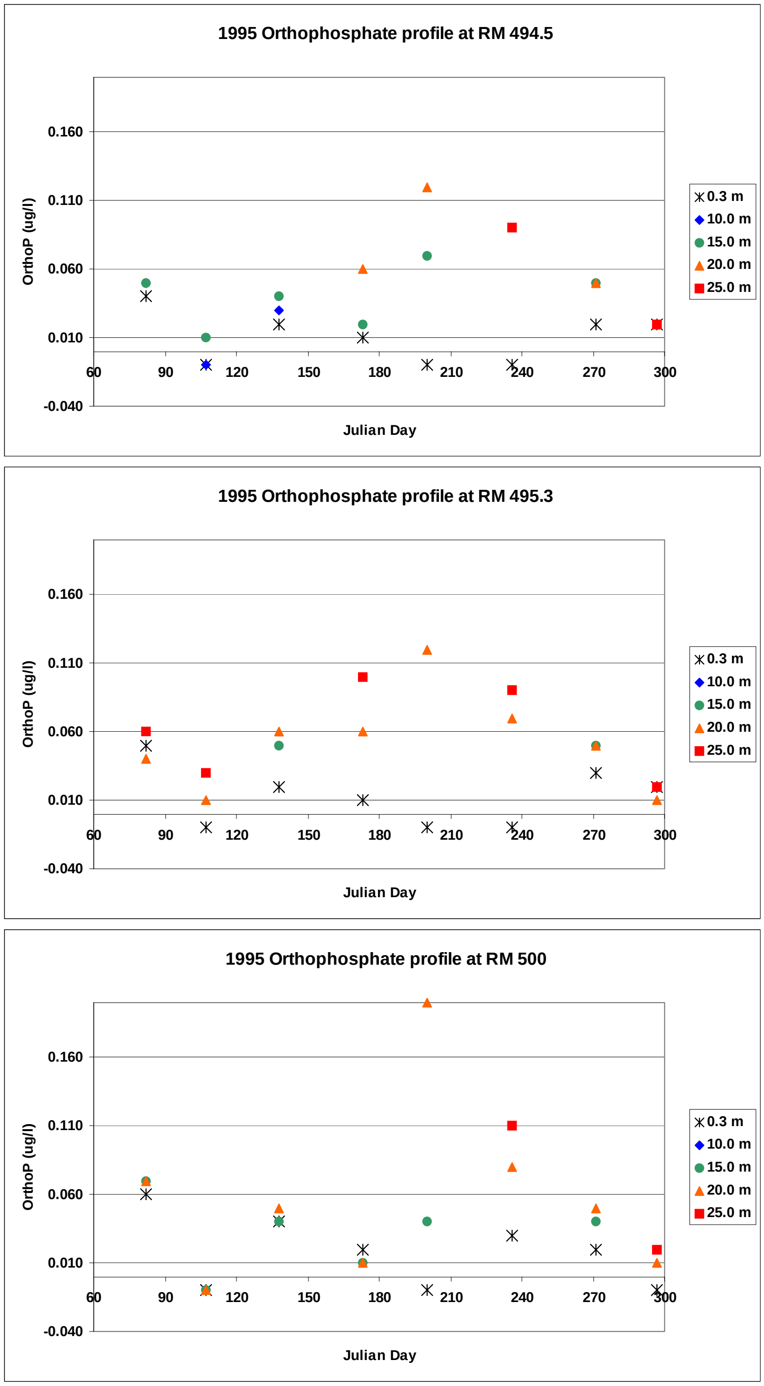


Figure 60. Orthophosphate profiles at RM 494.5, 495.3, and 500

C.J. Strike Reservoir Zonation

C.J. Strike reservoir shows distinctive zones, according to the average horizontal velocity throughout the reservoir (Figure 61). The fastest moving water is from RM 520 to 513, where a sharp drop occurs. This is the riverine portion of the reservoir. From RM 513 to 502, velocity fluctuates but shows a general slowing trend in the transition zone. The lacustrine zone is from RM 502 to 494 where the velocities are the slowest. The plan view of the reservoir in Figure 57 and the side view of the reservoir in Figure 58 demonstrate how the shape of the channel affects slowing, with the reach from RM 502 to 494 being the broadest and deepest part of the reservoir.

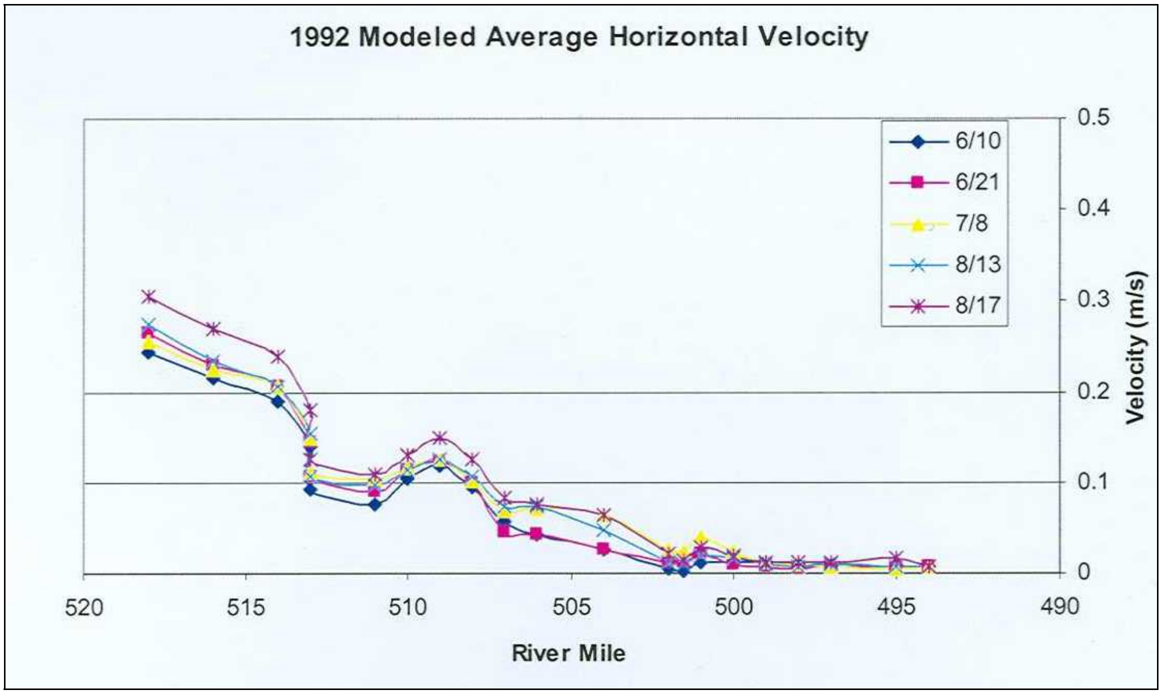


Figure 61. Average horizontal velocity by river mile in C.J Strike Reservoir, 1992 data.

Nutrient Characteristics

When a nutrient, generally nitrogen or phosphorus, is not available in sufficient quantities to support plant growth, it is termed the limiting nutrient To determine the limiting nutrient, most aquatic plants contain 7.2 times as much nitrogen as phosphorus. Therefore, if the N:P ratio is less than 7.2:1, nitrogen is limiting. If the ratio is higher than 7.2:1, phosphorus is limiting. In the Idaho Power Company license application for a Federal Energy Regulatory Commission license renewal, a water quality report describes the C.J. Strike reservoir as a phosphorus limited system (Idaho Power Company 1998). When excess quantities of a limiting nutrient are added to a system, plant and algae populations (total organic matter) are elevated to a nuisance polluting level.

Also, the waters nearest the reservoir do not show orthophosphorus, indicating that phosphorus is the limiting nutrient. Referring to Figure 60, the data points below the X-axis are the non-detect numbers. This indicates that the reservoir is not so enriched to the point that there is always excess phosphorus. The downward spike in orthophosphate shows that phosphorus is not overly enriched. The high volume and depth of the reservoir help in this assimilative capacity. The residence time is not so high that orthophosphate never moves.

Trophic Status

Several classification systems have been developed to classify the trophic status of lakes and reservoirs. The Carlson Trophic Index and Vollenweider classification system, described in Table 30, are two general methods to classify lakes and reservoirs as oligotrophic, mesotrophic, eutrophic, or hypertrophic (EPA 1999).

Table 30. Trophic status classification systems

Carlson Trophic Status Index (TSI) for biomass-related measures		
TSI (Chlorophyll-a) = 30.6 + 9.81 ln[1] (Chl)	TSI < 40 =	Oligotrophic
TSI (Total Phosphorus) = 4.15 + 14.42 ln (TP)	35<TSI<45=	Mesotrophic
TSI (Secchi Depth) = 60 – 14.41 ln (SD)	TSI > 45 =	Eutrophic
TSI (Total Nitrogen) = 54.45 + 14.43 ln (TN)	TSI > 60 =	Hypertrophic

Vollenweider Trophic status classification						
Water Quality Parameter	Oligotrophic		Mesotrophic		Eutrophic	
	Mean	Range	Mean	Range	Mean	Range
Total phosphorus (µg/l)	8	3-18	27	11-96	84	16-390
Total nitrogen (µg/l)	660	310-1,600	750	360-1,400	1900	390-6,100
Chlorophyll a (µg/l)	1.7	0.3-4.5	4.7	3-11	14	2.7-78
Peak chlorophyll a (µg/l)	4.2	1.3-11	16	5-50	43	10-280
Secchi depth (m)	9.9	5.4-28	4.2	1.5-8.1	2.4	0.8-7.0

[1]ln: natural log

Since phosphorus is the limiting nutrient, its concentration will be most indicative of the trophic status of the reservoir. When all of the phosphorus concentration measurements in the reservoir are weighted, according to the volume of the reservoir, the volumetrically-weighted average total phosphorus concentration is 0.11 mg/l (110 µg/L). By the Carlson trophic status index, C.J. Strike is hypertrophic, and by the Vollenweider classification, it is eutrophic.

Dissolved Oxygen

In this particular eutrophic to hypertrophic system, the elevated phosphorus levels contribute to excess organic matter, which in turn contributes to a depletion of dissolved oxygen, which is detrimental to cold water aquatic life. Temperature and dissolved oxygen are important to evaluating water quality, as their range throughout the reservoir and throughout the year equate with habitat availability. Available habitat is diminished when elevated nutrient levels deplete the levels of dissolved oxygen to the point that aquatic life can no longer survive. Idaho's water quality standards at IDAPA 58.01.02.250 define the dissolved oxygen requirements for cold water aquatic life as 6.0 mg/l at all times, except in the bottom-most portion of lakes and reservoirs:

In lakes and reservoirs, this standard does not apply to:

- The bottom twenty percent (20%) of water depth in natural lakes and reservoirs where depths are thirty-five (35) meters or less
- The bottom seven (7) meters of water depth in natural lakes and reservoirs where depths are greater than thirty-five (35) meters.
- Those waters of the hypolimnion in stratified lakes and reservoirs.

The hypolimnion, which is excluded from meeting this dissolved oxygen standard in a stratified system, is defined in the Idaho water quality as a zone with a rapid temperature drop of 1°C or more. It if further defined as:

. . . the deepest zone in a thermally-stratified body of water. It is fairly uniform in temperature and lies beneath a zone of water which exhibits a rapid temperature drop with depth of at least one (1) degree C per meter.

Since aquatic life is the most sensitive designated use in C.J. Strike Reservoir, the indicator of water quality is dissolved oxygen, and the desired water quality target is to be above 6 mg/l at all times, except in the excluded bottommost portion of the reservoir.

In 1995, Idaho Power Company collected vertical profile measurements for dissolved oxygen and temperature in the C.J. Strike Reservoir at the following river miles: 494.5, 495.3, 498, 500, 502, 504, 506, 508, and 510 (see Figure 57 for locations). These vertical temperature profiles help show whether the water column is isothermal or stratified. DEQ analyzed the vertical profile measurements to identify violations of Idaho's water quality standards for dissolved oxygen. The difference in temperature between the topmost and bottommost water column measurements identifies whether the water column is isothermal or stratified. If the difference in temperature is 3°C or greater in collected data, the water column is evaluated as stratified; if the difference is less than 3°C, the water column is evaluated as isothermal. Using 3°C as the variance between the surface and bottom reservoir temperatures is a general limnological guideline (Wetzel 2001) as well as a standard of DEQ's trophic monitoring plan for lakes and reservoirs (not published).

If the reservoir is stratified on a given monitoring date at a given river mile, then the hypolimnion is identified as the area of the water column below which a temperature drop of greater than 1°C per meter is sustained. The hypolimnion is excluded from meeting the 6.0

mg/l dissolved oxygen standard. Any waters of the metalimnion or epilimnion, with a dissolved oxygen concentration of 6 mg/l or less, show a violation of the water quality standard. If there is no zone with a temperature drop greater than 1°C per meter, the water column will be evaluated as isothermal. The temperature and dissolved oxygen measurements are linearly interpolated for each meter of depth where necessary to identify the metalimnion.

If the reservoir is isothermal, different qualifications to the standard apply. If the reservoir is deeper than 35 meters, which occurs only at river mile 494.5, then the bottom 7 meters of the reservoir are excluded from the dissolved oxygen standard. If the reservoir is less than or equal to 35 meters deep, then the bottom 20% of the total depth is excluded from meeting the dissolved oxygen standard. The flow chart in Figure 62 summarizes the analysis performed on the temperature and dissolved oxygen measurements in C.J. Strike Reservoir.

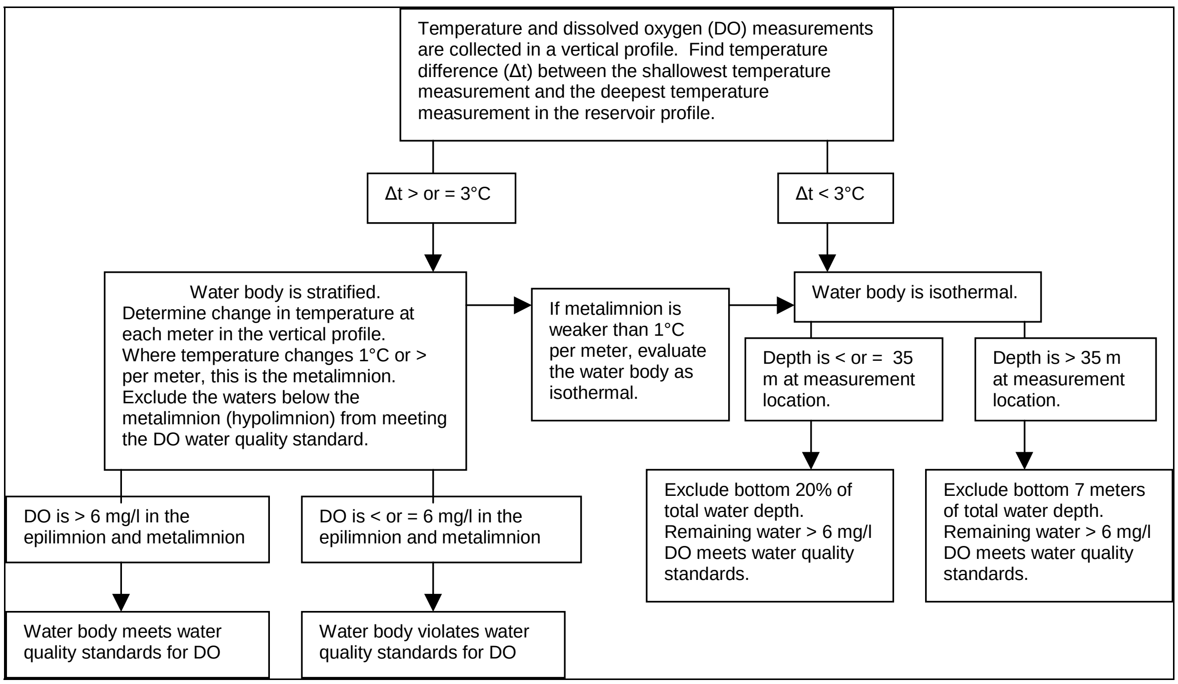


Figure 62. Summary of dissolved oxygen water quality standard application

Examples of how the Idaho Power Company dissolved oxygen data were compared to the Idaho Water Quality Standards and Wastewater Treatment Requirements can be found in Appendix K.

Results of analyzing the 1995 Idaho Power vertical profile measurements for dissolved oxygen and temperature in the C.J. Strike Reservoir show depleted dissolved oxygen measurements, which violate Idaho's water quality standards. In summary, the dissolved oxygen depletion problems occurred on the following dates and river miles:

- June 5 through September 12 at river mile 494.5
- May 18 through September 12 at river mile 495.3
- May 18 through August 24 at river mile 498
- May 18 through August 24 at river mile 500
- August 24 at river mile 502

Specific dissolved oxygen violations are shown in Figure 63 and listed in Table 31. There are 69 total dissolved oxygen violations, 64 of which (93%) are between depths of 10m to 25m.

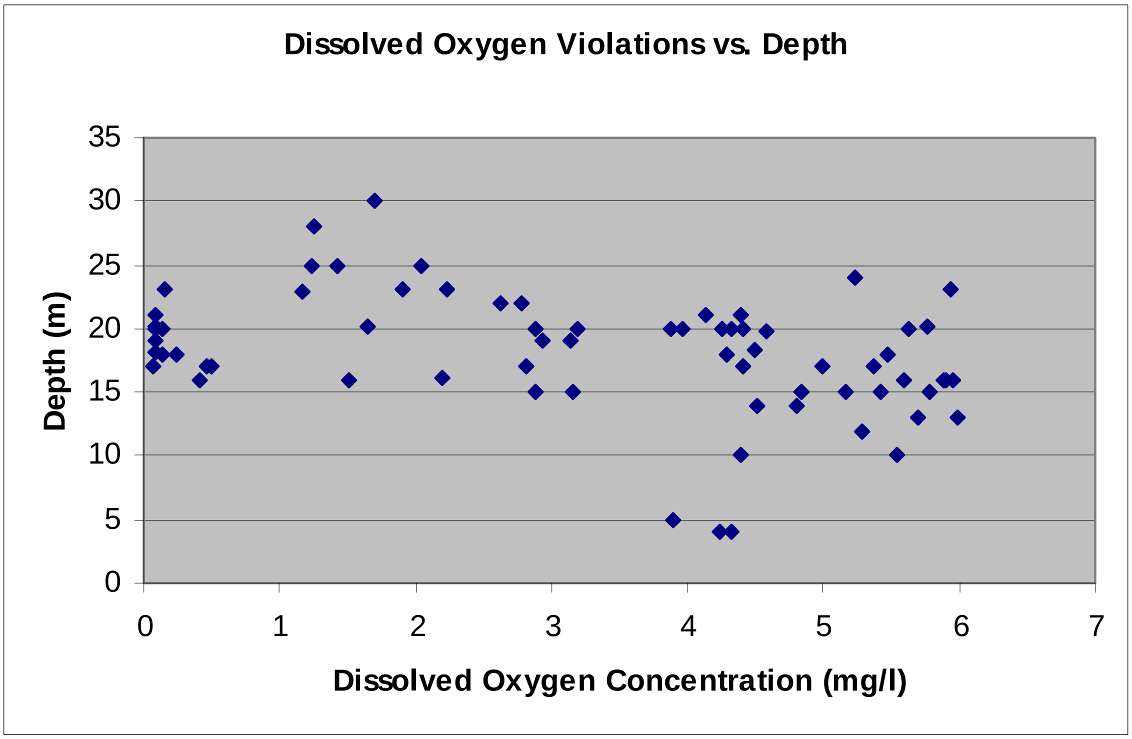


Figure 63. C.J. Strike Reservoir dissolved oxygen measurements below 6.0 mg/L vs. depth

Table 31. Violation of the 6.0 mg/L water quality standard in C.J. Strike Reservoir, based on 1995 data

Date	River Mile	DO[1]	Depth (m)	Date	River Mile	DO	Depth (m)
9/12	494.5	4.32	4	7/3	495.3	2.93	19
9/12	494.5	4.23	4	7/19	500	0.08	19
9/12	494.5	3.89	5	6/5	495.3	4.58	19.7
9/12	494.5	5.55	10	7/3	498	4.41	19.9
9/12	495.3	4.39	10	6/22	495.3	4.26	20
9/12	495.3	5.29	12	6/22	498	5.63	20
7/19	498	5.7	13	7/3	495.3	2.88	20
7/19	495.3	5.98	13.1	7/19	495.3	0.13	20
7/19	495.3	4.52	13.9	7/19	500	0.08	20
7/19	498	4.81	14	8/24	494.5	3.88	20
7/3	494.5	5.43	15	8/24	495.3	4.33	20
7/19	495.3	3.16	15	8/24	498	3.19	20
7/19	498	2.88	15	8/24	500	3.96	20
8/24	494.5	4.84	15	5/18	495.3	5.76	20.1
8/24	495.3	5.17	15	6/22	494.5	1.64	20.1
8/24	498	5.78	15	7/19	498	0.09	20.1
7/3	500	5.96	15.9	5/18	498	4.39	21
7/3	495.3	5.59	16	6/22	494.5	4.13	21
7/3	498	5.88	16	7/19	500	0.09	21.1
7/19	498	0.41	16	6/22	495.3	2.78	22
7/19	500	1.51	16	8/24	495.3	2.62	22
8/24	502	5.9	16	7/3	495.3	1.16	22.9
7/19	495.3	2.2	16.1	5/18	500	5.93	23
7/3	498	5	17	6/22	494.5	2.23	23
7/19	498	0.07	17	6/22	495.3	1.91	23
7/19	500	0.46	17	7/19	495.3	0.15	23
8/24	498	5.37	17	5/18	500	5.24	24
8/24	500	4.41	17	6/22	494.5	1.43	25
8/24	502	2.82	17	6/22	495.3	1.24	25
7/19	495.3	0.5	17.1	8/24	494.5	2.04	25
6/22	495.3	5.48	18	6/22	494.5	1.25	28
7/3	495.3	4.29	18	8/24	494.5	1.69	30
7/19	495.3	0.14	18	--	--	--	--
7/19	500	0.24	18	--	--	--	--
7/19	498	0.08	18.1	--	--	--	--
6/5	494.5	4.49	18.4	--	--	--	--
6/5	498	3.14	19	--	--	--	--

[1] Dissolved Oxygen

These violations of the dissolved oxygen water quality standard show that habitat availability for aquatic life is diminished during these episodes. To help visualize the extent of the problem of dissolved oxygen depletion, Figure 64 shows a cross-sectional view of the reservoir when violations occur. The violations mostly occur between depths of 10 and 25 meters up to river mile 504.

In the transition zone from RM 510 to 504 (blue grid) and also in the surface layers of the rest of the reservoir from the surface to a depth of ten meters (pink grid), there are no dissolved oxygen depletion problems. In the bottom layers of the reservoir from a depth of 25 to 30 meters (yellow grid), the water becomes very depleted of oxygen, but the bottommost portion of the reservoir is excluded from meeting the 6 mg/l standard, because this oxygen depletion is a natural occurrence in very deep lakes and reservoirs.

From RM		494	495	496	497	498	499	499	500	500	501	501	502	503	504	505	506	506	507	508	509
To RM		495	496	497	498	499	499	500	500	501	501	502	503	504	505	506	506	507	508	509	510
Segment	30	29	28	24	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10
Length	0.0	2414.0	1609.3	1609.3	841.2	847.3	911.4	992.1	681.2	940.3	1040.9	1152.1	1444.8	1281.7	1249.7	1543.8	752.9	888.5	1609.3	1609.3	1609.3
Depth (m)	Width (m)																				
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	875	885	598	751	622	488	473	263	229	383	1002	335	310	198	172	285	388	269	204	264
4	0	853	856	594	698	618	482	461	256	221	375	977	308	303	195	168	273	377	231	185	223
6	0	819	803	584	640	607	465	432	245	208	353	951	273	291	185	158	252	342	192	153	177
8	0	789	746	571	558	586	448	393	233	194	326	921	243	277	172	145	210	223	151	90	20
10	0	763	684	557	491	563	433	351	220	181	298	890	219	250	156	132	127	50	50	20	0
12	0	735	623	537	442	535	415	304	203	168	267	852	198	188	134	118	90	30	20	0	0
14	0	701	553	509	392	499	381	251	183	110	225	749	175	150	116	98	50	20	0	0	0
16	0	662	469	475	248	461	305	201	164	90	193	314	150	110	100	73	30	0	0	0	0
18	0	610	401	432	294	429	237	169	146	70	173	204	112	50	20	30	0	0	0	0	0
20	0	541	336	375	227	388	177	145	90	50	50	50	50	20	0	0	0	0	0	0	0
22	0	448	273	313	168	276	134	121	70	40	30	20	20	0	0	0	0	0	0	0	0
24	0	305	217	256	128	130	100	87	50	30	20	0	0	0	0	0	0	0	0	0	0
25	0	203	185	155	96	90	50	50	30	20	0	0	0	0	0	0	0	0	0	0	0
26	0	124	90	90	50	50	30	30	20	0	0	0	0	0	0	0	0	0	0	0	0
28	0	50	50	50	30	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Layer thickness = 2																					

Figure 64. Dissolved oxygen violations in C.J. Strike Reservoir.

The problematic portion of the reservoir lies in the area between 10 and 25 meters deep, from RM 494 to RM 504 (peach grid). This is where almost all (93%) of the dissolved oxygen violations occur. The volume of each of these portions of the reservoir is calculated and shown in Figure 65. The area with most of the dissolved oxygen violations equals over 35% of the volume of the reservoir.

			% total volume
Volume of 0-9.9-503.9 grid =	86479092.4	m^3	50
Volume of 10-24.9-503.9 grid =	62125590	m^3	35.50
Volume of 25-30-503.9 grid =	6785995.6	m^3	4.00
Volume of 504-510 grid =	18329948.8	m^3	10.50
Total volume (m^3)=	173720627	m^3	100.00

Figure 65. Volume of portions of C.J. Strike Reservoir

Bruneau Arm Dissolved Oxygen

The Bruneau River arm of C.J. Strike Reservoir also experiences dissolved oxygen depletion, although not to the extent of the Snake River arm. The Bruneau River arm is shallower than the Snake River arm and is more susceptible to wind related mixing in the upper layers of the reservoir. As a result, the number of dissolved oxygen values below 6.0 mg/L (above the hypolimnion) is minimal (less than 10%) and not numerous enough to constitute a violation of the water quality standards. Table 32 shows the specific dissolved oxygen violations. The location of the river miles can be seen on Figure 57.

Table 32. Violation of the 6.0 mg/L water quality standard in Bruneau River arm of C.J. Strike Reservoir, based on 1995 data

Date	River Mile	DO	Depth (m)
7/19	2	5.05	11
7/19	2	5.12	10
7/19	2	5.12	8
8/24	2	5.91	10
9/12	2	2.5	10
9/12	2	0.67	9
9/12	2	0.84	8
9/12	2	1.85	5.1
9/12	2	4.91	3
9/12	2	1.96	4
8/24	4.3	4.68	7
8/24	4.3	4.95	5.1
9/12	4.3	3.97	8

The Bruneau River arm dissolved oxygen violations shown in Table 32 occurred during the following periods:

- July 19 through September 12 at river mile 2
- August 24 through September 12 at river mile 4.3

The violations at river mile 2 are somewhat non-typical because from Bruneau River mile zero to about river mile 2.5 the Bruneau River arm is susceptible to mixing with the hypolimnetic waters from the lacustrine zone of the Snake River arm. The Bruneau River arm dissolved oxygen data show that in July and August the concentrations in the lower levels of the metalimnion and the hypolimnion are actually higher than the concentrations above those levels. This non-typical phenomenon is due to the influence from the Snake River arm water.

Total Phosphorus

All of the total phosphorus measurements for the reservoir are volumetrically weighted by multiplying the average concentration of each measurement (C(P)) by the percent volume of the grid in which it was measured (%V(P)), and dividing the average of the weighted average concentrations by 100 (AVE{C(P)*%V(P)}/100). When the concentration of all the total phosphorus measurements are weighted according to the volume of these portions of the reservoir, the total volumetrically-weighted concentration of total phosphorus equals 0.11 mg/l (110 µl). Dissolved oxygen is volumetrically weighted in the same manner (Figure 66).

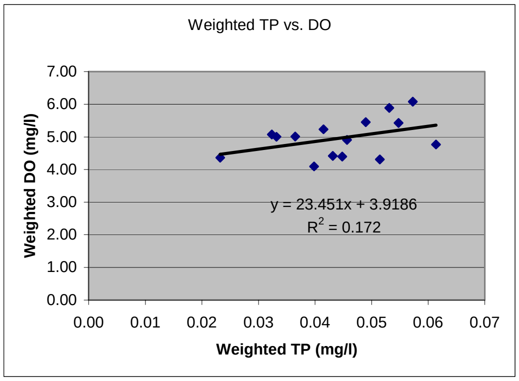
	mg/l of TP weighted avg concentration	kg of TP Weighted average weight
Volumetric Concentration of 0-9.9-503.9 grid=	0.04	7.78
Volumetric Concentration of 10-24.9-503.9 grid=	0.04	7.46
Volumetric Concentration of 25-30-503.9 grid=	0.01	1.02
Volumetric Concentration of 504-510 grid=	0.01	2.02
Total volumetric concentration =	0.11	18.27

	mg/l of DO weighted avg concentration	kg of DO Weighted average weight
Volumetric Concentration of 0-9.9-503.9 grid=	4.88	847.50
Volumetric Concentration of 10-24.9-503.9 grid=	2.36	410.03
Volumetric Concentration of 25-30-503.9 grid=	0.18	30.54
Volumetric Concentration of 504-510 grid=	1.08	186.97
Total volumetric concentration =	8.49	1475.03

Figure 66. Volumetrically-weighted average concentration of total phosphorus and dissolved oxygen.

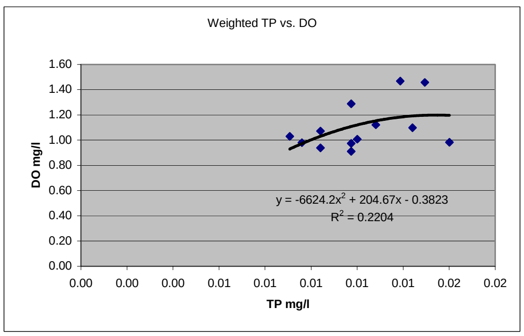
When all of the volumetrically-weighted average concentrations of each grid were regressed for total phosphorus versus dissolved oxygen, the pink and blue grids showed no correlation between phosphorus and oxygen. This was expected since the transition zone still has some high and fluctuating horizontal velocities (see back to Figure 61), which mix and oxygenate all of the layers of water. The surface waters down to 10 meters are also well-oxygenated, being more available to wind-mixing and other activities on the surface. The lack of a correlation between dissolved oxygen and total phosphorus in these areas means that even if total phosphorus concentrations are high, contributing to excess organic matter and oxygen-depleting activities, the mixing action of the wind and waves compensate by creating sufficient oxygen for aquatic life.

However, correlations between volumetrically weighted average concentrations of total phosphorus versus dissolved oxygen in the peach and yellow grids showed very strong correlations. These zones of the reservoir do not have access to mixing actions of the wind and waves. Thus, all of the oxygen-depleting activities in these zones are more sensitive to excess phosphorus in the system. Figure 67 illustrates these correlations.



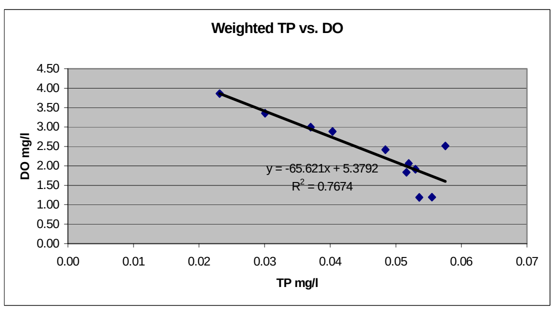
Avg TP & DO of 0-9.9-503.9 grid			
Avg TP	Avg DO	Weighted TP	Weighted DO
0.09	8.73	0.04	4.40
0.10	10.83	0.05	5.45
0.11	11.69	0.05	5.89
0.12	12.08	0.06	6.08
0.12	9.47	0.06	4.77
0.10	8.55	0.05	4.31
0.08	10.39	0.04	5.23
0.07	10.08	0.03	5.08
0.05	8.66	0.02	4.36
0.07	9.94	0.03	5.01
0.09	8.77	0.04	4.42
0.08	8.13	0.04	4.09
0.07	9.95	0.04	5.01
0.09	9.75	0.05	4.91
0.11	10.78	0.05	5.43

No Correlation



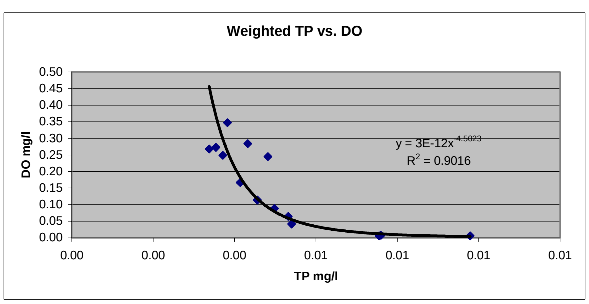
Avg TP and DO of 504-510 grid			
10.67278 %of total volume			
Avg TP	Wtd TP	Avg DO	Wtd DO
0.11	0.01	9.13	0.97
0.12	0.01	10.51	1.12
0.13	0.01	13.75	1.47
0.14	0.01	13.65	1.46
0.15	0.02	9.20	0.98
0.14	0.01	10.29	1.10
0.11	0.01	9.44	1.01
0.09	0.01	9.18	0.98
0.11	0.01	8.53	0.91
0.10	0.01	8.79	0.94
0.09	0.01	9.64	1.03
0.10	0.01	10.04	1.07
0.11	0.01	12.06	1.29

No Correlation



Avg TP and DO of 10-24.9-503.9 grid			
35.59798 %of total volume			
Avg TP	Avg DO	Wtd TP	Wtd DO
0.10	8.42	0.04	3.00
0.08	9.42	0.03	3.35
0.07	10.85	0.02	3.86
0.11	8.10	0.04	2.88
0.16	7.06	0.06	2.51
0.15	5.38	0.05	1.92
0.14	6.78	0.05	2.41
0.15	5.79	0.05	2.06
0.16	3.35	0.06	1.19
0.15	3.34	0.05	1.19
0.15	5.15	0.05	1.83

Correlated



Avg TP and DO of 25-30-503.9 grid			
3.375986 %of total volume			
Avg TP	Wtd TP	Avg DO	Wtd DO
0.10	0.00	7.93	0.27
0.11	0.00	8.08	0.27
0.11	0.00	7.37	0.25
0.12	0.00	4.93	0.17
0.14	0.00	3.37	0.11
0.15	0.00	2.62	0.09
0.16	0.01	1.23	0.04
0.23	0.01	0.22	0.01
0.29	0.01	0.18	0.01
0.22	0.01	0.18	0.01
0.16	0.01	1.91	0.06
0.14	0.00	7.25	0.24
0.13	0.00	8.40	0.28
0.11	0.00	10.29	0.35

Coorelated

Figure 67. Correlations of volumetrically weighted total phosphorus and dissolved oxygen

Looking at graphs showing the deepest measurements of total phosphorus in the deepest parts of the reservoir plotted with the dissolved oxygen measurements taken at the same spot as the phosphorus measurements seems to support this correlation (Figure 68.) Where total phosphorus shows the highest climb, there is a distinct dip in dissolved oxygen.

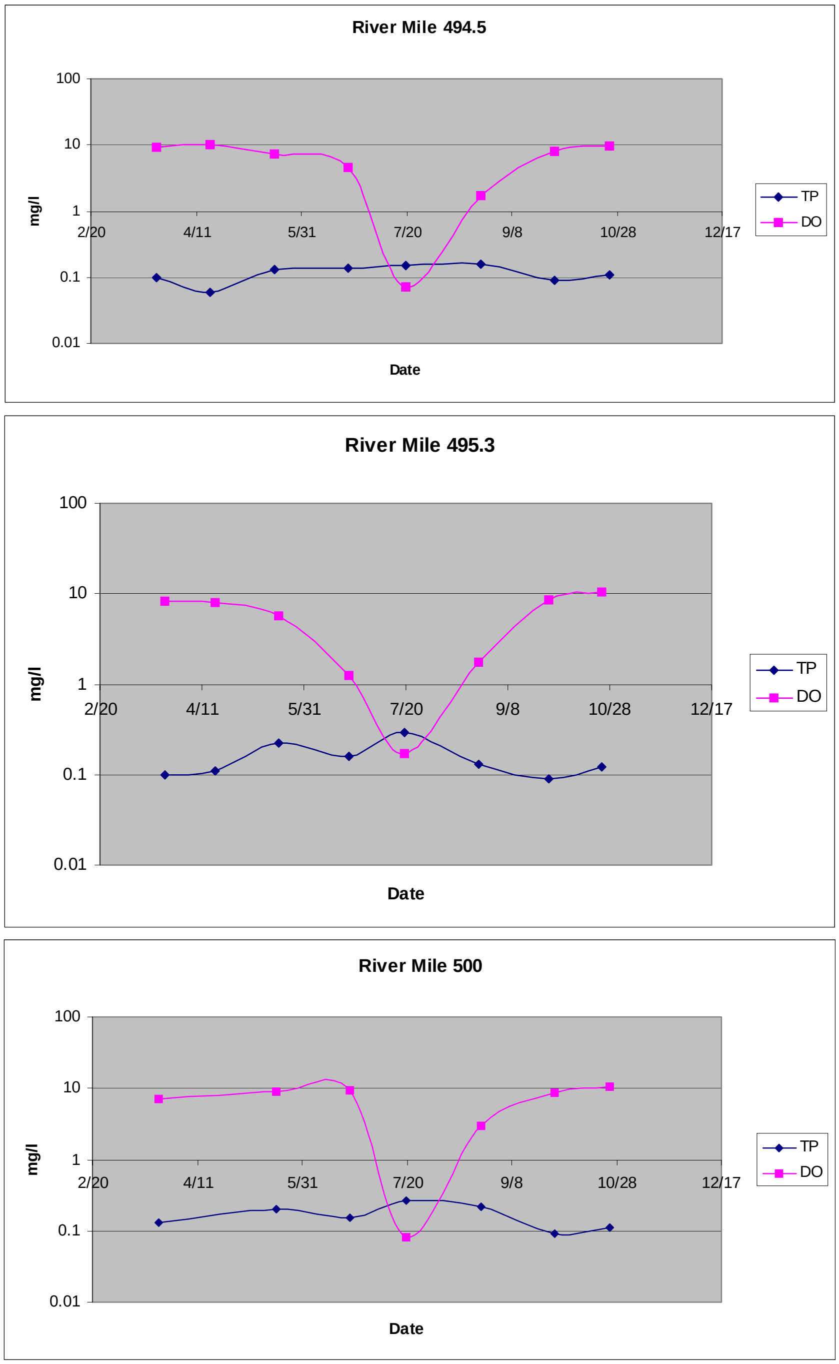


Figure 68. Deepest total phosphorus concentrations with corresponding dissolved oxygen concentrations

Chlorophyll-a

Evaluating chlorophyll-a concentrations is another way to assess water quality in the reservoir. Chlorophyll-a screening provides a method to measure algae in the system since most of the mass of an algal cell is the chlorophyll-a photosynthetic component. Algae seem to have three distinct blooms in the reservoir in May, June, and August (Figure 69).

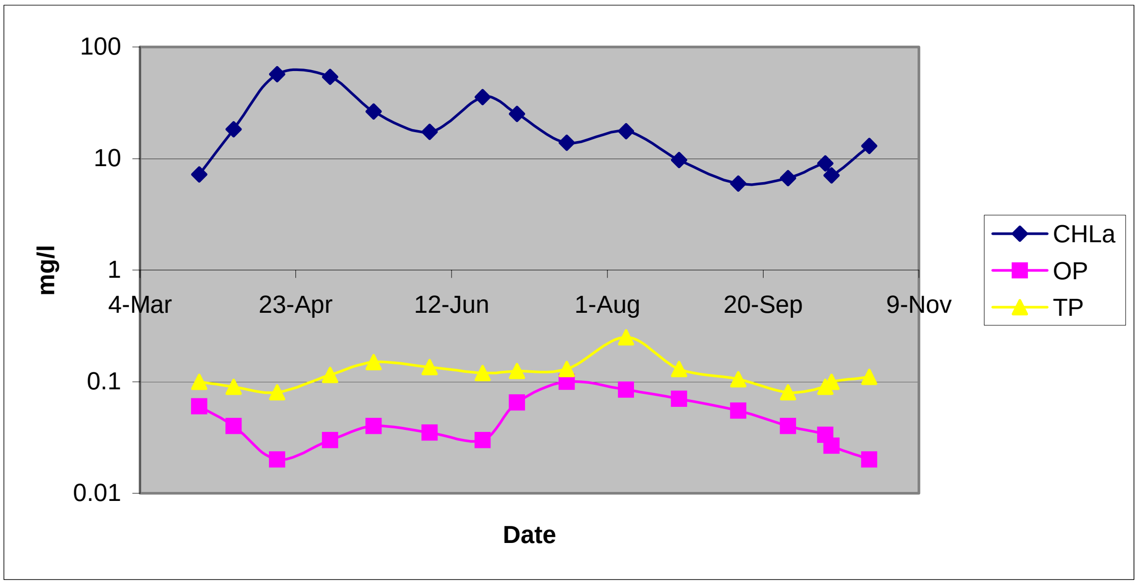


Figure 69. Chlorophyll-a, orthophosphorus, and total phosphorus data from C.J. Strike Reservoir

After the algal blooms occur, all phosphorus measurements in the water column consistently decrease. When the algal cells die, the phosphorus content of their bodies becomes part of the detritus by settling into the sediments. This means more phosphorus sinks to the bottom thus increasing the total loading. The algal blooms must be facilitated by the orthophosphorus coming in from the river upstream of the reservoir since only limited vertical mixing brings the high internal loading up out of the hypolimnion into the photic (light) zone of the surface waters to allow algal growth (Figures 70 and 71).

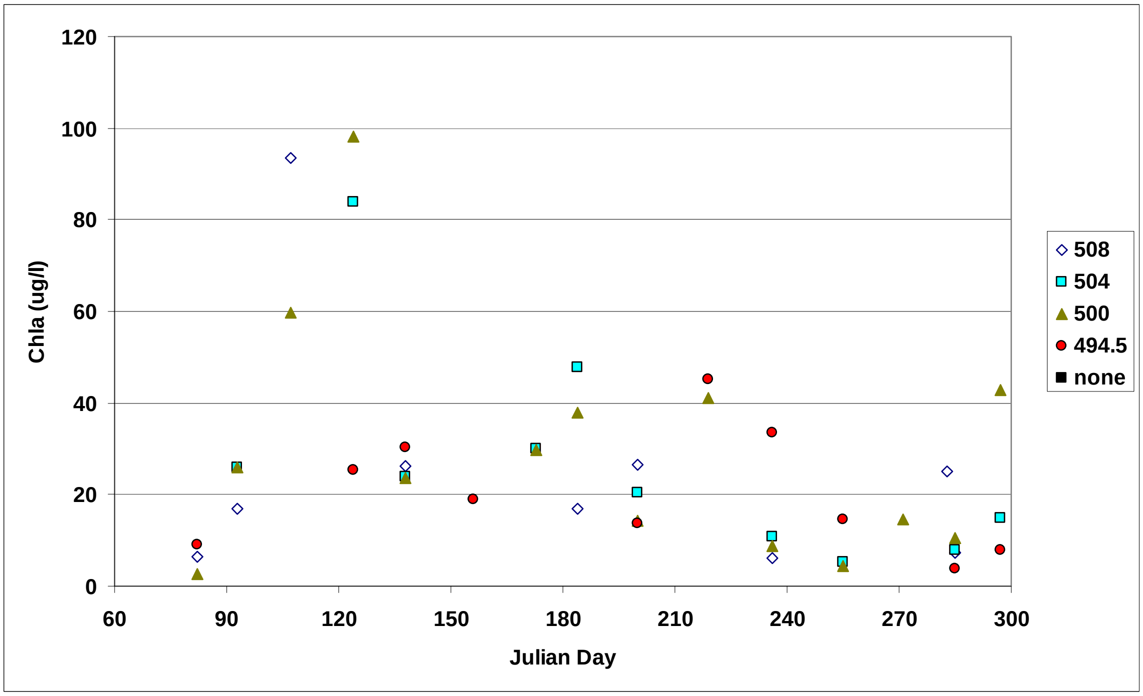


Figure 70. C.J. Strike Reservoir chlorophyll-a concentrations at the 0.3 meter depth

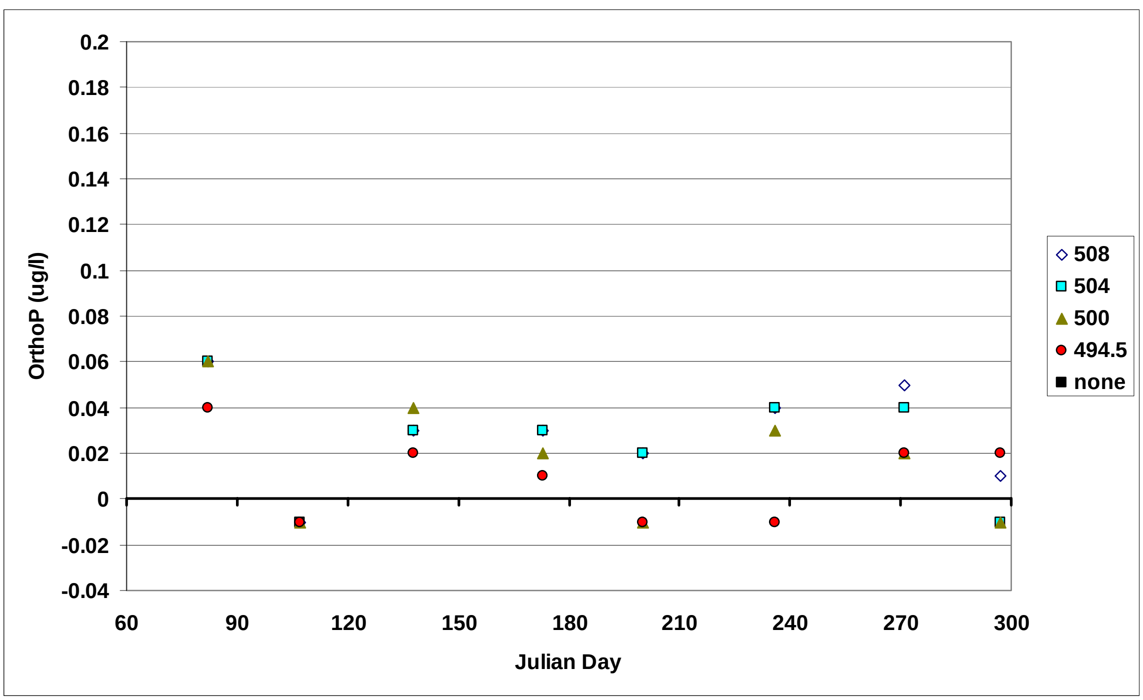


Figure 71. C.J. Strike Reservoir orthophosphate concentrations at the 0.3 meter depth

Nutrient Loading Analysis Summary

Overall, C.J. Strike reservoir is very slow to utilize its excess nutrient load. It is consistently eutrophic without major spikes. Phosphorus is the limiting nutrient. The reservoir is consistently stratified during the critical summer months. There is a very high internal loading of phosphorus being released from the sediments. With consistent stratification, there is limited vertical mixing of the phosphorus out of the hypolimnion and metalimnion. As a result, the metalimnetic dissolved oxygen concentrations frequently fall below 6.0 mg/L. If the phosphorus were not trapped on the bottom throughout the summer, the high internal load would affect nuisance algal growth to a greater extent. Algal blooms add to the internal phosphorus load by sinking to the bottom. The algal blooms are facilitated by the phosphorus coming in from the river upstream.

This type of stratified deep reservoir is fairly insensitive to load reductions. It will be slow to show improvement. However, phosphorus loading needs to be reduced to prevent further eutrophication. The phosphorus load reduction will have the biggest effect on the zone where all of the dissolved oxygen violations occur.

Total Dissolved Gas Loading Analysis – C.J. Strike Dam

C.J. Strike Reservoir is a 226,800 acre-foot impoundment of the Snake and Bruneau Rivers, located in Elmore and Owyhee counties. Located at Snake River mile 494.0, C.J Strike Dam was constructed in 1952. The primary function of the reservoir is to provide hydroelectric power, although it also serves other secondary functions such as irrigation and recreation. The plant's three generators have a total generating capacity of 82,800 kilowatts (Idaho Power Company 2004). The dam’s spillway falls 68 feet at a gradient of approximately 44% to the Snake River. Located between the generators and the spillway is a section of land known as Scout Park. Figure 72 shows an overview schematic of the reservoir, dam, and downstream Snake River (Idaho Power Company 1998). Figure 73 shows the spillway on the north side of the dam.

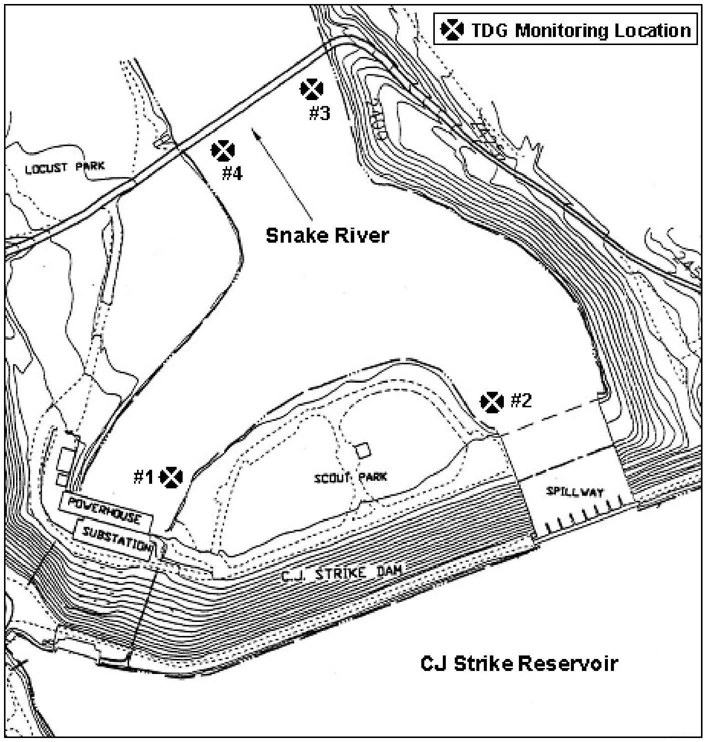


Figure 72. C.J Strike Dam and Idaho Power Company

Figure 73. C.J. Strike Dam spillway

The intent of this analysis is to use the available total dissolved gas (TDG) data to evaluate TDG conditions at established sampling locations in the Snake River below C.J. Strike Dam. The bases of this evaluation are the TDG requirements as they appear in the *Idaho Water Quality Standards and Wastewater Treatment Requirements (IDAPA 58.01.02)*. The TDG requirements can be found in section 250.01.b as follows:

> **The total concentration of dissolved gases not exceeding one hundred and ten percent (110%) of saturation at atmospheric pressure at the point of sample collection.**
>
> Section 300.01.a also specifies that *the director (of IDEQ) has the authority to specify the applicability of the gas supersaturation standard with respect to excess stream flow conditions.*

TDG Impact on Beneficial Uses
Chronically elevated total dissolved gas concentrations (above 110% of saturation) are known to have detrimental effect on aquatic life. High concentrations of gas dissolved in the water can result in *gas bubble trauma*, which occurs when air bubbles form in the circulatory system of resident fish (USA COE, 1999). "Gas bubble trauma results when the sum of the dissolved gas pressures exceeds the compensating pressures of hydrostatic head, blood, tissue, and water surface tension" (IPCo, 1998c, 1999b, 1999f).

Available Data for the C.J. Strike dam Area
A number of fish species susceptible to TDG illness are know to inhabit the Snake River in the vicinity of C.J. Strike dam. Most notably, Idaho Power Company has documented hatchery-grown rainbow trout and resident white sturgeon in the C.J Strike project area.

Total dissolved gas data below C.J. Strike dam are available on a weekly basis from March 3, 1999 through June 16, 1999 (n=15). Data were also collected during this period in the Snake River near Grandview (n=6). All measurements were collected by Idaho Power Company officials using a calibrated Hydrolab multi-parameter probe. Measurements were taken 0.3 meters below the water's surface. Data were collected at four locations, as shown in Figure 72.

Observed Effects on Fisheries
Although sampling is limited to one day in the spring from 1988-1990 and 1994-1996, Idaho Power Company biologists have not observed signs of TDG induced illness in the trout population below C.J. Strike Reservoir (Idaho Power Company 2003). This appears to be the case in both spill and non-spill years.

Similar results have been noted for the white sturgeon population below C.J. Strike Dam. During Idaho Power Company's 1994-1996 white sturgeon survey in the C.J. Strike-Swan Falls reach, no TDG trauma was noted in captured fish (Idaho Power Company 1998). Spill events occurred in 1995 and 1996, but not in 1994. At 130% of period of record (POR), 1996 was a particularly high flow year meaning elevated spill rates likely occurred. Even so, TDG induced trauma was not noted.

TDG Data Analysis

The TDG data from below C.J. Strike dam were analyzed in a stepwise fashion to derive a data set that best represents the TDG conditions affecting the local aquatic life community (primarily fish). Table 33 outlines the steps used to derive the final data set for which compliance with the TDG standard was based.

Table 33. Steps used to derive the final TDG data set for compliance purposes

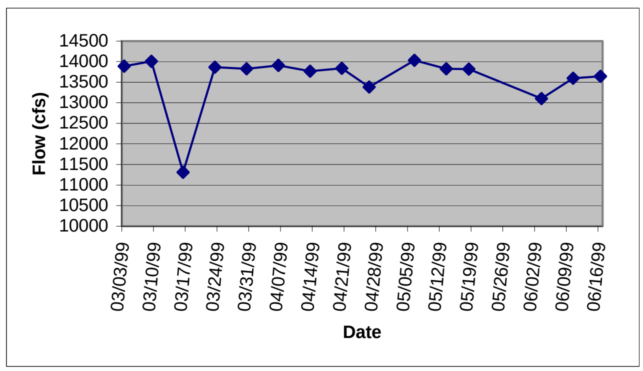
<table>
<tr><th>Step</th><th>Objective / Rationale</th></tr>
<tr><td>Used the bridge directly below the dam as the compliance point</td><td>While not required to allow a mixing, DEQ chose to establish a compliance point approximately 500 yards downstream from the dam (sites #3 and #4, at the bridge). Therefore, the data from sites #1 and #2 were not used in the analysis.</td></tr>
<tr><td>Established a width integrated data set at the bridge</td><td>Since bridge data were available from the spill side of the channel (site #3) and the powerhouse side of the channel (site #4), the data were composited, via flow weighting, into a single data set for compliance determination purposes.</td></tr>
<tr><td>Flow weighted the site #3 and site #4 TDG data</td><td>For the March 3, 1999, through June 16, 1999 (n=15), period of record the powerhouse flows show relatively little variation (Figure A), whereas the spill flows show a significant level of variation (Figure B).


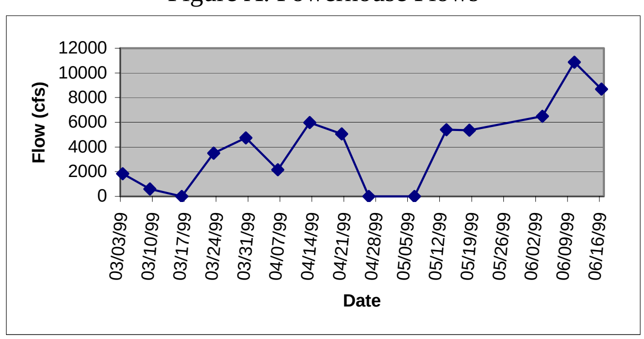
Figure A. Powerhouse Flows


Figure B. Spill Flows
To account for this variability in flows, their effect on TDG, and to prevent one data set from statistically outweighing the other, the data sets were flow weighted.</td></tr>
<tr><td>Compared the flow weighted TDG data to the TDG standard</td><td>The flow weighted TDG data were compared to the TDG standard as it appears in IDAPA 58.01.02. 250.01.b. The 10% exceedence guidance from Grafe 2002 was used to determine compliance (10% of the data can exceed the criteria).</td></tr>
</table>

Table 34 shows the site #3 and #4 TDG data, the spill and powerhouse flows, the total flow at Strike Dam Bridge and the flow weighted TDG at Strike Dam Bridge. Figure 74 shows the site #3 and #4 TDG data as compared to the flow weighted TDG at Strike Dam Bridge.

Table 34. Flow weighted TDG at Strike Dam Bridge

Date	Site #4 TDG (%Sat)	Powerhouse Flow CFS	Site #3 TDG (%Sat)	Spill Flow (cfs)	Total Flow	Flow Weighted Ave TDG (%Sat)
03/03/99	101	13887	110	1838	15725	**102**
03/09/99	101	14004	104	600	14604	**102**
03/16/99	105	11309	104	0	11309	**105**
03/23/99	108	13861	113	3500	17361	**109**
03/30/99	105	13822	115	4750	18572	**108**
04/06/99	103	13906	111	2148	16054	**104**
04/13/99	106	13763	117	5971	19734	**109**
04/20/99	108	13835	116	5058	18893	**110**
04/26/99	106	13385	105	0	13385	**106**
05/06/99	100	14032	100	0	14032	**100**
05/13/99	104	13822	118	5400	19222	**108**
05/18/99	103	13815	118	5350	19165	**107**
06/03/99	102	13105	118	6492	19597	**108**
06/10/99	105	13600	121	10869	24469	**112**
06/16/99	104	13646	104	8700	22346	**104**

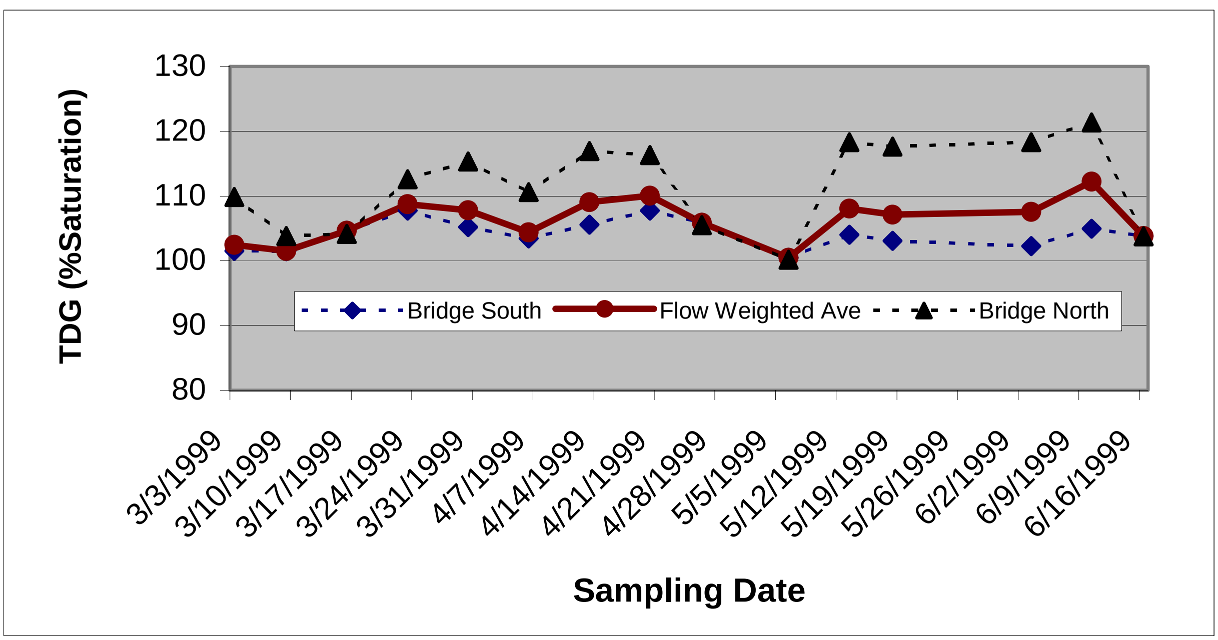


Figure 74. Flow weighted TDG at Strike Dam Bridge as compared to site #3 and site #4 data

As shown in Table 34 and Figure 74, the cross-sectional flow weighted TDG values at the bridge exceed the 110% criteria very infrequently. A single exceedence of 112% occurred on June 10, which was also the day when the highest spill occurred (10,869 cfs). This single exceedence accounts for 7% of the data set, and as such, does not constitute a violation of the TDG water quality standard (less than 10% exceed).

Excess River Flow Considerations

As noted above in the standards discussion, section 300.01.a of the *Idaho Water Quality Standards and Wastewater Treatment Requirements* specify that the director (of IDEQ) has the authority to specify the applicability of the gas supersaturation standard with respect to excess stream flow conditions.

Spill from C.J. Strike Reservoir is largely dependent on water-year and, therefore, does not occur every year (Idaho Power Company 1998). In low flow years, frequent spills beyond the spring are typically not necessary. In higher flow years when spill does occur, the powerhouse is normally at full operational capacity (~15,500 cfs). The spills occur as a function of operating the reservoir as a run-of-the-river.

The available data show that the flow weighted TDG at the bridge may exceed 110% when spill flows exceed 10,000 cfs. Figure 75 shows the correlation between the total flow of the river and TDG at the bridge. The total flow is a combination of powerhouse flows (usually always near 14,000 cfs) and spill flows.

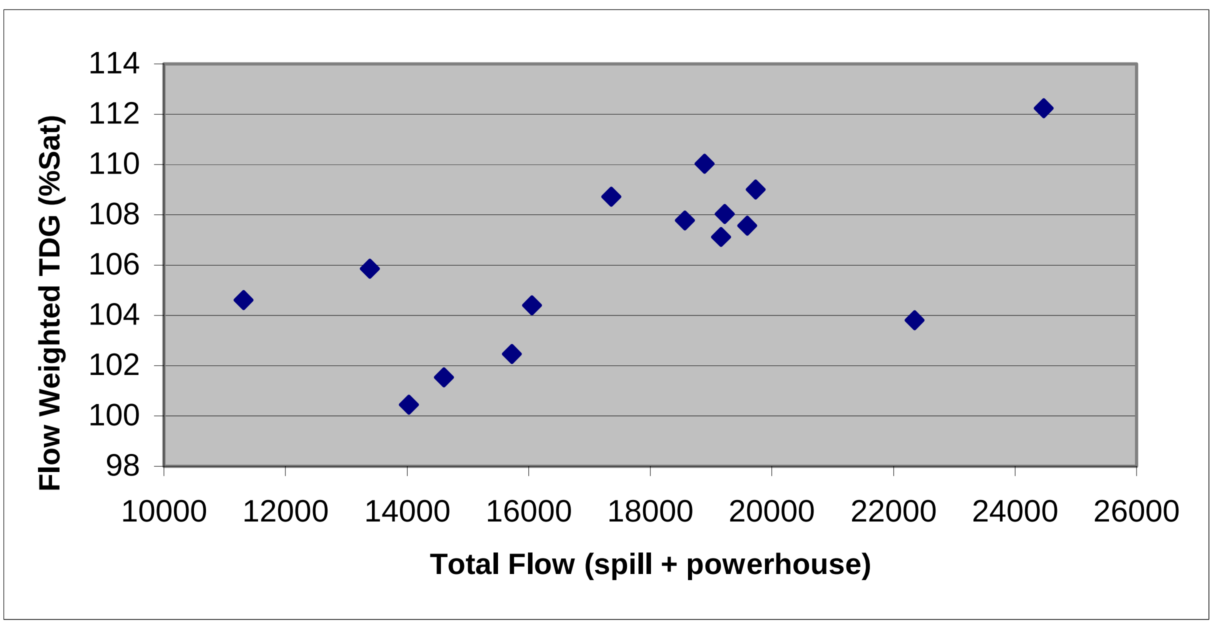


Figure 75. Correlation between total flow and flow weighted TDG at the bridge

The relationship between total flow and flow weighted TDG shown in Figure 75 is based on three months data from 1999, which was a high flow year (141% of POR). Due to the low number of data points, there is some uncertainly as to the total flow/TDG relationship beyond a total flow of 25,000 cfs. That is, TDG values may continue to rise as flows exceed 25,000 cfs, or, TDG values may plateau at some level of total flow. To account for this data gap, the Final Environmental Impact Statement recommended that Idaho Power Company continue to monitor TDG when spills exceed 10,000 cfs to better define the relationship (FERC 2002). This strategy is intended to provide better data to assess the effects of project operation on TDG and determine whether corrective actions are necessary to eliminate violations of the state TDG standard (FERC 2002).

TDG Summary and §303(d) Listing Recommendation

The flow weighted TDG data calculated at the bridge directly below C.J. Strike dam show that the 110% saturation standards is exceed 7% of the time, when spill flows exceed 10,000 cfs. Due to the infrequency of this spill volume and because no TDG induced illness has been noted in local aquatic life, DEQ recommends not listing TDG as a pollutant of concern on the §303(d) list. Since 1999 was a high flow year (141% of POR), this recommendation contains some level of conservativeness. However, since the recommendation is based on only three months data collected from a single year, DEQ agrees with the Federal Energy Regulatory Commission’s recommendation to monitor TDG when spills exceed 10,000 cfs.

Conclusions and Status of Beneficial Uses in C.J Strike Reservoir

The pesticides analysis shows that the calculated t-DDT and dieldrin water column concentrations and the measured concentrations for several other pesticides of interest in C.J. Strike Reservoir do not exceed the target concentrations for cold water aquatic life or domestic water supply beneficial uses. As such, pesticides are not impairing these beneficial uses and TMDLs are not recommended.

The nutrient analysis shows that there is limited vertical mixing of the phosphorus out of the hypolimnion and metalimnion. As a result, the metalimnetic dissolved oxygen concentrations frequently fall below 6.0 mg/L during the critical summer months. While this type of stratified deep reservoir is fairly insensitive to load reductions and will be slow to show improvements, a TMDL to reduce phosphorus loading needs to be prepared to help prevent further eutrophication. The phosphorus load reduction will have the biggest effect on the metalimnion where nearly all of the dissolved oxygen violations occur.

The analysis of TDG in the Snake River below C.J. Strike Dam shows that the flow weighted TDG directly below C.J. Strike Dam exceeds 110% very infrequently (7% of the time). Additionally, no excess TDG induced illness has been noted in the fish below the dam. Based on the low exceedance percentage and a lack of aquatic life impairment, TDG does not appear to be impairing beneficial uses and a TMDL is not recommended.

Table 35 summarizes the beneficial use support status for C.J. Strike Reservoir as it pertains to the pollutants of concern and outlines the pollutant(s) for which TMDLs will be developed.

Table 35. Summary of the water quality assessments for C.J. Strike Reservoir, HUC 17050101

Pollutant of Concern	Impaired Beneficial Use(s) [1]	TMDL Required	Comments
Pesticides	None	No	--
Nutrients	CWAL	Yes	C.J. Strike Reservoir will receive a phosphorus load allocation based on in-flowing conditions. Additional management will be required to meet the dissolved oxygen criteria. See Chapter 5 for details.
Total Dissolved Gas	None	No	--

[1]CWAL: cold water aquatic life

Additional Resource Management Considerations

Idaho Power Company has found the Idaho Springsnail (*Pyrgulopsis idahoensis*) in both the Snake River and Bruneau River arms of C.J. Strike Reservoir (Idaho Power Company 1998). However, additional work has suggested that the populations inhabiting C.J. Strike Reservoir may be more appropriately classified as *Pyrgulopsis robusta*, which is an un-listed (by the Endangered Species Act) subgenus (Hershler and Liu 2004). Idaho Springsnails are cold water stenotherms (prefers cold water) typically restricted to cold springs and spring-fed locations (Frest and Johannes 2000). However, Idaho Power Company has located Springsnails in water temperatures exceeding 22^{o}C (Idaho Power Company 1998).

Additionally, white sturgeon (*Acipenser transmontanus)* occur in C.J. Strike Reservoir. Most of the sturgeon were collected within river miles 504 and 505, which is near the Cove Arm (refer to Figure 50) (Idaho Power Company 1998).

In the case of C.J. Strike Reservoir, management of the Idaho Springsnail and white sturgeon is not in the purview of the TMDL. TMDL allocations alone are not comprehensive enough to fully consider the propagation and growth dynamics of either species. A more holistic management strategy for these species is already in place and is recognized by federal agencies responsible for managing threatened and endangered species as well as FERC and Idaho Power Company.

Regarding management of the Idaho Springsnail, Idaho Power Company entered into a settlement agreement with the U.S. Fish and Wildlife Service in February 2004. The two parties agreed that additional studies and analysis were desirable in order to more accurately assess the effects, if any, that the Mid-Snake and C.J. Strike projects may have on one or more of the listed snail species. The parties agreed upon an operational regime for the projects that will both permit six years of studies and analyses of various project operations on the listed snail species and provide interim protection of the listed species. After the studies are completed, Idaho Power Company and the U.S. Fish and Wildlife Service intend to jointly develop a plan that will address project operations and the protection of listed snails for the remainder of new license terms (Idaho Power Company 2004).

Regarding the white sturgeon, Idaho Power Company has initiated a white sturgeon conservation plan. The plan is intended to serve as a master plan for guiding the implementation of feasible mitigation measures for Snake River white sturgeon populations impacted by Idaho Power Company's hydroelectric projects. These measures are designed to help ensure the species' long-term persistence and restore opportunities for beneficial use. This plan outlines proposed measures and strategies for Snake River white sturgeon that IPC would implement once the WSCP were accepted and new project licenses issued by FERC (Idaho Power Company 2003).

2.5 Subbasin Assessment Summary

Total maximum daily loads were developed for four water body segments (nine assessment units) in the King Hill-C.J. Strike watershed. Table 36 summarizes the stream segments addressed in this assessment and the actions that will be taken as a result of the assessment.

Table 36. Summary of King Hill-C.J Strike Reservoir subbasin assessment conclusions

Water Body	§303(d) Boundary[1]	Listed Pollutants	Proposed Action
Snake River	King Hill to Highway 51 Bridge (Loveridge Bridge)	Sediment	TMDLs for sediment and nutrients
C.J. Strike Reservoir	Entire Reservoir	Pesticides, Nutrients	TMDL for nutrients with no in-reservoir reduction requirements. Additional management to meet the dissolved oxygen criteria De-list pesticides Do not list TDG
Alkali Creek	Headwaters to Snake River	Sediment	De-list sediment
Bennett Creek	Headwaters to Snake River	Unknown	De-list for unknown
Browns Creek	Headwaters to Snake River	Sediment	De-list sediment
Cold Springs Creek	Ryegrass Creek to Snake River	Unknown	TMDL for sediment
Deadman Creek	Headwaters to Snake River	Sediment	De-list sediment
Little Canyon Creek	Headwaters to Snake River	Sediment, Flow Alteration	TMDL for sediment, no action for flow alteration
Ryegrass Creek	Headwaters to Cold Springs Creek	Sediment	De-list sediment
Sailor Creek	Headwaters to Snake River	Sediment	De-list sediment

[1] The §303(d) boundaries are not always the same as the boundaries for which TMDLs were developed. In many cases impairment does not exist throughout the entire segment, or, the segment is split for other reasons. Chapter 5 discusses the TMDL boundaries in more detail.

3. Subbasin Assessment–Pollutant Source Inventory

This chapter describes the point and nonpoint pollutant sources within the King Hill-C.J. Strike Reservoir watershed. The nonpoint source descriptions are not intended to be specific by source. Rather, they are a description of the general processes whereby nonpoint source pollutants are delivered to the water bodies of concern.

3.1 Point Sources

The Glenns Ferry wastewater treatment plant (WWTP) is the only municipal National Pollution Discharge Elimination System (NPDES) permitted facility located in the King Hill-C.J. Strike subbasin. Table 37 shows the facility details.

Table 37. NPDES System-permitted facilities in the King Hill-C.J. Strike Reservoir subbasin

Facility	Design Capacity (MGD)[1]	Permit Expiration Date	Receiving Water
City of Glenns Ferry (Permit # ID-002200-4)	0.44	November 24, 2008	Snake River

[1]Million gallons per day

RCRA and CERCLA Sites

There are several sites in the King Hill-C.J. Strike Reservoir subbasin that must comply with the federal Resource Conservation and Recovery Act (RCRA) or the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), commonly called Superfund. Appendix L shows a list of the facilities that have EPA identification numbers, although many of the sites are no longer active.

Nonpoint Source Pollutant Transport

The following descriptions of pesticides, nutrient and sediment transport are not intended to be specific by source; they are descriptions of the general processes whereby nonpoint source pollutants are delivered to the water bodies of concern. More detailed descriptions of locations and potential sites for improvement will be located in the final TMDL implementation plan.

Pesticides

The erosion of pesticide-laden soil associated with runoff is the most common transport mechanism for introducing pesticides into surface waters. Pesticides can be moved by runoff when they are either dissolved in the water or bound to eroding soil particles. Pesticide

residues in surface waters can cause injury to crops, livestock, or humans if the contaminated water is used downstream and also can lead to contaminated groundwater.
When a pesticide is introduced into the environment, whether by application, disposal, or a spill, many processes can influence its transport. These natural and anthropogenic processes determine the ultimate fate of the pesticide by affecting its persistence and movement in the environment. The processes that affect the fate and transport dynamics of pesticides include adsorption, volatilization, leaching, photo, microbial and chemical degradation, and bioaccumulation. Once introduced into the environment, some pesticides may take more upwards of fifty years to completely degrade.

Phosphorus
Phosphorus is found naturally throughout the environment. It can be present as a constituent of certain rock types (silicious igneous rock) and in the mineral *apatite*. The environment itself can also be a factor in the phosphorus levels occurring within a region, due to the climate, pH of natural waters, and the presence of other substances that may adsorb or release phosphorus. However, there are also anthropogenic nutrient sources that greatly increase phosphorus levels over those found naturally: applied fertilizers in farming or landscaping, the duration and density of livestock grazing, the creation of artificial waterways and water levels through agricultural practices, and the presence of sewage and septic waste (treated and untreated) in the surface, subsurface, and ground water of a region often represent significant contributions to the phosphorus concentrations in an area.

Nitrogen
Nitrogen occurs in the environment in a variety of sources and forms. It can be present as a mineral constituent of certain rock types; as a result of the decomposition of plant and other organic material; in rainfall; as a component of agricultural or urban/suburban runoff; and as a constituent in treated or untreated wastewater from industrial, municipal, or septic discharges. In addition, the air is composed of about 80% nitrogen gas. Blue-green algae can use atmospheric nitrogen at the surface-water interface or the nitrogen dissolved in the water as a source of nitrogen to support growth. Since algae can use atmospheric nitrogen, reducing nitrogen in the water is not often targeted as a factor to achieve water quality improvements in water systems dominated by blue-green algae. Since reducing watershed-based sources of nitrogen is not usually a successful treatment option in these systems, total phosphorus reductions are often sought.

Sediment
The most common source of sediment in surface waters is erosion. Sediment may originate from natural causes, such as landslides, forest or brush fires, high flow events, or anthropogenic sources such as urban/suburban storm water runoff or erosion from roadways, agricultural lands, and construction sites. Sediment loads within the system are typically highest in the spring when high flow volumes and velocities result from snowmelt in the higher elevations.

The mass wasting (such as landslides) contribution of sediment loading in the King Hill-C.J. Strike watershed appears to be low. Surveys of the tributaries and the Snake River suggest that chronic loading is much more significant that acute loading.

3.2 Data Gaps

The best available data were used to develop the current subbasin assessment. The data were used to reach conclusions of support status and to, where necessary, develop defensible TMDLs. However, DEQ acknowledges there are additional data that would be helpful to increase the accuracy of the analyses. The data gaps that have been identified are outlined in Table 38.

Table 38. Data gaps identified during development of the King Hill-C.J. Strike Subbasin Assessment

Pollutant or Other Factor	Data Gap
Flow	Multiple years flow data for the upper, middle, and lower segments of the §303(d) listed tributaries to the Snake River Horizontal flow velocities from river miles 510 to 520 (C.J. Strike Reservoir)
Biological (fish, macroinvertebrates, and aquatic plants)	Additional salmonid presence/absence information for the §303(d) listed tributaries, particularly for Ryegrass and Alkali Creeks The quantification of macrophytes and other coarse particulate organic matter, and their direct effects on water quality in the Snake River and C.J. Strike Reservoir.
Pesticides	Recent t-DDT and dieldrin data at multiple locations in C.J. Strike Reservoir
Sediment	Multiple years suspended sediment concentration data for the Snake River at King Hill and Indian Cove. Baseline substrate conditions in the Snake River between King Hill and Indian Cove (during a period when macrophyte growth is not at nuisance levels) Multiple year suspended sediment concentration data for the lower segments of the §303(d) listed tributaries to the Snake River Multiple years substrate particle size distributions for the upper and lower segments of the §303(d) listed tributaries to the Snake River
Dissolved Oxygen	Diurnal dissolved oxygen concentration in the Snake River and C.J. Strike Reservoir Additional TDG data from below C.J. Strike Dam

Where viable, steps should be taken to fill the data gaps. Planned efforts to do so will be further outlined in the TMDL implementation plan. The information developed through these efforts may be used to revise the appropriate portions of the TMDL and determine and/or adjust implementation methods and control measures. Changes to the TMDL will not result in the production of a new TMDL document. Minor changes will be in the form of addenda to the existing document(s). More extensive changes will be in the form of supplementary documentation or chapter replacement. Wherever practical, the goal is to build upon rather than replace the original work. The schedule and criteria for reviewing new data will be addressed in the TMDL implementation plan. The opportunity to revise the TMDL and necessary control measures is consistent with current and developing EPA TMDL guidance, which emphasizes an iterative approach to TMDL development and implementation. However, any additional effort on the part of DEQ to revise the TMDL or implementation plan and control measures must be addressed on a case-by-case basis as additional funding becomes available.

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

This section describes past and present pollution control efforts in the subbasin, including control of point sources and nonpoint sources, along with a discussion of those authorities that provide reasonable assurance that the efforts are conducted in accordance with regulatory requirements.

4.1 Point Sources

The Glenns Ferry WWTP treats the wastewater from Glenns Ferry and the immediate outlying area and discharges its effluent to the Snake River. The facility is federally regulated as part of the NPDES program. As part of the discharge monitoring report portion of their NPDES permits, the WWTP is required to monitor their effluent to determine compliance with their permit effluent limits. Effluent limits are set to levels at which it has been certified that violations in the state water quality standards will not occur as a result of the effluent. If permit violations occur, the facility is required to notify EPA and DEQ to find a solution. The monthly discharge monitoring reports are sent to EPA and DEQ and are kept on file at the facility.

Confined Animal Feeding Operations (CAFOs) are also point sources within the subbasin. In 1996, EPA reissued the Idaho general NPDES permit for confined animal feeding operations. This general permit allows permitted facilities to discharge animal waste only during unusual climatic events. The permit also requires permitted facilities to land apply animal waste at agronomic rates and requires record keeping of animal waste management practices. It is believed that these provisions will reduce discharges to surface waters and ground water.

The Idaho Department of Agriculture Beef Cattle Animal Feeding Operation (AFO) Program was initiated to bring Idaho into compliance with the Beef Cattle Environmental Act in the shortest possible timeframe. The impetus of the program is to bring an estimated 1,500 Beef Cattle AFOs into compliance with the Beef Cattle Environmental Act. Additionally, the Department of Agriculture will regulate all beef cattle AFOs. In the past, only beef Confined Animal Feeding Operations were regulated.

4.2 Nonpoint Sources

In Elmore and Owyhee Counties, water quality programs exist for nonpoint source pollutant reductions. Cooperators may make improvements on their own or seek cost-share funds from one of the many programs available. Most of the agricultural programs are either state or federally funded through the Idaho Soil Conservation Commission (ISCC) or the Natural Resource Conservation Service (NRCS). These programs are targeted at the agricultural community to assist with conservation practices.

For example, the Owyhee Soil Conservation District (SCD) has Water Quality Program for Agriculture (WQPA) money available to address on-the-farm pollutant reductions. Table 39 shows some of the typical component practices that may serve as standalone best management practices (BMPs) or be used in combination to address agricultural related pollutants. The appropriate component or combination of components is determined on a site-specific basis.

The Water Quality Program for Agriculture is a state of Idaho water quality program that provides cost share incentives to local operators for pollutant reductions. The Bruneau, Elmore, and Owyhee SCDs work with agricultural operators in their respective counties to provide technical assistance to implement BMPs. The agricultural community, through local conservation districts and other funding sources, has demonstrated a willingness to protect water quality throughout the basin.

Table 39. Typical management components used to address agriculturally related pollutants, either standalone or in combination (not a complete list)

Best Management Practice	Control Effectiveness	Installation Cost	Maintenance Cost
Sediment			
Livestock Exclusion	High	Moderate	Low
Sediment Basins	High	Low	Moderate
Surge Irrigation System	High	High	Moderate
Sprinkler Irrigation System	High	High	Moderate
Filter Strips	Moderate	Low	Low
Polyacrylamide (PAM)	Moderate	Moderate	Moderate
Bacteria			
Livestock Exclusion	High	Moderate	Low
Waste Management System	High	High	Moderate
Wetland Development	Moderate	High	Moderate
Prescribed Grazing	Moderate	Low	Low
Fencing	Low	Moderate	Low
Nutrients			
Livestock Exclusion	High	Moderate	Low
Nutrient Management	High	Moderate	Low
Filter Strips	Moderate	Low	Low
Irrigation Water Management	Moderate	Low	Low
Fencing	Low	Moderate	Low

Other state and federal funding sources include the state §319 grant program, the Resource Conservation and Rangeland Development Program, the United States Department of Agriculture Environmental Quality Incentive Program, the Wildlife Habitat Incentives Program, and IDWR agricultural loans. Participation from local operators is voluntary. Other sources of funding include private sources, such as Ducks Unlimited, The Nature Conservancy, and colleges and universities.

4.3 Reasonable Assurance

The state has responsibility under Sections 401, 402, and 404 of the CWA to provide water quality certification. Under this authority, the state reviews dredge and fill, stream channel alteration, and NPDES permits to ensure that the proposed actions will meet Idaho's water quality standards.

Under Section 319 of the CWA, 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 to achieve implementation of nonpoint source BMPs, includes a schedule for program 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 takes 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 high priority watersheds to assist DEQ and other state agencies in formulating specific actions needed to decrease pollutant loading from point and nonpoint sources that affect water quality limited water bodies. The King Hill-C.J. Strike Reservoir WAG was established in 2003 and is the designated advisory group for the basin.

The Idaho water quality standards refer to existing authorities to control nonpoint pollution sources in Idaho. Some of these authorities and responsible state agencies are listed in Table 40.

Table 40. State of Idaho's regulatory authority for nonpoint pollution sources.

Authority	IDAPA Citation	Responsible Agency
Rules Governing Solid Waste Management	58.01.02.350.03(b)	Idaho Department of Environmental Quality
Rules Governing Subsurface and Individual Sewage Disposal Systems	58.01.02.350.03(c)	Idaho Department of Environmental Quality
Rules and Standards for Stream-channel Alteration	58.01.02.350.03(d)	Idaho Department of Water Resources
Rules Governing Exploration and Surface Mining Operations in Idaho	58.01.02.350.03(e)	Idaho Department of Lands
Rules Governing Placer and Dredge Mining in Idaho	58.01.02.350.03(f)	Idaho Department of Lands
Rules Governing Dairy Waste	58.01.02.350.03(g)	Idaho Department of Agriculture

The state of Idaho uses a voluntary approach to address agricultural nonpoint sources. However, regulatory authority can be found in the water quality standards (IDAPA 58.01.02.350.01 through 58.01.02.350.03). 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 approved BMPs (IDHW and SCC 1993). A portion of the Ag Plan outlines responsible agencies or elected groups (Soil Conservation Districts) 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.

If a voluntary approach does not succeed in abating the pollutant problem, the state may seek injunctive relief for those situations that may be determined to be an imminent and substantial danger to public health or the environment (IDAPA 58.01.02.350.02(a)).

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). If necessary, the state may seek injunctive or other judicial relief against the operator of a nonpoint source activity.

The water quality standards list designated agencies responsible for reviewing and revising nonpoint source BMPs: the Soil Conservation Commission for grazing and agricultural activities, the Department of Transportation for public road construction, Idaho Department of Agriculture for aquaculture, and DEQ for all other activities (IDAPA 58.01.02.003).

5. Total Maximum Daily Load(s)

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

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

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

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

5.1 In-stream Water Quality Targets

In-stream water quality targets were selected such that they will restore full support of designated beneficial uses. The following provides a discussion of target selection and monitoring locations.

Target Selection

Important considerations in target selections were critical periods for target application, recovery time for the water body, and appropriateness of surrogates.

Section 2.4 of the subbasin assessment outlines the water quality targets / standards for each water body of concern (tributaries, Snake River, C.J. Strike Reservoir). Accompanying each target is the justification for the target and a description of the linkage between meeting the target(s) and improving beneficial use support status. These targets and standards also serve as the targets for TMDL development.

Table 41 summarizes the targets on which each respective TMDL is based. The values shown represent the condition(s) the water should be in when the TMDL(s) are met.

It should also be noted that flow alteration is listed as a "pollutant of concern" in Little Canyon Creek. However, EPA does not believe that flow (or lack of flow) is a pollutant as defined by CWA Section 502(6). Since TMDLs are not required to be established for water bodies impaired by pollution but not pollutants, a TMDL has not been established for the flow alteration aspect of Little Canyon Creek.

Table 41. Water quality targets used in TMDL development.

Pollutant	TMDL Target	Water Bodies for Which TMDLs are Developed Using the Target
Sediment	A geometric mean of 50 mg/L suspended sediment for no longer than 60 consecutive days	Snake River Little Canyon Creek Cold Springs Creek
Sediment	Less than or equal to 30% fine material (particles less than 6.0 mm in diameter) in riffles	Little Canyon Creek Cold Springs Creek
Nutrients (Total Phosphorus)	Less than or equal to 0.075 mg/L (75 µg/L) total phosphorus at all locations	Snake River C.J Strike Reservoir

Monitoring Locations

Monitoring locations for each water body are discussed in detail in Section 2.4. Refer to that section for the location of monitoring points for each water body. An attempt was made collect or use data from monitoring stations that were representative of the segments of interest.

5.2 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 type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads.

The type and amount of data available greatly influence how DEQ calculates existing loads. These methods have been discussed in detail in the Data Assessment Methods section of this document (see Section 2.4); a summary of the methods used to determine loads for the four segments targeted for TMDLs (see Table 36) is as follows:

Nutrient Load—C.J. Strike Reservoir

The current nutrient load in C.J. Strike Reservoir is based on the sum of the boundary conditions to the reservoir, which includes the Snake River and Bruneau River arms. An attempt was not made to base the current reservoir load on in-reservoir concentrations and the reservoir flow rate (through the reservoir).

Nutrient and Sediment Load—Snake River at King Hill

The current nutrient and sediment loads in the Snake River at King Hill were calculated using a flow of 11,407 cfs. It was determined that this flow represents typical flow conditions in the river. The loading concentrations are based on measured water column data from 1997-2002. These years include high, medium and low flow years, thereby representing the variation that is expected to occur over the long term.

Sediment Load—Cold Spring and Little Canyon Creeks

In Cold Springs and Little Canyon Creeks, where the primary source of sediment is from bank erosion, existing sediment loads were determined using the bank erosion inventory process, which provided direct measurement of erosion rates within the reach. The erosion rate was then used to calculate the current in-stream delivery of sediment within the system. In instances where sediment was generated via agricultural or other nonpoint source activities, the existing loads were calculated using

5.3 Sediment Total Maximum Daily Loads

This section describes the required elements of the sediment TMDLs for the Snake River, Cold Springs Creek and Little Canyon Creek, including load capacity, margin of safety, seasonal variation, background, reserve for growth, and sediment load and wasteload allocations.

Load Capacity

The load capacity (LC) is the amount of pollutant a water body can receive without violating water quality standards. Seasonal variations and a margin of safety (MOS), to account for any uncertainty, are calculated within the load capacity. The MOS accounts for uncertainty about assimilative capacity, the precise relationship between the selected target and beneficial use(s), and variability in target measurement. The load capacity is based on existing uses within in the watershed. The load capacity for each water body and specific pollutant are tailored to both the nature of the pollutant and the specific use impairment.

A required part of the loading analysis is that the load capacity be based on critical conditions – the conditions when water quality standards are most likely to be violated. If it is protective under critical conditions, a TMDL will be *more* protective (or, at worst, *as* protective) under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

Sediment load capacities for the Snake River, Cold Springs Creek, and Little Canyon Creek are as follows.

Snake River
The LC for the Snake River sediment TMDL is determined by using the target of 50 mg/L suspended sediment concentration (SSC) and an average flow value of 11,407 cfs (calculated from 1997-2002 flow data). The 50 mg/L SSC chronic target was used for developing the TMDL because, as opposed to the 80 mg/L acute target, it represents conditions that are more likely to be achieved over the long term with BMP implementation.

As noted above, the sediment load capacity is based on an average flow that is expected to represent typical flow conditions. While the load capacity is helpful in gaining a relative understanding of the reduction required, and will apply reasonably over most water years, it should be noted that the exact level of reduction required will depend on flow and concentration values specific to a given water year.

Cold Springs and Little Canyon Creeks
In Cold Springs Creek and Little Canyon Creeks, where sediment primarily results from stream bank erosion, the load capacity is based on the load generated from banks that are greater than 80% stable. This load defines the load capacity for the remaining segments of the stream.

Margin of Safety

The margin of safety (MOS) factored into the Snake River sediment TMDL is 5.0% of the load capacity. That is, 5.0% of the load in the river when the 50 mg/L target is met is removed from being available. This 5.0% MOS accounts for uncertainty in the data used to develop the loads and adds a level of conservativeness to the TMDL.

The MOS for the Cold Springs Creek and Little Canyon Creek TMDLs are implicit due to several conservative factors used to determine the existing sediment loads. These factors include the following:

- The desired bank erosion rates are representative of background conditions.
- The water quality target for percent fines is consistent with values measured and as set by local land management agencies, based on established literature values, and incorporate an adequate level of fry survival to provide for stable salmonid production.

Seasonal Variation

TMDLs must be established with consideration of seasonal variation. In the Snake River and its tributaries, there are seasonal influences on nearly every pollutant addressed. The summer growing season is typically when concentrations of sediment and nutrients are the highest. Seasonal variation as it relates to development of these TMDLs is addressed simply by ensuring that the loads are reduced during the *critical period* (when beneficial uses are impaired and loads are controllable). Thus, the effects of seasonal variation are built into the load allocations.

The critical period for each sediment TMDL is based on the time of year when beneficial uses must be protected and when pollutant loads exceed the assimilative capacity. Each respective TMDL was developed such that the water quality standards will be achieved year-round. Table 42 shows the critical period for each sediment TMDL.

Table 42. Critical periods for sediment TMDLs.

Water Body	Pollutant	Critical Period (Time of Year the TMDL is Applicable)
Snake River	Sediment	January-December
Little Canyon Creek	Sediment	January-December
Cold Springs Creek	Sediment	January-December

Background

The sediment allocations for the Snake River, Cold Springs Creek, and Little Canyon Creeks are not explicitly adjusted to account for background conditions. Since the Snake River at King Hill and Indian Cove is already below the 50 mg/L SSC target (18 and 25 mg/L, respectively) no additional reductions will be required by the TMDL (see allocations below). As a result, it is not necessary to include the any potential background load in the allocations.

Additionally, the Cold Springs Creek and Little Canyon Creek TMDLs already include an accommodation for background sediment by way of the 80% bank stability target. That is, the 80% bank stability target allows for 20% of the banks to be less than stable, which is to be expected in a stream's naturally functioning state. Thus, background is considered, but no adjustments are made to the allocations.

Reserve for Growth

The sediment allocation for the Snake River includes a 10% reserve for growth. That is, 10% of the load in the river when the 50 mg/L target is met is removed and is made available for any future sources of sediment, which are typically point sources. While an abundance of growth is not expected in the near future, the 10% reserve helps accommodate any growth that may occur while still ensuring that the river will meet the TMDL.

The Cold Springs Creek and Little Canyon Creek TMDLs do not include a reserve for growth. While growth may occur, the expectation is that no additional bank sediment will be discharged to the systems as a result of the growth. This can be achieved via the use of best management practices.

Sediment Load and Wasteload Allocations

This section describes the sediment load and wasteload allocations for the Snake River and Cold Springs Creek and Little Canyon Creek TMDLs.

Snake River Sediment Allocations

The SSC water column target in the Snake River between King Hill and Indian Cove, on which the TMDL is based, is 50 mg/L. While the target is durational in nature (based on a geometric mean over 60 consecutive days), the TMDL is not based on duration. The 50 mg/L target for the Snake River is intended to provide protection for the mix of aquatic life species that inhabit the river. A detailed discussion of the selection of the targets can be found in the subbasin assessment portion of this document (Chapter 2).

Table 43 shows the sediment load allocation for the Snake River at King Hill and wasteload allocations for the Glenns Ferry WWTP. Table 43 also includes a generalized no-net-increase allocation for the tributaries to the river. DEQ recommends collecting additional data during the implementation phase of the TMDL to further clarify the tributary allocations.

The Glenns Ferry WWTP wasteload allocation is based on the plants current NPDES permit limit for total suspended solids. The relative mass of sediment contributed by the WWTP is quite small. The plant already removes much of the influent suspended solids as part of the treatment process; further treatment at this time would result in high costs with little tangible benefit to the river. However, the plant must continue to meet the minimum percent removal requirement in its permit. Fixed load allocation targets were selected because the management practices that affect sediment loading to the river is not expected to change on a day-to-day basis.

Table 43. Sediment load and wasteload allocations for Snake River at King Hill and the Glenns Ferry WWTP

Name	Typical Existing Load	Load Capacity	Margin of Safety	Reserve for Growth	Allocation Type / Allocation	Percent Reduction from Existing Load
Snake River at King Hill	544 tons/day SSC	1,540 tons/day SSC	77 tons/day SSC	154 tons/day SSC	Load / 1,309 tons/day SSC	0% Typical existing is below LA
Unmonitored[1] Snake River tributaries	Not Defined	N/A	N/A	N/A	No increase beyond current loads	0%
Glenns Ferry WWTP[2]					Wasteload /	
• Average Monthly	125 lb/day TSS	N/A	N/A	N/A	125 lb/day TSS	0%
• Average Weekly	188 lb/day TSS	N/A	N/A	N/A	188 lb/day TSS	0%

[1] SSC loading data are not available for the tributaries to the Snake River. DEQ recommends initiating a monitoring regime as part of the TMDL implementation plan.
[2]Based on current NPDES permit limits for TSS

Little Canyon Creek and Cold Springs Creek are receiving sediment allocations due to excess stream bank erosion. Table 44 shows the load allocations for the representative segment. The monitored reaches, as well as the segments the reaches represent, are shown geospatially in Figure 76. The worksheets used to derive these load allocations are located in Appendix M.

The derivation of the numbers shown in Table 44 was based on the following:

- The current erosion rate is based on the bank geometry and lateral recession rate (as described in Appendix E) at each measured reach.
- The target erosion rate is based on the bank geometry of the measured reach and the lateral recession rate at a calculated reference reach.
- The reference reach is based on the hydrogeologic conditions for that stream that would result in greater than 80% bank stability and less than 30% fine substrate material in riffles.
- The loading capacity is the total load present when banks are at least 80% stable. As such, the loading capacity and the load allocations are the same. Note that these are the overall decreases necessary in the stream, but can only reasonable apply to areas where banks are less than 80% stable.

Table 44. Stream bank erosion load allocations for Little Canyon Creek and Cold Springs Creek.

Water Body	Current Erosion Rate (tons/mile/ year)	Target Erosion Rate (tons/mile/ year)	Current Total Erosion (tons/year)	Target Total Erosion (tons/year) Load Allocations Loading Capacity	% Decrease
Little Canyon Creek, Segment 1	315.97	236.98	183.26	137.45	25
Little Canyon Creek, Segment 2	345.58	218.26	1,814.31	1,145.88	36.84
Cold Springs Creek	113.36	82.44	457.97	333.07	29.41

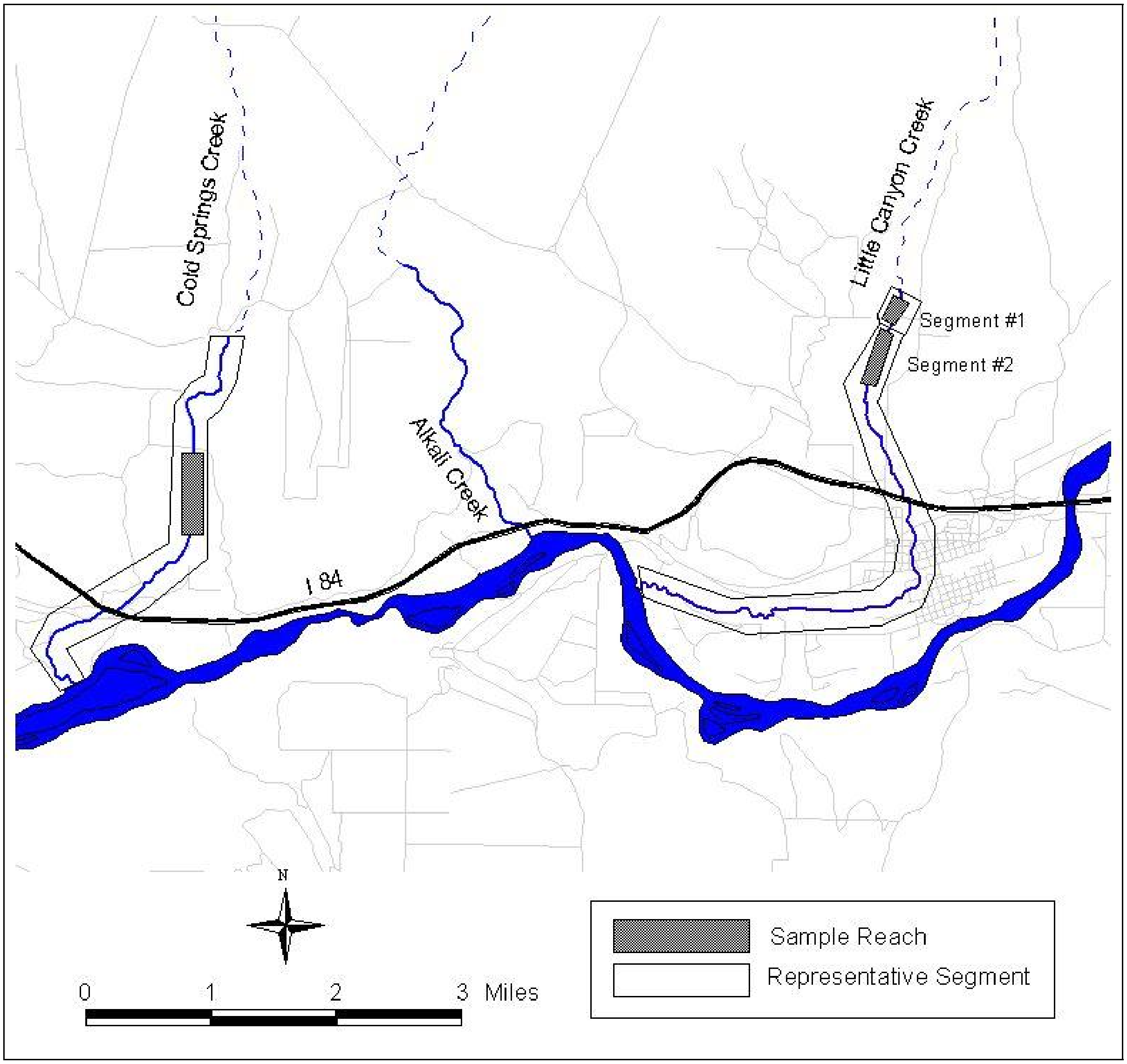


Figure 76. Segments of Little Canyon Creek and Cold Springs Creek receiving sediment load allocations.

5.4 Nutrient Total Maximum Daily Loads

This section describes the required elements for the Snake River and C.J. Strike Reservoir nutrient TMDLs, including load capacity, margin of safety, seasonal variation, background, reserve for growth, and nutrient load and wasteload allocations.

Load Capacity

The load capacity (LC) is the amount of pollutant a water body can receive without violating water quality standards. Seasonal variations and a margin of safety (MOS) to account for any uncertainty are calculated within the load capacity. The MOS accounts for uncertainty about assimilative capacity, the precise relationship between the selected target and beneficial use(s), and variability in target measurement. The load capacity is based on existing uses within in the watershed. The load capacity for each water body and specific pollutant are tailored to both the nature of the pollutant and the specific use impairment.

A required part of the loading analysis is that the load capacity be based on critical conditions – the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will more likely be *as* protective under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

Snake River

The load capacity for the Snake River nutrient TMDL is determined by using the target of 0.075 mg/L TP and an average flow value of 11,407 cfs (calculated from 1997-2002 flow data). As noted above, the phosphorus load capacity is based on an average flow that is expected to represent typical flow conditions. While the load capacity is helpful in gaining a relative understanding of the reduction required, and will apply reasonably over most water years, it should be noted that the exact level of reduction required will depend on flow and concentration values specific to a given water year.

Currently, total phosphorus levels are at or above the target concentration year-round. While the aquatic plant growth and algae blooms that occur as a result of the excess nutrients are seasonal in nature, typically extending from the beginning of May through the end of September, the effects of the annual nutrient loading on the reservoir must be recognized. As a result, the TP load reduction requirements will be applied annually.

Due to water column nutrients, particularly TP, being more abundant than plant uptake rates, responses by plant communities to management efforts will take time. As TP inputs are reduced, plants that obtain nutrients from the water column (such as algae and epiphytes) will likely be the first to decline. Because nutrients persist longer in sediments, plants that obtain nutrients from the sediments (such as macrophytes) will persist longer. Nevertheless, as reductions in TP (and sediment) continue, sediment bound nutrients will gradually be depleted as plant uptake outpaces recharge rates.

C.J. Strike Reservoir

The load capacity for the Snake River nutrient TMDL is determined by using the target of 0.075 mg/L TP and average flow values for the Snake River and the Bruneau River—11,375 cfs and 325 cfs, respectively—both of which are calculated from 1997-2002 flow data.

The phosphorus load capacity is identified for this average flow scenario. While this value is helpful in gaining a relative understanding of the reduction required, and will apply reasonably over most water years, it should be noted that the exact level of reduction required will depend on flow and concentration values specific to a given water year.

It should also again be noted that an attempt was not made to determine a load capacity for the reservoir itself. The load capacity and the ensuing TMDL for C.J. Strike Reservoir are based on inflowing loads from the Snake River and the Bruneau River.

Margin of Safety

The margin of safety (MOS) factored into the Snake River nutrient TMDL is 5.0% of the load capacity. That is, 5.0% of the load in the river when the 0.075 mg/L TP target is met is removed from being available. This 5.0% MOS accounts for uncertainty in the data used to develop the loads and adds a level of conservativeness to the TMDL.

No explicit MOS is factored into the C.J. Strike Reservoir nutrient TMDL. Rather, the MOS is implicit, based on the MOS established as part of the river nutrient TMDL. The reservoir boundary condition for model simulation purposes is based on the premise that the river will meet its TMDL (0.075 mg/L TP). Since the river TMDL includes a 5% MOS, the reservoir TMDL includes an implicit MOS.

Seasonal Variation

TMDLs must be established with consideration of seasonal variation. In the Snake River and C.J. Strike Reservoir, there are seasonal influences on nearly every pollutant addressed. The summer growing season is typically when nutrient concentrations of sediment are the highest. Seasonal variation, as it relates to development of the TMDL, is addressed simply by ensuring that the loads are reduced during the critical period (when beneficial uses are impaired and loads are controllable). Thus, the effects of seasonal variation are built into the load allocations.

Nutrient TMDL Critical Periods

The critical periods for the Snake River and C.J. Strike Reservoir TMDLs are based on the time of year when beneficial uses must be protected and when pollutant loads exceed the assimilative capacity. Each respective TMDL was developed such that the water quality standards will be achieved year-round. Table 45 shows the critical period for each TMDL.

Table 45. Critical periods for Snake River and C.J. Strike Reservoir TMDLs.

Water Body	Pollutant	Critical Period (Time of Year the TMDL is Applicable)
Snake River	Nutrients, Sediment	January-December
C.J. Strike Reservoir	Sediment	January-December

Reserve for Growth

The nutrient and sediment allocations for the Snake River include 5% and 10%, respectively, reserves for growth. That is, 5% of the overall nutrient load and 10% of the overall sediment load in the river when the targets are met is removed and made available for any future sources, which are typically point sources. While an abundance of growth is not expected in the near future, these reserves help accommodate any growth that may occur while still ensuring that the river will meet the TMDLs.

Nutrient Load and Wasteload Allocations

This section describes the nutrient load and wasteload allocations for the Snake River and C.J. Strike Reservoir TMDLs.

Snake River Nutrient Allocations

The total phosphorus water column target in the Snake River between King Hill and Indian Cove, on which the TMDL is based, is less than or equal to 0.075 mg/L (75 µg/L). The target is intended to apply at any location in the river between King Hill and Indian Cove. The target is intended to provide protection for the mix of aquatic life species that inhabit the river as well as reduce the amount of aquatic plant growth. A detailed discussion of the selection of the target can be found in the subbasin assessment portion of this document (Chapter 2).

Table 46 shows the total phosphorus load allocation for the Snake River at King Hill and the wasteload allocation for the Glenns Ferry WWTP. Table 46 also includes a generalized no-net-increase allocation for the tributaries to the river. There are no specific load allocations because the data are very limited and not robust enough to develop accurate allocations. DEQ recommends collecting additional data during the implementation phase of the TMDL to further clarify the tributary allocations.

The flow component for the Glenns Ferry WWTP wasteload allocation is based on the plant's current design capacity. The current NPDES permit does not have a total phosphorus effluent limit; as such, the current effluent concentration is not known. DEQ estimated, in conjunction with the City of Glenns Ferry, an effluent concentration of 7.0 mg/L. This concentration is likely higher that the actual concentration. The Water Environment Federation Manual of Municipal Wastewater Practice (1992) reported 7.0 mg/L as the typical total phosphorus concentration for *untreated* domestic effluent. Tchobanoglous (1991) reported values as low as 4 mg/L for untreated domestic effluent, with the low values applying to small communities, such as Glenns Ferry. Given that most lagoon facilities remove between 15% and 50% (EPA 2004) of total phosphorus, the actual total phosphorus effluent concentration is likely far less than 7.0 mg/L. To account for this unknown, DEQ recommends revising the Glenns Ferry WWTP wasteload allocation once the TP effluent concentration has been better characterized based on monitoring data. The WWTP is required to begin monitoring its effluent in January 2006, but DEQ suggests that characterization monitoring begin sooner.

Table 46. Nutrient load and wasteload allocations for Snake River at King Hill and the Glenns Ferry WWTP.

Name	Typical Existing Load	Load Capacity	Margin of Safety	Reserve for Growth	Allocation Type / Allocation	Percent Reduction from Existing Load
Snake River at King Hill	2,349 kg/day TP	2,097 kg/day TP	105 kg/day TP	105 kg/day TP	Load / 1,888 kg/day TP	19.6%
Snake River tributaries[1]	Not Defined	N/A	N/A	N/A	No increase beyond current loads	0%
Glenns Ferry WWTP[2]	11.6 kg/day TP	N/A	N/A	N/A	Wasteload / 11.6 kg/day TP	0%

[1] Conclusive TP loading data are not available for the tributaries to the Snake River. DEQ recommends initiating a monitoring regime as part of the TMDL implementation plan.
[2]Based on the design capacity for flow and an estimated TP concentration. DEQ recommends revising the Glenns Ferry WWTP wasteload allocation once the TP effluent concentration has been better characterized based on monitoring data.

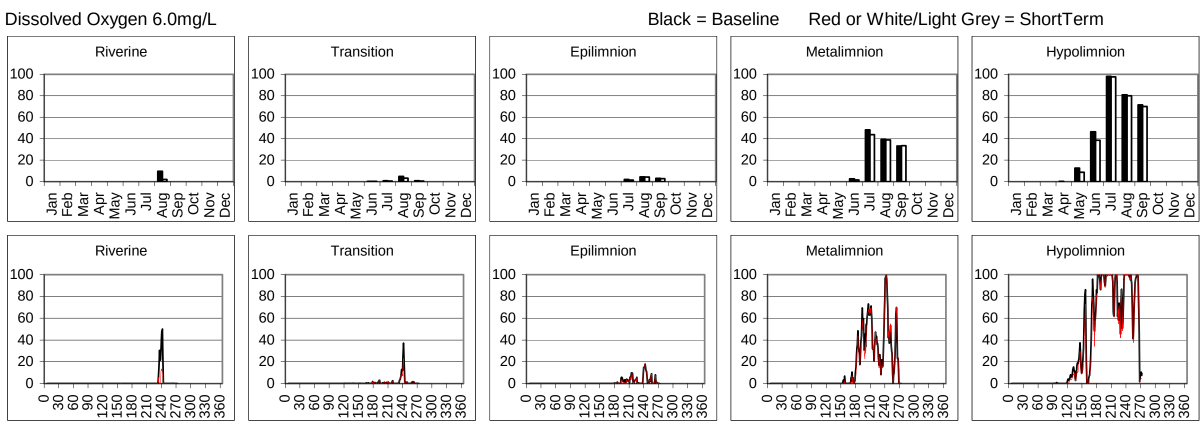
C.J. Strike Reservoir Nutrient Allocations

The CE-QUAL-W2 water quality model was used to simulate the water quality response to the 0.075 mg/L total phosphorus target in the C.J. Strike Reservoir. The model was also used to simulate the water quality response to a target of 0.050 mg/L TP in the reservoir. Since there was very little detectable change in reservoir DO by dropping the target to 0.050 mg/L, the analysis went forward with 0.075 mg/L as the target. This keeps the King Hill-C.J. Strike Reservoir target consistent with the upstream target (Mid Snake River TMDL).

Idaho Power Company and contract personnel performed the modeling work, with review from DEQ. Two primary model simulations were performed: a projection of short-term (benefits realized quickly) and long-term (benefits realized over an extended period) water quality improvements, both based on the attainment of the 0.075 mg/L total phosphorus target. The following section contains a summary of the information provided by Idaho Power Company regarding this modeling effort. The full memorandum, which contains more detail, is located in Appendix N.

To simulate meeting the 0.075 mg/L TP water column target, dissolved and organic phosphorus were reduced at the reservoir boundary (Indian Cove) such that the target was not exceeded. Additionally, the boundary condition was adjusted so that the dissolved oxygen concentration would not fall below 6.0 mg/L. These are the river conditions expected to be achieved upon implementation of the Snake River nutrient TMDL, so they also serve as appropriate reservoir boundary conditions for modeling purposes.

The results of the short-term simulation, which assumes a boundary condition water column concentration of 0.075 mg/L and all DO values greater than 6.0 mg/L, are shown in Figure 77. The dark colored lines show the percent of DO values below the 6.0 mg/L criterion at baseline (current) conditions—these are the violations described in the C.J. Strike Reservoir assessment in section 2.4. The light colored lines show the percent of DO values below the 6.0 mg/L criterion after implementing the .075 mg/L TP target, but with no resulting change in sediment oxygen demand.

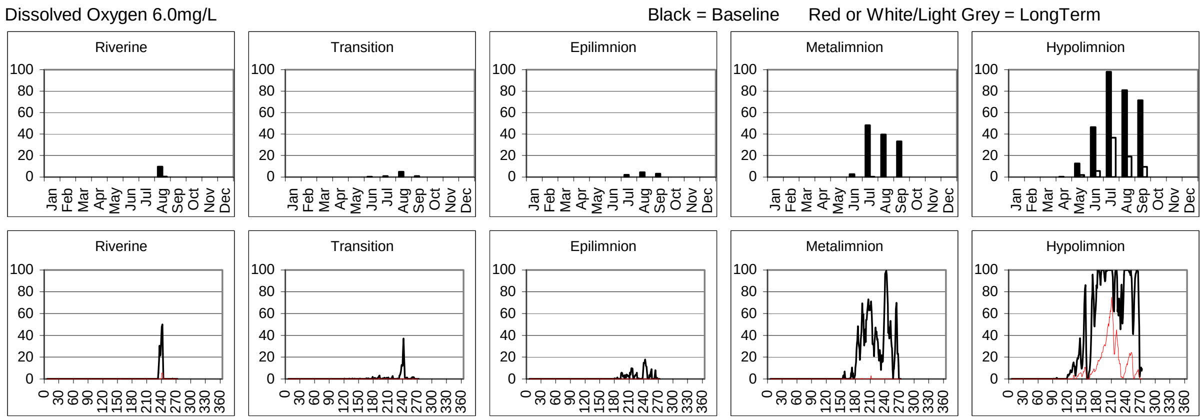


Y-Axis is percent of zone/strata volume below 6 mg/L, X-Axis is Julian day.

Figure 77. Percent of volume below 6.0 mg/L after short-term improvement resulting from implementation of the 0.075 mg/L TP target for the Upstream Snake River

The initial response of the reservoir to full implementation of the 0.075 mg/L TP target results in a very slight decrease in DO violations in the metalimnion. When the Snake River TMDL is first implemented, sediment oxygen demand will not change immediately. The response is slow, and this slow response time limits the initial level of improvement in the lacustrine zone (metalimnion) of the reservoir. (As mentioned above, similar results were seen with a target of 0.050 mg/L TP.)

Similarly to the short-term simulation shown in Figure 77, the reservoir response to the long-term simulation was modeled by again assuming a boundary condition water column concentration of 0.075 mg/L and all DO values greater than 6.0 mg/L (Figure 78). However, an additional assumption that the sediment oxygen demand (SOD) in the reservoir had reached a long-term baseline of 0.1 g m^{-2} day^{-1} was made. This SOD is more typical of naturally occurring sediment oxygen demand levels (Cole and Wells 2000). Additional explanation for this selecting this SOD is located in Appendix N. Again, the dark colored lines show the percent of DO values below the 6.0 mg/L criterion at baseline (current) conditions. The light colored lines show the percent of DO values below the 6.0 mg/L criterion after implementing the .075 mg/L TP target and with the reservoir reaching a baseline SOD of 0.1 g m^{-2} day^{-1}.

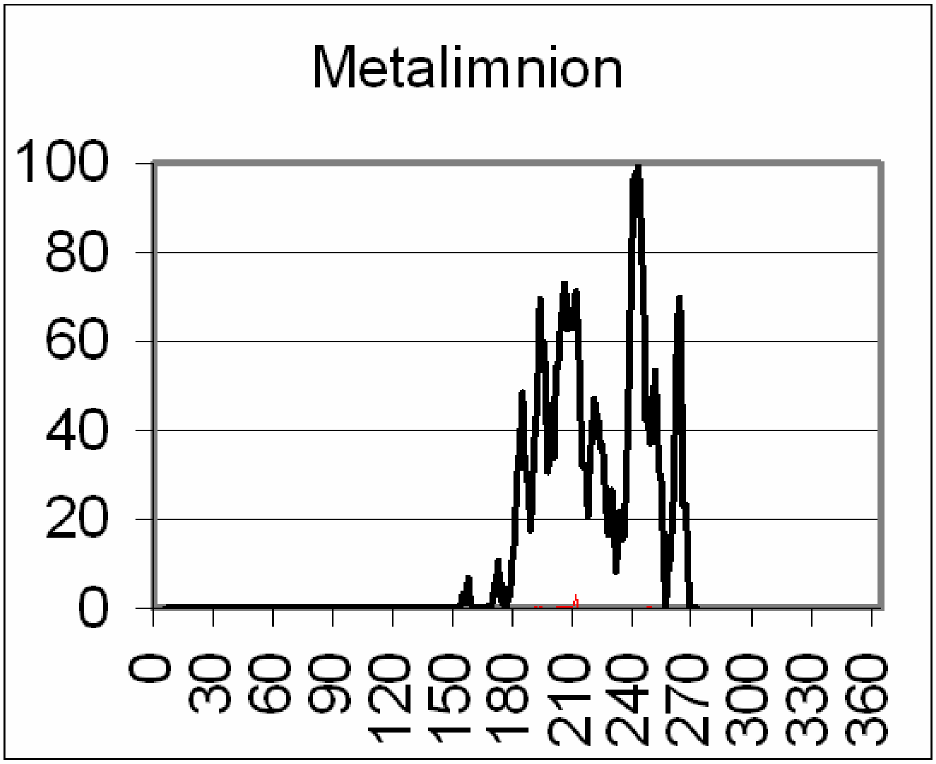


Y-Axis is percent of zone/strata volume below 6 mg/L, X-Axis is Julian day. ***Metalimnion has a small spike about Julian day 220.***

Figure 78. Percent of volume below 6 mg/L after long-term improvements resulting from implementation of the 0.075 mg/L TP target for the Upstream Snake River and resulting decrease in SOD to 0.1 g m^{-2} day^{-1}.

After meeting the 0.075 mg/L TP target and achieving a long-term baseline SOD of 0.1 g m^{-2} day^{-1}in the reservoir, there are substantial improvements in metalimnetic dissolved oxygen concentrations.

Only on Julian day 210 (July) do any values below 6.0 mg/L remain in the metalimnion. This is illustrated in Figure 79. Again, the dark line represents baseline (current) conditions while the light line represents long-term improved conditions.



Y-Axis is percent of zone/strata volume below 6 mg/L, X-Axis is Julian day.

Figure 79. Percent of volume below 6 mg/L after long-term improvements resulting from implementation of the 0.075 mg/L TP target for the Upstream Snake River and resulting decrease in SOD to 0.1 g m^{-2} day^{-1}

There are a small number of violations in the metalimnion even after long-term baseline conditions are achieved. This mass of dissolved oxygen equates to 2.2 tons/year (Appendix N). An additional dissolved oxygen mass allocation will be necessary to account for this shortfall.

As illustrated above, nutrient concentrations are linked with dissolved oxygen concentrations and closely linked to organic matter concentrations. Elevated concentrations of nutrients can lead to increased growth of algae and associated organic matter when other conditions, such as flow, depth, clarity, and temperature are conducive to enhanced growth. Algae and aquatic plants, in turn, consume oxygen from the water column during periods when respiration is the dominant process and in the aerobic decomposition of the dead algae and other detritus (non-living organic material). Total phosphorus has been identified as the nutrient of concern in the Snake River and C.J. Strike Reservoir. Improvements in dissolved oxygen in the reservoir can be achieved through attainment of growth-limiting concentrations of phosphorus and, ultimately, through long-term reductions in sediment oxygen demand.

The available data show that total phosphorus loading to the C.J. Strike Reservoir originates almost entirely from the Snake River and the Bruneau River, with the Snake River by far accounting for the largest portion. Table 47 contains the load allocations for the Snake River and Bruneau River as they apply to the C.J. Strike Reservoir TMDL.

Table 47. Nutrient load allocations for Snake River at Bruneau River as they apply to the C.J. Strike Reservoir TMDL.

Name	Typical Existing Load[1]	Load Capacity	Load Allocation	Percent Reduction from Existing Load
Snake River at Indian Cove	2315 kg/day TP	2,092 kg/day TP	2,092 kg/day TP	9.6%
Bruneau River	56 kg/day TP	60 kg/day TP	60 kg/day TP	0%

[1] Based on 1997-2002 mean annual flows: Snake River at Indian Cove=11,375 cfs, Bruneau River at Highway 51= 325 cfs

As indicated above, an additional dissolved oxygen load allocation is necessary in C.J Strike Reservoir to offset the calculated reduction in assimilative capacity. **The dissolved oxygen allocation requires the addition of 2.2 tons/year of oxygen into the metalimnion of C.J. Strike Reservoir.** The time when additional oxygen is necessary in the metalimnion of C.J Strike Reservoir is between Julian days 191 and 250 (the first of July through the first of September). However, nearly 80% of the necessity occurs between July 10 and July 31, with the actual level varying from day to day, ranging from 0.01 to 0.80 tons/day. This shows that the actual mass of dissolved oxygen necessary per day is not static and is dependent on system dynamics. The timing of oxygen addition, or other equivalent implementation measures, should be such that it coincides with those periods where dissolved oxygen sags occur and where it will be the most effective in improving aquatic life habitat and support of designated beneficial uses. Water column dissolved oxygen monitoring is also expected to continue.

It should be noted that the direct oxygenation of the metalimnion is not required. The additional 2.2 tons/year can be accomplished through equivalent reductions in total phosphorus or upstream organic matter, or other appropriate mechanisms that can be shown to result in the required improvement of dissolved oxygen in the metalimnion. Direct oxygenation can be used but should not be interpreted as the only mechanism available. Cost effectiveness of both reservoir and upstream BMP implementation should be considered in all implementation projects.

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)

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 for it, DEQ incorporates a gross waste load allocation WLA for anticipated construction storm water activities. Where DEQ is unable to quantify a WLA for the TMDL due to complexity and a lack of data, a construction storm water activity that obtains a permit and follows BMPs will be considered in compliance with the TMDL. 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

The purpose of the implementation strategies are to outline the pathways by which a larger, more comprehensive implementation plan will be developed 18 months after TMDL approval. The comprehensive implementation plan will provide details of the actions needed to achieve load reductions (set forth in a TMDL), a schedule of those actions, and specify monitoring needed to document actions and progress toward meeting state water quality standards. These details are typically set forth in the plans that follows approval of the TMDL. In the meantime, cursory implementation strategies are developed to identify the general issues, such as responsible parties, a time line, and a monitoring strategy for determining progress toward meeting the TMDL goals outlined in this document.

Responsible Parties

Development of the final implementation plan for the King Hill-C.J Strike Reservoir TMDL will proceed under the existing practice established for the state of Idaho. The plan will be cooperatively developed by DEQ, the King Hill-C.J Strike Reservoir WAG, the affected private landowners, and other “designated agencies” with input from the established public process. Of the four entities, the WAG will act as the integrator of the implementation planning process to identify appropriate implementation measures. Other individuals may also be identified to assist in the development of the site-specific implementation plans as their areas of expertise are identified as being beneficial to the process.

Designated state agencies are responsible for assisting with preparation of specific implementation plans, particularly for those sources for which they have regulatory authority or programmatic responsibilities. Idaho’s designated state management agencies are as follows:

- Idaho Soil Conservation Commission (ISCC): grazing and agriculture
- Idaho Department of Transportation (ITD): public roads
- Idaho Department of Agriculture (IDA): aquaculture, AFOs, CAFOs
- Idaho Department of Environmental Quality: all other activities

To the maximum extent possible, the implementation plan will be developed with the participation of federal partners and land management agencies (i.e., NRCS, U.S. Forest Service, BLM, U.S. Bureau of Reclamation, etc.). In Idaho, these agencies, and their federal and state partners are charged by the CWA to lend available technical assistance and other appropriate support to local efforts/projects for water quality improvements.

All stakeholders in the King Hill-C.J Strike Reservoir subbasin have a responsibility for implementing the TMDL. DEQ and the “designated agencies” in Idaho have primary responsibility for overseeing implementation, in cooperation with landowners and managers. Their general responsibilities are outlined below.

- **DEQ** will oversee and track overall progress on the specific implementation plan and monitor the watershed response. DEQ will also work with local governments on urban/suburban issues.
- **IDL** will maintain and update approved BMPs for forest practices and mining. IDL is responsible for ensuring use of appropriate BMPs on state and private lands.
- **ISCC**, working in cooperation with local Soil and Water Conservation Districts and ISDA, the ISCC will provide technical assistance to agricultural landowners. These agencies will help landowners design BMP systems appropriate for their property, and identify and seek appropriate cost-share funds. They also will provide periodic project reviews to ensure BMPs are working effectively.
- **ITD** will be responsible for ensuring appropriate BMPs are used for construction and maintenance of public roads.
- **IDA** will be responsible for working with aquaculture to install appropriate pollutant control measures. Under a memorandum of understanding with EPA and DEQ, IDA

also inspects AFOs, CAFOs and dairies to ensure compliance with NPDES requirements.

The designated agencies, WAG, and other appropriate public process participants are expected to:

- Develop BMPs to achieve LAs
- Give reasonable assurance that management measures will meet LAs, through both quantitative and qualitative analysis of management measures
- Adhere to measurable milestones for progress
- Develop a timeline for implementation, with reference to costs and funding
- Develop a monitoring plan to determine if BMPs are being implemented, individual BMPs are effective, LAs and WLAs are being met, and water quality standards are being met

In addition to the designated agencies, the public, through the activities of the WAG and other equivalent processes, will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical. Public participation will significantly affect public acceptance of the document and the proposed control actions. Stakeholders (landowners, local governing authorities, taxpayers, industries, and land managers) are the most educated regarding the pollutant sources and will be called upon to help identify the most appropriate control actions for each area. Experience has shown that the best and most effective implementation plans are those that are developed with substantial public cooperation and involvement.

Adaptive Management Approach

The goal of the CWA and its associated administrative rules for Idaho is that water quality standards shall be met or that all feasible steps will be taken towards achieving the highest quality water attainable. This is a long-term goal in this watershed, particularly because nonpoint sources are the primary concern. To achieve this goal, implementation must commence as soon as possible.

The TMDL is a numerical loading that sets pollutant levels such that in-stream water quality standards are met and designated beneficial uses are supported. DEQ recognizes that the TMDL is calculated from mathematical models and other analytical techniques designed to simulate and/or predict very complex physical, chemical, and biological processes. Models and some other analytical techniques are simplifications of these complex processes and, while they are useful in interpreting data and in predicting trends in water quality, they are unlikely to produce an exact prediction of how streams and other waterbodies will respond to the application of various management measures. It is for this reason that the TMDL has been established with a MOS.

For the purposes of the King Hill-C.J Strike Reservoir TMDL, a general implementation strategy is being prepared for EPA as part of the TMDL document. Following this submission, in accordance with approved state schedules and protocols, a detailed implementation plan will be prepared for pollutant sources.

For the single point source in the basin (Glenns Ferry WWTP), it is the initial expectation that the WWTP will meet its WLA immediately. This is because the WLA is based on the plant's design capacity and the plant is currently discharging below capacity. For nonpoint sources, DEQ also expects that implementation plans be implemented as soon as practicable. However, DEQ recognizes that it may take some time, from several years to several decades, to fully implement the appropriate management practices. DEQ also recognizes that it may take additional time after implementation has been accomplished before the management practices identified in the implementation plans become fully effective in reducing and controlling pollution. In addition, DEQ recognizes that technology for controlling nonpoint source pollution is, in many cases, in the development stages and will likely take one or more iterations to develop effective techniques. It is possible that after application of all reasonable best management practices, some TMDLs or their associated targets and surrogates cannot be achieved as originally established. Nevertheless, it is DEQ's expectation that nonpoint sources make a good faith effort to achieving their respective load allocations in the shortest practicable time.

DEQ recognizes that expedited implementation of TMDLs will be socially and economically challenging. Further, there is a desire to minimize economic impacts as much as possible when consistent with protecting water quality and beneficial uses. DEQ further recognizes that, despite the best and most sincere efforts, natural events beyond the control of humans may interfere with or delay attainment of the TMDL and/or its associated targets and surrogates. Such events could be, but are not limited to floods, fire, insect infestations, and drought. Should such events occur that negate all BMP activities, the appropriateness of re-implementing BMPs will be addressed on a case-by-case basis. In any case, post event conditions should not be exacerbated by management activities that would hinder the natural recovery of the system.

For some pollutants, pollutant surrogates have been defined as targets for meeting the TMDLs. The purpose of the surrogates is not to bar or eliminate human access or activity in the basin or its riparian areas. It is the expectation, however, that the specific implementation plan will address how human activities will be managed to achieve the water quality targets and surrogates. It is also recognized that full attainment of pollutant surrogates (system potential vegetation, for example) at all locations may not be feasible due to physical, legal, or other regulatory constraints. To the extent possible, the implementation plan should identify potential constraints, but it should also provide the ability to mitigate those constraints should the opportunity arise. If a nonpoint source that is covered by the TMDL complies with its finalized implementation plan, it will be considered in compliance with the TMDL.

DEQ intends to regularly review progress of the implementation plan. If DEQ determines the implementation plan has been fully implemented, that all feasible management practices have reached maximum expected effectiveness, but a TMDL or its interim targets have not been achieved, DEQ may reopen the TMDL and adjust it or its interim targets.

The implementation of TMDLs and the associated plan is enforceable under the applicable provisions of the water quality standards for point and nonpoint sources by DEQ and other state agencies and local governments in Idaho. However, it is envisioned that sufficient initiative exists on the part of local stakeholders to achieve water quality goals with minimal enforcement. Should the need for additional effort emerge, it is expected that the responsible agency will work with stakeholders to overcome impediments to progress through education, technical support, or enforcement. Enforcement may be necessary in instances of insufficient action towards progress. This could occur first through direct intervention from state or local land management agencies, and secondarily through DEQ. The latter may be based on departmental orders to implement management goals leading to water quality standards.

In employing an adaptive management approach to the TMDL and the implementation plan, DEQ has the following expectations and intentions:

- Subject to available resources, DEQ intends to review the progress of the TMDLs and the implementation plans on a five-year basis.
- DEQ expects that designated agencies will also monitor and document their progress in implementing the provisions of the implementation plans for those pollutant sources for which they are responsible. This information will be provided to DEQ for use in reviewing the TMDL.
- DEQ expects that designated agencies will identify benchmarks for the attainment of TMDL targets and surrogates as part of the specific implementation plans being developed. These benchmarks will be used to measure progress toward the goals outlined in the TMDL.
- DEQ expects designated agencies to revise the components of their implementation plans to address deficiencies where implementation of the specific management techniques are found to be inadequate.
- If DEQ, in consultation with the designated agencies, concludes that all feasible steps have been taken to meet the TMDL and its associated targets and surrogates, and that the TMDL, or the associated targets and surrogates are not practicable, the TMDL may be reopened and revised as appropriate. DEQ would also consider reopening the TMDL should new information become available indicating that the TMDL or its associated targets and/or surrogates should be modified. This decision will be made based on the availability of resources at DEQ.

Monitoring and Evaluation

The objectives of a monitoring effort are to demonstrate long-term recovery, better understand natural variability, track implementation of projects and BMPs, and track effectiveness of TMDL implementation. This monitoring and feedback mechanism is a major component of the "reasonable assurance of implementation" for the TMDL implementation plan.

The implementation plan will be tracked by accounting for the numbers, types, and locations of projects, BMPs, educational activities, or other actions taken to improve or protect water quality. The mechanism for tracking specific implementation efforts will be annual reports to be submitted to DEQ.

The “monitoring and evaluation” component has two basic categories:

- Tracking the implementation progress of specific implementation plans; and
- Tracking the progress of improving water quality through monitoring physical, chemical, and biological parameters.

Monitoring plans will provide information on progress being made toward achieving TMDL allocations and achieving water quality standards, and will help in the interim evaluation of progress as described under the adaptive management approach.

Implementation plan monitoring has two major components:

- Watershed monitoring and
- BMP monitoring.

While DEQ has primary responsibility for watershed monitoring, other agencies and entities have shown an interest in such monitoring. In these instances, data sharing is encouraged. The designated agencies have primary responsibility for BMP monitoring.

Watershed Monitoring

Watershed monitoring measures the success of the implementation measures in accomplishing the overall TMDL goals and includes both in-stream and in-river monitoring. Monitoring of BMPs measures the success of individual pollutant reduction projects. Implementation plan monitoring will also supplement the watershed information available during development of associated TMDLs and fill data gaps.

In the King Hill-C.J. Strike Reservoir TMDL, watershed monitoring has the following objectives:

- Evaluate watershed pollutant sources,
- Refine baseline conditions and pollutant loading,
- Evaluate trends in water quality data,
- Evaluate the collective effectiveness of implementation actions in reducing pollutant loading to the mainstem and/or tributaries, and
- Gather information and fill data gaps to more accurately determine pollutant loading.

BMP/Project Effectiveness Monitoring

Site or BMP-specific monitoring may be included as part of specific treatment projects if determined appropriate and justified, and will be the responsibility of the designated project manager or grant recipient. The objective of an individual project monitoring plan is to verify that BMPs are properly installed, maintained, and working as designed. Monitoring for pollutant reductions at individual projects typically consists of spot checks, annual reviews, and evaluation of advancement toward reduction goals. The results of these reviews can be used to recommend or discourage similar projects in the future and to identify specific watersheds or reaches that are particularly ripe for improvement.

Evaluation of Efforts over Time

Annual reports on progress toward TMDL implementation will be prepared to provide the basis for assessment and evaluation of progress. Documentation of TMDL implementation activities, actual pollutant reduction effectiveness, and projected load reductions for planned actions will be included. If water quality goals are being met, or if trend analyses show that implementation activities are resulting in benefits that indicate that water quality objectives will be met in a reasonable period of time, then implementation of the plan will continue. If monitoring or analyses show that water quality goals are not being met, the TMDL implementation plan will be revised to include modified objectives and a new strategy for implementation activities.

Time Frame

The implementation plan must demonstrate a strategy for implementing and maintaining the plan and the resulting water quality improvements over the long term. The final timeline should be as specific as possible and should include a schedule for BMP installation and/or evaluation, monitoring schedules, reporting dates, and milestones for evaluating progress. There may be disparity in timelines for different subwatersheds. This is acceptable as long as there is reasonable assurance that milestones will be achieved.

The implementation plan will be designed to reduce pollutant loads from sources to meet TMDLs, their associated loads, and water quality standards. DEQ recognizes that where implementation involves significant restoration, water quality standards may not be met for quite some time. In addition, DEQ recognizes that technology for controlling nonpoint source pollution is, in some cases, in the development stages and will likely take one or more iterations to develop effective techniques.

A definitive timeline for implementing the TMDL and the associated allocations will be developed as part of the implementation plan. This timeline will be developed in consultation with the WAG, the designated agencies, and other interested publics. In the meantime, implementation planning will begin immediately (2005). The goal is to attain the water quality standards and return beneficial uses to full support in the shortest time possible. DEQ expects full implementation of the TMDL and recovery of the beneficial uses to take upwards of 20 years. Some subwatersheds may take less time and some may take more, depending on the complexity of the system.

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GIS Coverages

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USGS. 2002. The Idaho GAP Analysis Project. Land stewardship coverage.

Glossary

305(b)

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

§303(d)

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

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. One acre-foot contains 1234 cubic meters of water.

Adsorption

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

Aeration

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

Aerobic

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

Algae

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

Ambient

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

Anaerobic

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

Anoxic

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 Unit (AU)

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

Assimilative Capacity

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

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

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

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

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

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

Benthic Organic Matter
The organic matter on the bottom of a water body.

Best Management Practices (BMPs)
Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.

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

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

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.

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.

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.

Decomposition

The breakdown of organic molecules (e.g., sugar) to inorganic molecules (e.g., carbon dioxide and water) through biological and nonbiological processes.

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.

Ecology	The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature.
Ecosystem	The interacting system of a biological community and its non-living (abiotic) environmental surroundings.
Effluent	A discharge of untreated, partially treated, or treated wastewater into a receiving water body.
Endangered Species	Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act.
Environment	The complete range of external conditions, physical and biological, that affect a particular organism or community.
Ephemeral Stream	A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table (American Geological Institute 1962).
Erosion	The wearing away of areas of the earth's surface by water, wind, ice, and other forces.
Eutrophic	From Greek for "well nourished," this describes a highly productive body of water in which nutrients do not limit algal growth. It is typified by high algal densities and low clarity.
Eutrophication	1) Natural process of maturing (aging) in a body of water. 2) The natural and human-influenced process of enrichment with nutrients, especially nitrogen and phosphorus, leading to an increased production of organic matter.
Exceedance	A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.

Existing Beneficial Use or Existing Use

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

Extrapolation

Estimation of unknown values by extending or projecting from known values.

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.

Flow

See *Discharge*.

Fluvial

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

Fully Supporting

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

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.

Geographical Information Systems (GIS)

A georeferenced database.

Geometric Mean

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

Gradient

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

Ground Water

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

Habitat

The living place of an organism or community.

Headwater

The origin or beginning of a stream.

Hydrologic 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.

Inorganic

Materials not derived from biological sources.

Instantaneous

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

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.

Irrigation Return Flow

Surface (and subsurface) water that leaves a field following the application of irrigation water and eventually flows into streams.

Land Application

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

Limiting Factor

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

Limnology

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

Load Allocation (LA)

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

Load(ing)

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

Load(ing) Capacity (LC)

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

Lotic

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

Macroinvertebrate

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

Macrophytes

Rooted and floating vascular aquatic plants, commonly referred to as water weeds. These plants usually flower and bear seeds. Some forms, such as duckweed and coontail (*Ceratophyllum sp.*), are free-floating forms not rooted in sediment.

Margin of Safety (MOS)

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

Mass Wasting

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

Mean

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

Median

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

Metric

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

Milligrams per Liter (mg/L)

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

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.

Nonpoint Source
A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.

Not Assessed (NA)
A concept and an assessment category describing water bodies that have been studied, but are missing critical information needed to complete an assessment.

Not 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 the separation of a chemical into two or more phases, such as partitioning of phosphorus between the water column and sediment.

Perennial Stream

A stream that flows year-around in most years.

pH

The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very

	alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.
Phosphorus	An element essential to plant growth, often in limited supply, and thus considered a nutrient.
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.
Point Source	A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable "point" of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	A very broad concept that encompasses human-caused changes in the environment which alter the functioning of natural processes and produce undesirable environmental and health effects. This includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.
Population	A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.
Primary Productivity	The rate at which algae and macrophytes fix carbon dioxide using light energy. Commonly measured as milligrams of carbon per square meter per hour.
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.

Reach

A stream section with fairly homogenous physical characteristics.

Reconnaissance

An exploratory or preliminary survey of an area.

Reference

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

Reference Condition

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

Reference Site

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

Representative Sample

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

Resident
A term that describes fish that do not migrate.

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

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

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

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

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.

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.

Subbasin

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

Subbasin Assessment (SBA)

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

Subwatershed

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

Surface Fines

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

Surface 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.

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 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.

Tributary

A stream feeding into a larger stream or lake.

Total Dissolved Solids

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

Tributary

A stream feeding into a larger stream or lake.

Trophic State

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

Turbidity

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

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 Quality

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

Water Quality Criteria

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

Water Quality Limited

A label that describes water bodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a §303(d) list.

Water Quality Limited Segment (WQLS)

Any segment placed on a state's §303(d) list for failure to meet applicable water quality standards, and/or is not expected to meet applicable water quality standards in the period prior to the next list. These segments are also referred to as "§303(d) listed."

Water Quality Management Plan

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

Water Quality Modeling

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

Water Quality Standards

State-adopted and 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.

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Appendix A. Unit Conversion Chart

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Table A-1. Metric - English unit conversions.

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

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

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Appendix B. State and Site-Specific Standards and Criteria

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Table B-1 outlines the water quality standards used in the King Hill-C.J. Strike Reservoir TMDL Subbasin Assessment and TMDL.

Table B-1. Idaho water quality standards used in the King Hill-C.J. Strike TMDL Subbasin Assessment and TMDL.

Pollutant	Applicable Water Quality Standard
Dissolved Oxygen Total Dissolved Gas	Greater than 6.0 mg/L except in hypolimnion of stratified lakes and reservoirs Total concentration of dissolved gas not exceeding one hundred ten percent (110%) if saturation at atmospheric pressure at the point of sample collection
Sediment	Sediment shall not exceed quantities specified in general surface water quality criteria (IDAPA 58.01.02.250 or 252) or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses
Turbidity (Cold Water Aquatic Life)	Less than 50 NTU[1] above background for any given sample or less than 25 NTU for more than 10 consecutive days (below any applicable mixing zone set by DEQ)
Floating, Suspended, or Submerged Matter (Nuisance Algae)	Surface waters shall be free from floating, suspended, or submerged matter of any kind in concentration causing nuisance or objectionable conditions or that impair designated beneficial uses and free from oxygen demanding materials in concentrations that would result in an anaerobic water condition
Excess Nutrients	Surface waters shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses
pH	Hydrogen ion concentration (pH) values within the range of 6.5 to 9.0
Toxic Substances (Pesticides)	Refer to the table located in IDAPA 58.01.02.210.01 for a complete listed of the numeric standards

[1]NTU = nephlometric turbidity unit

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Appendix C. Data Sources

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Table C-1. Major data sources for the Mid Snake River / Succor Creek Subbasin Assessment.

Water Body	Data Source[1]	Type of Data	When Collected
C.J. Strike Reservoir	Idaho Power Company, DEQ	Physical, Chemical, Biological	Ongoing
Snake River	Idaho Power Company, DEQ, USGS	Physical, Chemical, Biological	Ongoing
Bennett Creek	DEQ, IDFG	Physical, Biological	1993, 1993, 2002-04
Ryegrass Creek	DEQ	Physical	1996, 2003-04
Cold Springs Creek	DEQ, IDFG	Physical, Chemical, Biological	1995, 1997, 2002-04
Alkali Creek	DEQ	Physical, Chemical	1996, 2003-04
Little Canyon Creek	DEQ, IDFG	Physical, Chemical, Biological	1993, 1997, 2002-04
Browns Creek	DEQ	Physical	1995, 1998, 2003-04
Sailor Creek	DEQ	Physical	1995, 1998, 2003-04
Deadman Creek	DEQ	Physical	1995, 1998, 2003-04

[1]DEQ = Department of Environmental Quality, USGS = United States Geological Survey, IDFG = Idaho Department of Fish and Game

Table C-2. Data tiers[1] for data used in the Mid Snake River/Succor Creek TMDL

Stream Segment	Data Source	Data Tier[1]	Proposed TMDL Actions
C.J. Strike Reservoir	Idaho Power Company, DEQ	1	TMDLs for nutrients & DO, de-list pesticides
Snake River	Idaho Power Company, USGS, DEQ	1	TMDLs for sediment, nutrients
Bennett Creek	DEQ, IDFG	1, 2[2]	De-list Unknown
Ryegrass Creek	DEQ	1, 2[2]	De-list sediment
Cold Springs Creek	DEQ, IDFG	1, 2[2]	TDML for sediment
Alkali Creek	DEQ	1, 2[2]	De-list sediment
Little Canyon Creek	DEQ, IDFG	1, 2[2]	TMDL for sediment
Browns Creek	DEQ	2[2]	De-list sediment
Sailor Creek	DEQ	2[2]	De-list sediment
Deadman Creek	DEQ	2[2]	De-list sediment

[1]Based on IDEQ Water Body Assessment Guidance definitions of Tier 1-Tier 3 data (Grafe et. al. 2002)
2 Consists of site visits with the intent of collecting flow based data (or) site visits to confirm a zero-flow

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Appendix D. Distribution List

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LEIGH WOODRUFF
USEPA, REGION 10
1200 6TH AVE OW-134
SEATTLE WA 98101

IDAHO STATE LIBRARY
325 W. STATE STREET
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RON BLAKE
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795 SOUTH HASKETT ST
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P.O BOX 910
GLENNS FERRY ID 83623

KNIGHT DUERIG
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DORIAN DUFFIN
7840 APACHE WAY
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SUSIE VADER
7840 APACHE WAY
BOISE ID 83714

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IDAHO POWER COMPANY
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ROBERT WILLIAMS
31194 STATE HIGHWAY 51
BRUNEAU ID 83604

HARLEY RIGGS
5718 W DOUBLE ANCHOR DR
GLENNS FERRY ID 83623

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Appendix E. Assessment Methods used in the King Hill-C.J. Strike Reservoir TMDL, WBAG II & Stream Bank Erosion Inventory

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DEQ Water Body Assessment Guidance Document (WBAG) II

WBAG II (Grafe et al. 2000) is available in its entirety on DEQ's Web site. The address is: http://www.deq.state.id.us/water/surface_water/wbag/WBAG2001.htm

The 10 major components of WBAG II are described in this technical appendix

This Water Body Assessment Guidance (WBAG) is intended as an analytical tool to guide individuals through a standardized assessment process. The WBAG describes Idaho Department of Environmental Quality (DEQ) methods used to evaluate data and determine beneficial use support of Idaho water bodies. This document is a revision of the 1996 WBAG (DEQ 1996).

A water body assessment entails analyzing and integrating multiple types of water body data to address three primary objectives.

1. Determine the beneficial use support of a water body.

2. Determine the degree of biological integrity.

3. Compile descriptive information about the water body.

The regulatory context of the assessment process and how these rules, regulations, and policies are related to DEQ reporting requirements are discussed in Section 1. The Clean Water Act and Idaho water quality standards drive the assessment process and DEQ reporting requirements for the 303(d) list, 305(b) report, subbasin assessments, and legislative reports.

Section 2 discusses how DEQ collects, analyzes, and manages DEQ data used in the assessment process. This section describes the Beneficial Use Reconnaissance Program (BURP) and trend monitoring network. This also includes the methods used to stratify (classify data by stream order and land use) and compare the data for use support determination. Additionally, Section 2 explains the Idaho Water Body Identification System (the scale used to define Idaho water bodies) and the DEQ method used to distinguish between streams and rivers (water body classes for bioassessment).

In Section 3, the WBAG provides guidance on how to identify beneficial uses for assessment purposes. For designated waters, the assessor simply looks to the Idaho water quality standards. However, for undesignated waters, DEQ identifies beneficial uses for assessment based on existing data. Actual subsequent use designations may be different, depending upon additional information that may be received following the procedures described in Idaho Code and water quality standards.

In Section 4, the DEQ policy concerning when and how data from sources other than BURP may be used in water body assessments is discussed. All data are evaluated based on scientific rigor and relevance criteria. Tier I data—that is, BURP compatible data—is incorporated directly into the appropriate aquatic life assessment index.

Non-BURP compatible Tier I data may also be used for 303(d) listing or delisting purposes, if it meets DEQ data policy requirements set forth in this section.

DEQ uses Tier II data for 305(b) reporting and subbasin assessments, and Tier III data for planning purposes.

The interpretation of numeric or narrative criteria exceedances is explained in Section 5. Narrative criteria are largely evaluated based on the DEQ bioassessment process. A violation of numeric criteria for dissolved oxygen, pH, turbidity, temperature, and total dissolved gas occurs when more than 10 percent of the measurements are above the numeric criteria. DEQ considers climatic conditions, natural background, and species-specific spawning time periods when evaluating whether 10 percent or more of the temperature measurements are above the numeric criteria.

Section 6 explains how DEQ uses multimetric indexes to determine aquatic life use support. DEQ uses different indexes depending on whether the water body is classified as a stream or river. The Stream Macroinvertebrate Index, Stream Habitat Index, and Stream Fish Index comprise the stream indexes; the river indexes consist of the River Macroinvertebrate Index, River Diatom Index, and River Fish Index. Supporting technical analyses for these documents are found in the *Idaho Stream Ecological Assessment Framework* (Grafe 2002b) and *Idaho River Ecological Assessment Framework* (Grafe 2002c) documents distributed separately from the WBAG.

DEQ uses the integrated results from the appropriate multi-metric indexes to evaluate subcategories (cold water aquatic life and salmonid spawning) of the aquatic life beneficial use. DEQ applies appropriate numeric criteria separately for cold water aquatic life and salmonid spawning before formulating a final aquatic life use support determination.

How DEQ uses bacteria and toxic data to assess contact recreation beneficial use support is described in Section 7. DEQ uses the geometric mean of bacteria data to determine if water quality standards for primary or secondary contact have been violated. When no data are available, DEQ may evaluate the potential risk for a violation in determining use support.

In Section 8, how DEQ uses toxics data to evaluate domestic, agricultural, and industrial water supplies is discussed. In general, DEQ presumes these uses are fully supporting unless there is evidence to the contrary. This policy is similarly applied for wildlife habitat and aesthetics, as explained in Section 9.

Section 10 attempts to further explain the assessment process through the use of an example. The policies and methods described in Sections 2 through 7 are illustrated in this example. In Section 11, how the public may appeal use support determinations is discussed. The public may petition against assessment determinations during appropriate 303(d) listing or subbasin assessment public comment periods. DEQ will review the appeal and respond accordingly.

Stream Bank Erosion Inventory

Introduction

The intent of this summary is to document the in-stream sediment measures and data assessment methods used to develop the gross sediment budgets used in the Little Canyon Creek and Cold Springs Creek sediment TMDLs. These data are intended to characterize the existing condition of the stream banks, estimate the desired level of erosion and sedimentation (define reference conditions), and provide baseline data that can be used in the future to track the effectiveness of TMDL implementation. For example, the stream bank erosion inventories can be repeated after implementation and ultimately provide an adaptive management or feedback mechanism.

Stream Bank Erosion Inventory

The stream bank erosion inventory is used to estimate background and existing stream bank erosion following methods outlined in the proceedings from the NRCS Channel Evaluation Workshop (1983). Using the direct volume method, subsections of Little Canyon Creek and Cold Springs Creek were surveyed to determine the extent of chronic bank erosion and estimate the needed reductions.

The NRCS stream bank erosion inventory is a field based methodology that measures stream bank/channel stability, length of active eroding banks, and bank geometry. The stream bank/channel stability inventories were used to estimate the long-term lateral recession rate. The recession rate is determined from field evaluation of stream bank characteristics that are assigned a categorical rating ranging from 0 to 3. The categories of rating factors and rating scores are:

Bank Stability:
- Do not appear to be eroding - 0
- Erosion evident - 1
- Erosion and cracking present - 2
- Slumps and clumps sloughing off - 3

Bank Condition:
- Some bare bank, few rills, no vegetative overhang - 0
- Predominantly bare, some rills, moderate vegetative overhang - 1
- Bare, rills, severe vegetative overhang, exposed roots - 2
- Bare, rills and gullies, severe vegetative overhang, falling trees - 3

Vegetation/Cover On Banks:
- Predominantly perennials or rock-covered - 0
- Annuals / perennials mixed or about 40% bare - 1
- Annuals or about 70% bare - 2
- Predominantly bare - 3

Bank/Channel Shape:
V - Shaped channel, sloped banks - 0
Steep V - Shaped channel, near vertical banks - 1
Vertical Banks, U - Shaped channel - 2
U - Shaped channel, undercut banks, meandering channel - 3

Channel Bottom:
Channel in bedrock / non-eroding - 0
Soil bottom, gravels or cobbles, minor erosion - 1
Silt bottom, evidence of active down cutting - 2

Deposition:
No evidence of recent deposition - 1
Evidence of recent deposits, silt bars - 0

Each measured stream segment, which is representative of a larger reach of stream, is rated based on the criteria above. Each category is rated and summed. For example, a stream segment may receive a weighted score of 7 based on bank stability = 1, bank condition = 1, vegetation/cover on banks = 1.5, bank/channel shape = 2.0, channel bottom = 0.5, deposition = 1. From a score of 7, the stream segment then receives a weighted cumulative rating based on the criteria below. A score of 7 receives a cumulative rating of moderate.

Cumulative Rating:

Slight (0-4) Moderate (5-8) Severe (9+)

From the cumulative rating, the weighted lateral recession rate is assigned. This lateral recession a rate defines the amount of bank being lost per year due to bank erosion.

0.01 - 0.05 feet per year	**Slight**
0.06 - 0.15 feet per year	**Moderate**
0.16 - 0.3 feet per year	**Severe**
0.5+ feet per year	**Very Severe**

Stream banks were inventoried to quantify the bank erosion rate and annual average erosion. These data were used to develop a quantitative sediment budget to be used for TMDL development.

Site Selection

The first step in the bank erosion inventory is to identify key problem areas. Stream bank erosion tends to increase as a function of watershed area (NRCS 1983). As a result, the lower stream segment of larger watersheds tend to be problem areas. These stream segments tend to be alluvial streams commonly classified as response reaches (Rosgen B and C channel types).

Because it is often unrealistic to survey every stream segment, sampled reaches were used and bank erosion rates were extrapolated over a larger stream segment. The length of the sampled reach is a function of stream type variability where streams segments with highly variable channel types need a large sample, whereas segments with uniform gradient and consistent geometry need smaller sample.

Stream reaches are subdivided into sites with similar channel and bank characteristics. Breaks between sites are made where channel type and/or dominate bank characteristics change substantially. This is commonly defined by a corresponding change in land use. In a stream with uniform channel geometry there may be only one site per stream reach, whereas in an area with variable conditions there may be several sites.

Field Method

Stream bank erosion or channel stability inventory field methods were originally developed by the U.S. USFS (Pfankuch 1975). Further development of channel stability inventory methods are outlined in Lohrey (1989) and NRCS (1983). As stated above, the NRCS (1983) document outlines field methods used in this inventory. However, slight modifications to the field methods were made and are documented.

Field crews surveyed selected stream reaches measuring bank length, slope height and bank full width and depth. Additionally, while surveying field crews photograph key problem areas.

Bank Erosion Calculations

The direct volume method is used to calculate the average annual erosion rates for a given stream segment based on the bank recession rate determined in the survey (NRCS 1983). The erosion rate (tons/mile/year) is used to estimate the total bank erosion of the selected stream corridor. The direct volume method is summarized in the following equation:

$$E = [A_E * R_{LR} * \rho_B]/2000 \quad \text{(lbs/ton conversion)}$$

where:
E = bank erosion over sampled stream reach (tons/yr/sample reach)
A_E = eroding area (ft^2)
R_{LR} = lateral recession rate (ft/yr)
ρ_B = bulk density of bank material (lps/ft^3)

Total bank erosion is expressed as an annual average. However, the frequency and magnitude of bank erosion events are greatly a function of soil moisture and stream discharge (Leopold et al 1964). Because channel erosion events typically result from above average flow events, the annual average bank erosion value should be considered a long term average. For example, a 50-year flood event might cause 5 feet of bank erosion in one year, and over a ten-year period this event accounts for the majority of bank erosion. These factors have less of an influence where bank trampling is the major cause of channel instability.

The *eroding area* (A_E) is the product of linear horizontal bank distance and average bank slope height. Bank length and slope heights are measured while walking along the stream channel. A laser range finder is used to measure horizontal distance, and bank slope heights are continually measured and averaged over a given reach or site. The horizontal length is the length of the right or left bank, not both. Typically, one bank along the stream channel is actively eroding. For example, the bank on the outside of a meander. However, both banks of channels with severe head cuts or gullies will be eroding and are to be measured separately and eventually summed.

Determining the *lateral recession rate* (R_{LR}) is one of the most critical factors in this methodology (NRCS 1983). Several techniques are available to quantify bank erosion rates: aerial photo interpretation, anecdotal data, bank pins, and channel cross-sections among others.

To facilitate consistent data collection, the NRCS developed rating factors to estimate lateral recession rate. Similar to methods developed by Pfankuch (1975), the NRCS method measures bank and channel stability, and then uses the ratings as surrogates for bank erosion rates. For Little Canyon Creek and Cold Springs Creek, the NRCS measurement method is used (as described above). The lateral recession rates for each stream can be found in the worksheets in Appendix M.

The *bulk density* (ρ_B) of bank material is estimated occularly in the field, then verified based on the data provided by NRCS. Soil bulk density is the weight of material divided by its volume, including the volume of its pore spaces. A table of typical soil bulk densities can be used, or soil samples can be collected and soil bulk density measured in the laboratory.

Appendix F. Evaluation of Intermittence for Selected Streams in HUC 17050101

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Introduction and Scope

The King Hill-C.J. Strike basin (HUC 17050101) is a 2,133 square mile watershed consisting of the Snake River from King Hill to Loveridge Bridge (Highway 51) and C.J. Strike Reservoir. Several perennial and intermittent first through third order stream segments are also included in the HUC. Table F-1 and Figure F-1 show the §303(d) listed intermittent segments, which are the segments of concern addressed in this analysis. The state of Idaho defines an intermittent stream as one that has a period of zero (0) flow for at least one (1) week during most years or has a 7Q2 hydrologically-based flow of less than one-tenth (0.10) cfs (IDAPA 58.01.02.003.51). The 7Q2 is defined as the seven day average flow over a two week period. If a stream contains naturally perennial pools containing significant aquatic life, it is not considered intermittent.

Table F-1. §303(d) listed intermittent stream segments in HUC 17050101

Stream Name	§303(d) Listed Boundaries	Stream Aspect	Intermittent Segment
Bennett Creek	Headwaters to Snake River	North of river	Near 3773 feet[1] to Snake River
Ryegrass Creek	Headwaters to Cold Springs Creek	North of river	Near 3609 feet to Cold Springs Creek
Cold Springs Creek	Headwaters to Snake River	North of river	Near 3609 feet to near 2821 feet
Alkali Creek	Headwaters to Snake River	North of river	Near 3444 feet to near 2821 feet
Little Canyon Creek	Headwaters to Snake River	North of river	Near 4101 feet to near 2624 feet
Browns Creek	Headwaters to Snake River	South of river	Headwaters to near Snake River
Sailor Creek	Headwaters to Snake River	South of river	Headwaters to near Snake River
Deadman Creek	Headwaters to Snake River	South of river	Headwaters to near Snake River

[1] feet in elevation above sea level

The hydrology of each stream in Table F-1 is different depending on its location in the watershed. The upper canyon bound segments of each stream on the north side of the Snake River typically flow perennially due to spring influences. The streams then go dry due to seepage or adjudicated diversions as they move through the upland terrace above Glenns Ferry. Once the streams approach Glenns Ferry, they move down into the Snake River valley where they typically begin to gain water due to a combination of irrigation practices and groundwater influence.

The upper portions (above the Snake River valley) of the streams on the south side of the Snake River rarely contain water. The streams may flow in response to brief precipitation events, but go dry shortly thereafter. Once the streams reach the Snake River valley, they are similar to the north side streams in that they slowly gain water due to a combination of irrigation practices and groundwater influence.

The intent of this evaluation is to use the available data to show that the stream segments in Table F-1 are intermittent. Ideally, a calculation of the 7Q2 in combination with field notes and photographs would be used to determine the intermittence of a stream. Unfortunately, none of the intermittent stream segments of concern in HUC 17050101 contain enough flow data to calculate the 7Q2. While some states have developed region specific regression equations to calculate the 7Q2 for ungaged streams, none were identified for Idaho.

Regression equations to estimate the annual average stream flows were located, but the standard error of the estimates for the Snake River Basin were too large to provide reasonable flow estimates. Given the lack of flow data to calculate the 7Q2, two lines of evidence are used for the evaluation; 1) instantaneous flow measurements collected as part of the DEQ Beneficial Use Reconnaissance Project (BURP) and, 2) time-dated site photographs taken by DEQ and the Idaho Soil Conservation Commission. These lines of evidence provide enough data to determine whether periods of zero-flow exist.

IDAPA 58.01.02.070.07 states that water quality standards shall only apply to intermittent waters during optimum flow periods sufficient enough to support the beneficial uses for which the water body has been designated. The optimum flow for contact recreation is equal to or greater than five (5.0) cfs. The optimum flow for aquatic life is equal to or greater than one (1.0) cfs. When streams fall below the optimum flow, the narrative water quality standards may still apply.

The implication of this rule is that a TMDL for a stream is not appropriate unless it is shown that a *pollutant* (such as excess sediment) impairs aquatic life when flows exceed 1.0 cfs. The numeric criteria may still exist during optimal flow periods. However, the hydrology of most intermittent streams, including those listed in Table F-1, is such that the time of year when flows exceed 1.0 cfs typically corresponds with spring runoff or stochastic precipitation events. Determining beneficial use support status during these periods nearly always yields false determinations of pollutant caused impairment. These false determinations occur because the macroinvertebrate biotic community in the stream is first limited by high velocity flushing flows as runoff occurs and then by a shortage of time to establish a fully functioning community before the stream goes dry. Thus, the aquatic life community is limited by hydrological conditions, not a pollutant. For this reason, DEQ does not apply its biological integrity metrics to intermittent streams.

If instances occur where the flow exceeds 1.0 cfs during base flow (non-spring runoff) and water quality data is available to suggest that a pollutant impairs the biota, further evaluation will be performed and a TMDL will be considered. If this instance does not occur, it will be assumed that a TMDL is not appropriate and the stream segment will be proposed for de-listing based on *IDAPA 58.01.02.070.07*. If the stream is a substantive pollutant contributor to downstream perennial segments or the Snake River, the development of a TMDL will be considered.

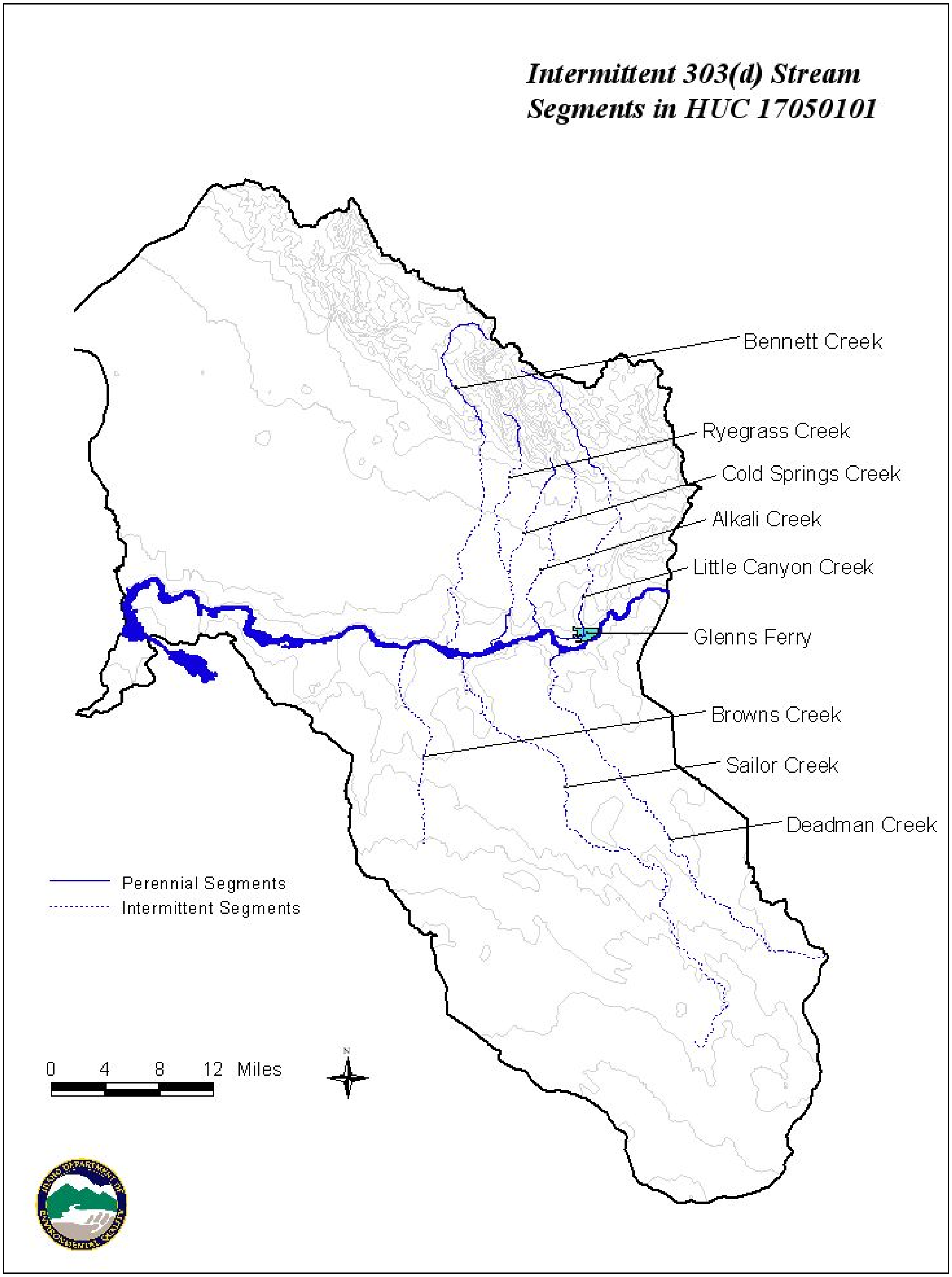

Figure F-1. Intermittent 303(d) stream segments in HUC 17050101

Flow Data Summary

Photographs of the following streams can be found in Appendix F-1 at the conclusion of this analysis. Figure F-2 and Table F-2 summarize the flow data for each intermittent stream segment. It should be noted that most of the streams flow to the Snake River. The near-river confluences of those streams often contain water year around due to backwater and Snake River bank storage. This hydrological aspect of the stream is not considered when determining the intermittence of the system.

Bennett Creek

Bennett Creek extends for a length of 32.41 miles from its headwaters to where it enters the Snake River. The data show that the intermittent segment of Bennett Creek is located between the stream elevation of 3773 feet and the Snake River, although this area changes somewhat from year to year. The stream segment above this area appears to be perennial. Data from June 1993, September 1997 and September 2003 show that the stream was dry throughout the intermittent segment. There are no major tributaries to Bennett Creek and its flow regime is dictated by the water year. In a normal year, Bennett Creek typically goes dry by late April and early May.

Ryegrass Creek

Ryegrass Creek extends for a length of 15.7 miles from its headwaters to where it enters Cold Springs Creek. The data show that the intermittent segment of Ryegrass Creek is located between the stream elevation of 3609 feet and its confluence with Cold Springs Creek, although this area changes somewhat from year to year. The stream segment above the 3609 foot elevation appears to be perennial. Data from June 1996 and September 2003 show that the stream was dry or nearly dry throughout the intermittent segment. There are no major tributaries to Ryegrass Creek and its flow regime is dictated by the water year. In a normal year, Ryegrass Creek typically goes dry by late April and early May.

Cold Springs Creek

Cold Springs Creek extends for a length of 16.8 miles from its headwaters to where it enters the Snake River. The data show that the intermittent segment of Cold Springs Creek is located between stream elevations of 3609 feet and 2821 feet, although this area changes somewhat from year to year. The stream segments above and below these areas appear to be perennial. Data from May 1995, September 1997 and September 2003 show that the stream contained 5.05 cfs in 1995, but was dry the remainder of the time. Ryegrass Creek, another intermittent stream, is the only major tributaries to Cold Springs Creek. In a normal year, Cold Springs Creek typically goes dry by late April and early May.

Alkali Creek

Alkali Creek extends for a length of 16.4 miles from its headwaters to where it enters the Snake River. The data show that the intermittent segment of Alkali Creek is located between the stream elevations of 3444 feet and 2821 feet, although this area changes somewhat from year to year. The stream segments above and below these areas appear to be perennial. Data from June 1996 and September 2003 show that the stream was dry or nearly dry throughout the intermittent segment. There are no major tributaries to Alkali Creek and its flow regime is dictated by the water year. In a normal year, Alkali Creek typically goes dry by late April and early May.

Little Canyon Creek

Little Canyon Creek extends for a length of 28.8 miles from its headwaters to where it enters the Snake River near Glenns Ferry. The data show that the intermittent segment of Little Canyon Creek is located between the stream elevations of 4101 feet and 2624 feet, although this area changes somewhat from year to year. The stream segments above and below those areas appear to be perennial. Data from July 1993, September 1997 and September 2003 show that the stream was dry or nearly dry throughout the intermittent segment. There are no major tributaries to Little Canyon Creek and its flow regime is dictated by the water year. In a normal year, Little Canyon Creek typically goes dry by late April and early May.

Browns Creek

Browns Creek extends for a length of 17.2 miles from its headwaters to where it enters the Snake River. The data show that the intermittent segment of Browns Creek is located between the headwaters of the stream and slightly above the confluence with the Snake River. Data from May 1995, June 1998 and September 2003 show that the stream was dry throughout the intermittent segment. Flows in Brown Creek may occur as a result of local cloudbursts, but DEQ has not documented water in the stream.

Sailor Creek

Sailor Creek extends for a length of 63.1 miles from its headwaters to where it enters the Snake River. The data show that the intermittent segment of Sailor Creek is located between the headwaters of the stream and slightly above the confluence with the Snake River. Data from May 1995, June 1998 and September 2003 show that the stream was dry throughout the intermittent segment. Flows in Sailor Creek may occur as a result of local cloudbursts, but DEQ has not documented water in the stream.

Deadman Creek

Deadman Creek extends for a length of 39.2 miles from its headwaters to where it enters the Snake River. The data show that the intermittent segment of Deadman Creek is located between the headwaters of the stream and slightly above the confluence with the Snake River. Data from May 1995, June 1998 and September 2003 show that the stream was dry throughout the intermittent segment. Flows in Deadman Creek may occur as a result of local cloudbursts, but DEQ has not documented water in the stream.

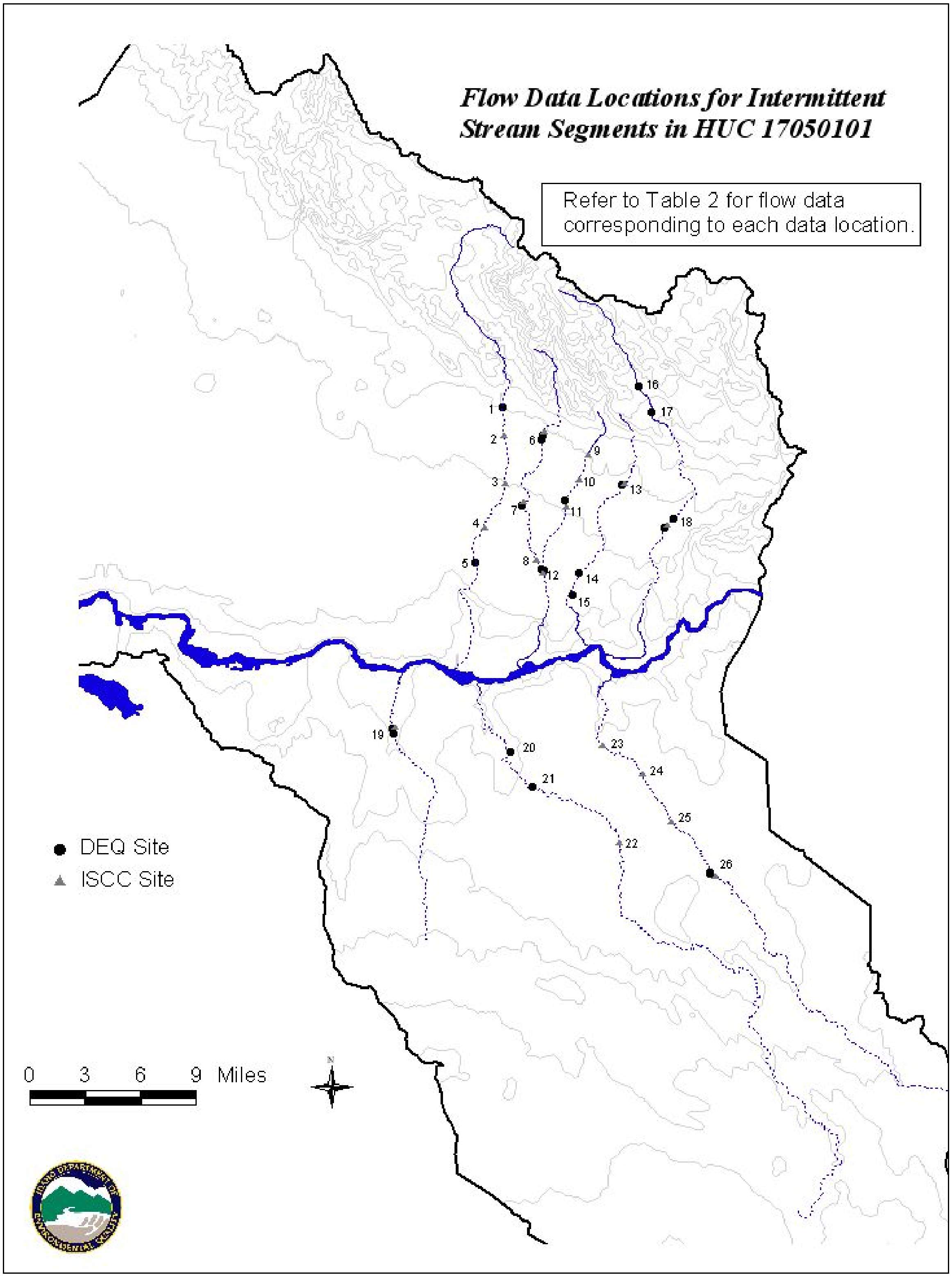

Figure F-2. Flow data locations for intermittent segments in HUC 17050101

Table F-2. Flow data for selected intermittent segments in HUC 17050101, flows in cfs

Stream Name, Location # from Figure F-2	Data Source[1]	Date, Flow (cfs)	Comments
Bennett Creek, 1	DEQ	6/93, Dry	
Bennett Creek, 2	ISCC	9/03, Dry	
Bennett Creek, 3	ISCC	9/03, Dry	
Bennett Creek, 4	ISCC	9/03, Dry	
Bennett Creek, 5	DEQ	9/97, Dry	
Ryegrass Creek, 6	ISCC DEQ	9/03, Dry 6/96, .30 cfs	
Ryegrass Creek, 7	ISCC DEQ	9/03, Dry 6/96, .20 cfs	
Ryegrass Creek, 8	ISCC	9/03, Dry	
Cold Springs Creek, 9	ISCC	9/03, Dry	
Cold Springs Creek, 10	ISCC	9/03, Dry	
Cold Springs Creek, 11	ISCC DEQ	9/03, Dry 9/97, Dry	
Cold Springs Creek, 12	ISCC DEQ DEQ	9/03, Dry 5/95, 5.05 cfs 9/97, Dry	
Alkali Creek, 13	ISCC DEQ	9/03, Dry 6/96, .19 cfs	
Alkali Creek, 14	DEQ	6/96, .07 cfs	
Alkali Creek, 15	DEQ	6/96, Dry	
Little Canyon Creek, 16	DEQ	7/93, 3.09 cfs	Located in perennial segment
Little Canyon Creek, 17	DEQ	9/97, 1.3 cfs	Located in perennial segment
Little Canyon Creek, 18	ISCC DEQ DEQ	9/03, Dry 7/93, 2.59 cfs 9/97, .04 cfs	
Browns Creek, 19	ISCC DEQ DEQ	9/03, Dry 5/95, Dry 6/98, Dry	
Sailor Creek, 20	DEQ	5/95, Dry	
Sailor Creek, 21	DEQ	6/98, Dry	
Sailor Creek, 22	ISCC	9/03, Dry	
Deadman Creek, 23	ISCC	9/03, Dry	
Deadman Creek, 24	ISCC	9/03, Dry	
Deadman Creek, 25	ISCC	9/03, Dry	
Deadman Creek, 26	ISCC DEQ DEQ	9/03, Dry 5/95, Dry 6/98, Dry	

[1] ISCC - Idaho Soil Conservation Commission, DEQ – Department of Environmental Quality

Conclusion

The data in the aforementioned narratives and in Figure F-2 and Table F-2 show that in most water years each of the respective streams have extended periods of zero-flow following spring run-off. As such, the streams are considered intermittent and the pollutant standards outlined in the *Idaho Water Quality Standards and Wastewater Treatment Requirements* apply only during base flow periods when flows exceed 1.0 cfs. The data in Table F-2 also show that in most years the base flow condition in each stream is a dry channel. Periods of zero-flow extending well beyond one week in length are the normal condition for these streams. Additionally, in the years when water has remained present into the expected base flow months (July-September) the flows are nearly always below 1.0 cfs. For these reasons, TMDLs to restore stream specific beneficial uses will not be prepared for the intermittent segments of Bennett, Ryegrass, Cold Springs, Alkali, Little Canyon, Browns, Sailor and Deadman Creeks.

Appendix F-1. Photographs of 303(d) listed intermittent stream segments in HUC 17050101

Following each photograph is a caption referring to the photo location in Figure F-2.

Bennett Creek

Location #3, September 2002

Location #5, September 2002

Ryegrass Creek

Location #6, September 2002

Location #8, September 2002

Cold Springs Creek

Location #9, September 2002

Location #12, September 2002

Alkali Creek

Location #13, September 2002

Location #15, July 2004

Little Canyon Creek

Location #18, September 2002

Browns Creek

Location #19, September 2002

Location #19, September 2002

Sailor Creek

Location #22, September 2002

Deadman Creek

Location #23, September 2002

Location #26, September 2002

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Appendix G. Analysis of (t)-DDT and Dieldrin Conditions in C.J. Strike Reservoir

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Introduction and Scope

The intent of this analysis is to document the use of Bioaccumulation Factors (BAF) to determine the water column concentrations of total (t)-DDT and dieldrin in C.J. Strike Reservoir. The water column concentrations are then compared to the applicable criteria from the *Idaho Water Quality Standards and Wastewater Treatment Requirements* for DDT and dieldrin to determine beneficial use support status for domestic water supply and cold water aquatic life. The full methodology by which BAFs were calculated is detailed in *"Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health"* (EPA 2000). The decision to use BAFs to estimate the C.J. Strike Reservoir concentrations was based on the fact that until recently (2004), no water column DDT or dieldrin concentration data existed for the reservoir. After reviewing the other types of available data, the ability to estimate the water column concentrations using BAFs became evident.

The USGS has collected a sufficient amount of DDT and dieldrin water column and fish tissue data from the Snake River near King Hill. The USGS has also collected fish tissue data from Loveridge Bridge, which falls within the transitional zone for C.J. Strike Reservoir. The water column data were collected as part of the USGS ambient water quality monitoring program while the fish tissue data were collected as part of the National Water Quality Assessment Program (NAWQA). Using the water column and fish tissue data from King Hill, BAFs for DDT and dieldrin were developed. The BAF for each respective pesticide was than applied to the Loveridge Bridge fish tissue data to estimate the water column concentration. Loveridge Bridge is used as the surrogate location for C.J. Strike Reservoir as a whole because no other data were available. The methods by which the BAFs were calculated are described below in more detail.

Introduction to Bioaccumulation

Bioaccumulation is defined as the net accumulation of a substance by an organism as a result of uptake from all environmental sources (EPA 2000). Depending on the species under consideration, bioaccumulation of a given substance may occur through eating, drinking or absorbing the substance.

Using the concept of bioaccumulation as a starting point, bioaccumulation factors were developed for DDT and dieldrin. In its general form, a BAF is defined as the ratio (in L/Kg-tissue) of a substance in tissue to its concentration in ambient water. The use of BAFs is particularly useful in situations such as the Snake River where both the organism and its food are exposed and the ratio does not change significantly over time (EPA 2000). Generally speaking, the BAF for a given substance can be mathematically described as:

$$\textbf{Measured BAF} = C_t/C_w$$

C_t = *total concentration of the chemical in wet tissue*
C_w = *total concentration of the chemical in the water*

This is known as the measured BAF.

Using the measured BAF, a baseline BAF is calculated. The baseline BAF takes into account other environmental variables that may affect the applicability of the BAF, such as the lipid fraction in the tissue of concern and the fraction of the total chemical that is freely dissolved in the ambient water. Integrating this additional information into the BAF calculation allows for a more accurate estimation of the actual concentration because the resultant BAF is expressed on a freely dissolved and lipid normalized basis.

The baseline BAF for a given substance can be mathematically described as:

Baseline BAF = [Measured BAF/f_{fd}] * (1/f_l)
Measured BAF = BAF based on total concentration in tissue and water
f_{fd} = Fraction of the total chemical that is freely dissolved in the ambient water
f_l = Fraction of the tissue that is lipid

The baseline BAF is used to estimate the water column concentration in C.J. Strike Reservoir. Again, the baseline BAF is better suited than the measured BAF because many of the environmental variables that affect bioaccumulation are accounted for in the calculation.

One of the variables used to calculate the baseline BAF is the fraction of total chemical that is freely dissolved in the ambient water. The equation for determining the freely dissolved fraction part of the baseline BAF calculation is as follows:

Fraction freely dissolved (f_{fd}) = 1/[1+(POC * K_{ow}) + (DOC * 0.08 * K_{ow})]
POC = concentration of particulate organic carbon (kg/L)
DOC = concentration of dissolved organic carbon (kg/L)
K_{ow} = n-octanol water partition coefficient (solubility of chemical)

Another variable used in the baseline BAF calculation is the fraction of tissue that is lipid. Lipid normalization of tissue concentrations reflect the assumption that BAFs for nonionic compounds (such as DDT and dieldrin) are directly proportional to the percent lipid in the tissue upon which the BAFs are based (EPA 2000). When possible, lipid content of the species of concern should be accounted for because nonionic compounds have a tendency to accumulate in lipids. Species with a high lipid content will bioaccumulate more chemical than species with a low lipid content. For this reason, it is important that the species used to calculate the baseline BAF and the species used to estimate the water column concentration be the same or at least have very similar lipid contents. Typically, the lipid fraction is reported in bioaccumulation studies, which it was in the USGS NAWQA studies. Otherwise, lipid content can be calculated using the following equation:

Lipid Fraction (f_l) = M_l/M_t
M_l = Mass of lipid in specified tissue
M_t = Mass of specified tissue (wet weight)

Applicable Data

Using the series of equations outlined above, baseline BAFs were developed for DDT and dieldrin. Again, the BAFs were developed using Snake River at King Hill data with the intent of applying the BAFs to Loveridge Bridge (C.J. Strike Reservoir) fish tissue data to estimate water column concentrations in C.J. Strike Reservoir. Table G-1 shows the data used to develop the BAFs as well as the source of the data. Figures G-1 and G-2 show the spreadsheets used to determine the estimated concentrations in C.J. Strike Reservoir. The estimated concentrations are calculated using the following equation:

C.J. Strike C_t / BAF_b
C.J. Strike C_t = fish tissue concentration in C.J. Strike Reservoir
BAF_b = baseline bioaccumulation factor

Table G-1. Data used to develop the DDT and dieldrin BAFs

DDT Bioaccumulation Factor			
Data Type	**Value**	**Data Source**	**Comments**
Fish tissue concentration at King Hill	187 µg/kg	Maret & Ott 1997	Whole body sucker, wet weight
Fish tissue concentration at C.J. Strike Reservoir	232 µg/kg	Clark & Maret 1998	Whole body sucker, wet weight
King Hill sucker tissue lipid fraction	0.1	Maret & Ott 1997	Mean value of three collected Largescale suckers
King Hill water column concentration	0.0036 µg/L	USGS NWIS Web http://waterdata.usgs.gov/id/nwis/qw	One-half of mean value calculated over the POR (10/65-8/71)
n-octanol water partition coefficient	6.91	TOXNET http://toxnet.nlm.nih.gov/	None
King Hill Particulate Organic Carbon Content	$4.73x10^{-7}$	Harrison 2004	None
King Hill Dissolved Organic Carbon Content	$1.31x10^{-6}$	Harrison 2004	None
Dieldrin Bioaccumulation Factor			
Data Type	**Value**	**Data Source**	**Comments**
Fish tissue concentration at King Hill	2.5 µg/kg	Maret & Ott 1997	One-half detection limit, whole body sucker, wet weight
Fish tissue concentration at C.J. Strike Reservoir	2.5 µg/kg	Clark & Maret 1998	One-half detection limit, whole body sucker, wet weight
King Hill sucker tissue lipid fraction	0.1	Maret & Ott 1997	Mean value of three collected Largescale suckers
King Hill water column concentration	0.0011 µg/L	USGS NWIS Web http://waterdata.usgs.gov/id/nwis/qw	Mean value calculated over the POR (5/94-9/02) using one-half detection limit where necessary
n-octanol water partition coefficient	5.4	TOXNET http://toxnet.nlm.nih.gov/	None
King Hill Particulate Organic Carbon Content	$4.73x10^{-7}$	Harrison 2004	None
King Hill Dissolved Organic Carbon Content	$1.31x10^{-6}$	Harrison 2004	None

The C.J. Strike DDT and dieldrin concentration estimations shown in Figures G-1 and G-2 illustrate that neither constituent exceeds current water quality criteria. It is important to note that the human health criterion is based on a carcinogenicity risk of 10^{-6}. Stated another way, the risk of developing cancer if this concentration of constituent is consumed in 1 in 1,000,000 (targets of 0.00059 µg/L DDT & 0.00014 µg/L dieldrin). If the carcinogenicity risk is lowered, the target changes accordingly. However, the carcinogenicity risk of 10^{-6} was chosen to add an additional margin of safety to the analysis.

Analysis of t-DDT in CJ Strike Reservoir* using Bioaccumulation Factors

italic=1/2 1972 measured level

	King Hill	CJ Strike
Tissue Concentration (µg/kg)= C_t	187	232
Tissue Lipid Fraction = F_L	0.1	NA
Water Column Concentration (µg/L) = C_w	*0.0036*	x
K_{ow} *(unitless)*	6.91	NA
Particulate Organic Carbon Content (kg/L) = POC	4.74286E-07	NA
Dissolved Organic Carbon Content (kg/L) = DOC	1.30762E-06	NA

	Equation	Calculated Value	Final Unit
King Hill - Measured Bioaccumulation Factor = BAF_T	C_t/C_w	51944	L/kg
King Hill - Fraction of freely dissolved chemical = F_d	$1 / [1 + (POC * K_{ow}) + (DOC * 0.08 * K_{ow})]$	0.999996	L/kg
Baseline Bioaccumulation Factor = BAF_b	$[BAF_T / F_d - 1] * 1 / F_L$	519437	L/kg
Estimated Water Column Concentration at CJ Strike	CJ Strike C_t / BAF_b	**0.000446638**	µg/L
t-DDT Water Column Target - Aquatic Life (IDAPA 58.01.02.210)		**0.001**	µg/L
t-DDT Water Column Target - Human Health (IDAPA 58.01.02.210)		**0.00059**	µg/L
Aquatic Life Target Exceeded?		No	
Human Health Target Exceeded?		No	

* The "CJ Strike Reservoir" data are collected at Loveridge Bridge, which is the inflow to CJ Strike Reservoir.
No pesticides data are available from the body of the reservoir.

Figure G-1. Estimation of DDT concentration in C.J. Strike Reservoir

Analysis of Dieldrin in CJ Strike Reservoir* using Bioaccumulation Factors
italic=1/2 detection limit used

	King Hill	CJ Strike
Tissue Concentration (µg/kg)= C_t	*2.5*	*2.5*
Tissue Lipid Fraction = F_L	0.1	NA
Water Column Concentration (µg/L) = C_w	*0.0011*	x
K_{ow} (unitless)	5.4	NA
Particulate Organic Carbon Content (kg/L) = POC	4.74286E-07	NA
Dissolved Organic Carbon Content (kg/L) = DOC	1.30762E-06	NA

	Equation	Calculated Value	Final Unit
King Hill - Measured Bioaccumulation Factor = BAF_T	C_t/C_w	2273	L/kg
King Hill - Fraction of freely dissolved chemical = F_d	$1 / [1 + (POC * K_{ow}) + (DOC * 0.08 * K_{ow})]$	0.999996874	L/kg
Baseline Bioaccumulation Factor = BAF_b	$[BAF_T / F_d - 1] * 1 / F_L$	22717	L/kg
Estimated Water Column Concentration at CJ Strike	CJ Strike C_t / BAF_b	**0.000110048**	µg/L
Dieldrin Water Column Target - Aquatic Life (IDAPA 58.01.02.210)		**0.0019**	µg/L
Dieldrin Water Column Target - Human Health (IDAPA 58.01.02.210)		**0.00014**	µg/L
Aquatic Life Target Exceeded?		No	
Human Health Target Exceeded?		No	

* The "CJ Strike Reservoir" data are collected at Loveridge Bridge, which is the inflow to CJ Strike Reservoir.
No pesticides data are available from the body of the reservoir.

Figure G-2. Estimation of dieldrin concentration in C.J. Strike Reservoir

Appendix H. C.J. Strike Reservoir CE-QUAL-W2 Water Quality Modeling Summary

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A full description of the CE-QUAL-W2 model selection and setup can be found in Harrison et al (2004), available from Idaho DEQ, Boise Regional Office. This appendix is intended to outline the major components of the model documentation, such that the reviewer(s) of this TMDL can see that all aspects of proper model application were addressed.

The C.J. Strike CE-QUAL-W2 water quality modeling report addresses the following major components:

1. Introduction
    - Overview and Hydrology of C.J. Strike Reservoir
    - Water Quality
2. Model Selection and Setup
    - Model Selection
    - Model Setup
        - *Geometry and Bathymetry*
        - *Meteorological Data*
        - *Hydrology and Water Balance*
        - *Water Quality Initial and Boundary Conditions*
        - *Coefficients*
    - Parameter Optimization
        - *Hydrodynamics/Water Temperature*
        - *Dissolved Oxygen (Water Quality)*
3. Model Sensitivity Analysis
    - Coefficients
4. Conclusions
5. References

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Appendix I. Photographs of Macrophyte Beds in the Snake River between King Hill and Indian Cove

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At Indian Cove Bridge September 2004. Photo: Idaho Power Company

Macrophytes on boat trailer, Indian Cove Bridge, September 2004. Photo: Idaho Power Company

Macrophyte build-up on sampling equipment at Indian Cove. Cable had been in the water for 4 minutes. Photo: Idaho Power Company.

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Appendix J. Glenns Ferry Wastewater Treatment Plant Impact Analysis

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Glenns Ferry WWTP Total Phosphorus Impact Analysis

	Flow (cfs)	TP (mg/L)	Mixed Flow in Snake River	Mixed Conc. in Snake River	Load in Snake River (lbs/day)
Snake River @ King Hill	7431	0.075			3009.6
King Hill Irrigation, King Hill	-12	0.075	7419.00	0.075	3004.7
King Hill Creek	16	0.210	7435.00	0.075	3022.8
King Hill Irrigation, Glenns Ferry	-46	0.075	7389.00	0.075	3004.1
Glenns Ferry Drinking Water Facility	-1.6	0.075	7387.40	0.075	3003.5
Glenns Ferry WWTP	0.7	7.000	7388.08	0.076	3029.2
	Increase due to Glenns Ferry WWTP			**0.0006**	**25.7**
	Percent increase due to WWTP			**0.847**	**0.856**

Data Sources:

Snake River @ King Hill Flow	1909-2003 USGS NWIS Data, lowest minimum of daily mean flows for the POR
Snake River @ King Hill TP Target	Based on King Hill-C.J. Strike TMDL
King Hill Irrigation Withdrawal Flow, King Hill	1988-2003 USGS NWIS Data, mean of mean monthly flows for April-Oct over POR
King Hill Creek Flow	1913, 1938-41 USGS NWIS Data, mean of mean month flows for Jan-Dec over POR
King Hill Creek TP Concentration	Estimated using Little Canyon data from April-Sept 2003
King Hill Irrigation Withdrawal Flow, Glenns Ferry	1988-1994 USGS NWIS Data, mean of mean monthly flows for April-Oct over POR
Glenns Ferry Drinking Water Facility Withdrawal Flow	Facilities *proposed* maximum design flow, personal communication with Jeff Cook, Glenns Director of Public Works
Glenns Ferry WWTP Flow	Facilities maximum design flow, personal communication with Brian Donaldson, JUB Engineering
Glenns Ferry WWTP TP Concentration	Typical major pollutant composition, from: Design of Municipal Wastewater Treatment Plants, Vol. 1, WEF 1991

Analysis Summary:

The analysis shows that the Glenns Ferry WWTP may increase the TP concentration and load in the Snake River by an estimated 0.8%.
This increase is considered diminimus, especially when considering the increase is lower than the TP laboratory detection limit (0.005 mg/L).
The analysis is also relatively conservative for the following reasons:
1) The analysis does not include a mixing zone, which is allowed for in the NPDES permit
2) The Snake River at King Hill flow (7431 cfs) is the lowest mean of the daily mean flows
3) The Glenns Ferry Drinking Water Facility will normally withdraw 0.60 cfs (400,000 gpd), not the 1.6 cfs (1,000,000 gpd) for which it is designed
4) The Glenns Ferry WWTP flow is based on the design capacity flow of .44 MGD (0.68 cfs), yet the plant currently operates at an average of .25 MGD (0.39 cfs)

Appendix K. Example of Applying the Idaho Dissolved Oxygen Standards to C.J. Strike Reservoir Dissolved Oxygen Data

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The following example shows the data interpretation for a stratified vertical profile (top) and an isothermal vertical profile (bottom).

Measure Date	River Mile	Water Depth (m)	Sample Depth (m)	Temperature (°C)	DO (mg/l)	Temperature change	Isothermal or Stratified	DO violations
8/7/1995 9:48	495.3	30	0.2	24.02	14.12	0.21	7.14	**none**
Interpolated Depth			1	23.81	13.5	0.21	= Stratified	**All DO<6mg/l is**
Interpolated Depth			2	23.59	12.88	0.21		**in hypolimnion**
8/7/1995 9:45	495.3	30	3	23.38	12.26	0.21		**=excluded**
8/7/1995 9:47	495.3	30	4	22.12	9.14	1.26		
8/7/1995 9:44	495.3	30	5.1	21.63	7.85	0.49		
Interpolated Depth			6	21.48	7.554	0.15		
Interpolated Depth			7	21.33	7.258	0.15		
Interpolated Depth			8	21.18	6.962	0.15		
Interpolated Depth			9	21.03	6.666	0.15		
8/7/1995 9:34	495.3	30	10	20.88	6.37	0.15		
8/7/1995 9:42	495.3	30	11	20.63	6.32	0.25		
8/7/1995 9:40	495.3	30	12.1	20.51	**5.19**	0.12		
8/7/1995 9:36	495.3	30	13	20.27	**2.81**	0.24		
8/7/1995 9:38	495.3	30	14	20.15	**5.62**	0.12		
8/7/1995 9:23	495.3	30	15	19.93	**4.61**	0.22		
8/7/1995 9:32	495.3	30	16	19.73	**3.27**	0.2		
8/7/1995 9:28	495.3	30	17	19.31	**1.65**	0.42		
8/7/1995 9:26	495.3	30	18	19.06	**0.55**	0.25		
Interpolated Depth			19	18.86	0.35	0.2		
8/7/1995 9:22	495.3	30	19.9	18.66	**0.15**	0.2		
Interpolated Depth			21	18.304	0.156	0.356		
Interpolated Depth			22	17.948	0.162	0.356		
Interpolated Depth			23	17.592	0.168	0.356		
Interpolated Depth			24	17.236	0.174	0.356		
8/7/1995 9:19	495.3	30	25	16.88	**0.18**	0.356		

1.Difference between 24.02°C at the topmost measurement and 16.88°C at the bottom is 7.14°C, which is greater than a 3°C difference, so the reservoir is stratified.

2.Temperature change between sample depth 3m and 4m = 1.26°C.

This is the metalimnion,

3.All of the dissolved oxygen measurements below 6 mg/l are in the hypolimnion, so they are excluded from meeting the water quality standard.

1. Difference between 21.09°C at the topmost measurement and 18.77°C at the bottom is 2.32°C, which is less than a 3°C difference, so the reservoir is isothermal.

Measure Date	River Mile	Water Depth (m)	Sample Depth (m)	Temperature (°C)	DO (mg/l)	Isothermal or Stratified	DO violations
8/24/1995 13:25	500	27	0.3	21.09	8.63	2.32	
8/24/1995 13:24	500	27	3	20.61	8.17	Isothermal	
8/24/1995 13:22	500	27	5	20.59	8.07	Exclude	
8/24/1995 13:19	500	27	10	20.55	7.93	bottom 20%	
8/24/1995 13:18	500	27	15	20.35	7.46	=21.60	
8/24/1995 13:16	500	27	16	20.16	6.99		
8/24/1995 13:13	500	27	17	19.28	**4.41**		**3.96 at 20 m**
8/24/1995 13:12	500	27	20	18.88	**3.96**		**4.41 at 17 m**
8/24/1995 13:10	500	27	25	18.77	**2.97**	Excluded	

2. Exclude measurements at the bottom of the reservoir.

3. Remaining dissolved oxygen measuring below 6 mg/l are violations of the water quality standard.

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Appendix L. RCRA and CERCLA Sites in HUC 17050101

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RCRA and CERCLA Sites in HUC 17050101

Handler Name	EPA ID	Site Type
RHONE-POULENC AG IDAHO DIST CORP	ID0000228023	RCRA
MAGIC WEST INC	ID0000309492	RCRA
US DOI BOR WPR ANDERSON RANCH DAM POWERP	ID5142300065	RCRA
CHEVRON PIPELINE CO MOUNTAIN HOME FACILI	IDD000641928	RCRA
SAMSON TRUCK LINE	DD004865317 I	RCRA, CERCLA
HOLLY CORP	IDD020924031	RCRA
SIMCHEM	IDD057201352	RCRA
WESTERN FARM SERVICE GLENNS FERRY	IDD073124281	RCRA
AMALGAMATED SUGAR CO LLC MT HOME	IDD981774078	RCRA
MOUNTAIN HOME FORD LIN MER INC	IDD984667055	RCRA
MOUNTAIN HOME FORD	IDD984669556	RCRA
JACKS BODY SHOP	IDD984672444	RCRA
TECH AUTO BODY	IDD984672535	RCRA
ROCKIN S RANCH	IDR000000323	RCRA
US ECOLOGY IDAHO INC RTF	IDR000000406	RCRA
DOUFAS PAINTING CONTRACTORS MH	IDR000001529	RCRA
WAL MART SUPERCENTER 2782	IDR000200345	RCRA
US AFB MOUNTAIN HOME	ID3572124557	RCRA, CERCLA
CHEVRON PIPELINE CO GLENNS FERRY STATION	IDD000641951	RCRA
NEW FRONTIER CHRYSLER	IDD033981416	RCRA
NORTHWEST PIPELINE CORP MTN HOME SALES	IDD984667618	RCRA
MOUNTAIN HOME OIL INC	IDD984672758	RCRA
SHEEHAN PIPE LINE CONSTRUCTION CO	IDD984674358	RCRA
COX AUTOBODY INC	IDR000000430	RCRA
ID DEQ BRO HOT CREEK ORPHAN WASTE SITE	IDR000001180	RCRA
UNITED PARCEL SERVICE MT HOME	IDR000001792	RCRA
MOUNTAIN HOME R	IDT170010185	RCRA
US DOI BLM KING HILL DUMP	ID9141100082	RCRA
SNAKE RIVER CHEMICALS GF	IDD000467282	RCRA
NORTHWEST PIPELINE CORP MTN HOME COMPR S	IDD000642249	RCRA
CHEVRON USA INC MTN HOME BULK PLNT	IDD000832550	RCRA
MOUNTAIN HOME TRUCKING INC	IDD984666156	RCRA
ECONO WASH	IDD984667683	RCRA

JBS BODY & FENDER	IDD984669549	RCRA
US DOI BLM GF STRYCHNINE SITE	IDR000200774	RCRA
IDAHO CIRCUIT TECHNOLOGY	IDD113391775	RCRA
KMART 7668	IDR000000208	RCRA
LEOS TOWING	ID0000013128	RCRA
MOUSERS AUTO BODY	ID0000013136	RCRA
USDOI BLM BLACK MESA DUMP	ID0141100016	CERCLA
USDOI BLM CLOVER HOLLOW ILLEGAL AIRSTRIP	ID2141100113	CERCAL
USDOI BLM HAMMETT DUMP	ID5141190038	CERCLA
ISDOI BLM CLARKS AIR SERVICE AIRSTRIP	ID7141190044	CERCLA
NORTHWEST PIPELINE CORP - MOUNTAIN HOME	IDD984666065	CERCLA
MOUNTAIN HOME LANDFILL	ID984666297	CERCAL
T & LC FARMS LLC	IDR000201418	RCRA

Appendix M. Streambank Erosion Worksheets for the Little Canyon Creek and Cold Springs Creek Sediment TMDLs

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Cold Springs Creek

T5S, R9E, Sec 20, SW 1/4 to Snake River, Baseline (Pre-TMDL) Conditions

Segment Length 4.04 miles

Segment #	Ave Slope HT (ft)	Bank Length (ft)	A_E (ft^2)	R_{LR}	D_B
1	2.63	63	165.9	0.165	110
2	3.73	72	268.8		
3	2.85	144	410.4		
4	3.97	105	416.5		
5	3.15	90	283.5		
6	2.82	138	388.7		
7	3.20	69	220.8		
8	1.42	90	127.7		
9	0.48	243	116.6		
10			0.0		
		1014	2398.9 Total Area		

$E = [A_E*R_{LR}*D_B]/2000$

21.8 tons/year Bank erosion rate at sampled reach
113.36 tons/mile/year Bank erosion rate per mile

457.97 tons/year Total erosion from segment per year

Slope Heights

Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 9
2.4	2	3.7	2.4	2.6	4.5	2.1	1.6	0.8
1.2	2.8	2.4	6.5	3.1	3.1	2.2	1.7	0.36
1.1	5.3	3	2.1	2.4	2.5	6.1	1.7	0.47
2	5.1	2.5	7.1	4.5	2.5	1.9	2	0.52
7	3.5	2.4	2.8	4.5	2.1	4.2	0.9	0.38
2.1	3.7	3.1	2.9	1.8	2.2	2.7	0.61	0.35

Cold Springs Creek

T5S, R9E, Sec 20, SW 1/4 to Snake River, TMDL Conditions

Segment Length 4.04 miles

Segment #	Ave Slope HT (ft)	Bank Length (ft)	A_E (ft^2)	R_{LR}	D_B	Target R_{LR}
1	2.63	63	165.9	0.165	110	0.12
2	3.73	72	268.8			*Rosgen C4*
3	2.85	144	410.4			
4	3.97	105	416.5			
5	3.15	90	283.5			
6	2.82	138	388.7			
7	3.20	69	220.8			
8	1.42	90	127.7			
9	0.48	243	116.6			
10			0.0			
		1014	2398.9 Total Area			

$E = [A_E * R_{LR} * D_B]/2000$

21.8	tons/year	Bank erosion rate at sampled reach
113.36	tons/mile/year	Bank erosion rate per mile
457.97	tons/year	Total erosion from segment per year
15.8	tons/year	Target erosion rate at sampled reach
82.44	tons/mile/year	Target bank erosion rate per mile
333.07	tons/year	Target total erosion from segment per year

30.92 tons/mile/year *Load Reduction achieved if restored to functioning C4*

27.27 Percent Reduction

Slope Heights

Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 9
2.4	2	3.7	2.4	2.6	4.5	2.1	1.6	0.8
1.2	2.8	2.4	6.5	3.1	3.1	2.2	1.7	0.36
1.1	5.3	3	2.1	2.4	2.5	6.1	1.7	0.47
2	5.1	2.5	7.1	4.5	2.5	1.9	2	0.52
7	3.5	2.4	2.8	4.5	2.1	4.2	0.9	0.38
2.1	3.7	3.1	2.9	1.8	2.2	2.7	0.61	0.35

Little Canyon Creek (1)

T5S, R10E, Sec 8, SW 1/4 to T5S, R10E, Sec 18, SE 1/4, Baseline (Pre-TMDL) Conditions

Segment Length 0.58 miles

Segment #	Ave Slope HT (ft)	Bank Length (ft)	A_E (ft^2)	R_{LR}	D_B
1	7.90	123	971.7	0.16	110
2	6.22	69	429.0		
3	7.58	228	1729.0		
4	5.10	168	856.8		
5	6.50	114	741.0		
6	8.93	225	2010.0		
7	4.63	66	305.8		
8	7.17	105	752.5		
9	5.65	189	1067.9		
10	6.63	660	4376.8		
		1947	13240.4 Total Area		

$E = [A_E * R_{LR} * D_B]/2000$

116.5	tons/year	Bank erosion rate at sampled reach
315.97	tons/mile/year	Bank erosion rate per mile
183.26	tons/year	Total erosion from segment per year

Slope Heights

Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 9	Seg 10
7	8	8.3	4.6	4.3	11.4	6.8	10.4	3.5	7.1
8.2	8	9.7	9.2	5.4	12.1	6.6	3.4	3.7	7.4
5.7	7.6	5.4	3.4	7.5	4.5	5.3	3.8	4.8	5.3
7.4	6.8	5.7	3.2	4.5	8.6	3.1	9.3	6.5	6.1
14	3.2	8.6	5.2	8.6	8.5	3	8	8.2	7.5
5.1	3.7	7.8	5	8.7	8.5	3	8.1	7.2	6.3

Little Canyon Creek (1)

T5S, R10E, Sec 8, SW 1/4 to T5S, R10E, Sec 18, SE 1/4, Current Conditions

Segment Length 0.58 miles

Segment #	Ave Slope HT (ft)	Bank Length (ft)	A_E (ft^2)	R_{LR}	D_B	Target R_{LR}
1	7.90	123	971.7	0.16	110	0.12
2	6.22	69	429.0			*Rosgen C4*
3	7.58	228	1729.0			
4	5.10	168	856.8			
5	6.50	114	741.0			
6	8.93	225	2010.0			
7	4.63	66	305.8			
8	7.17	105	752.5			
9	5.65	189	1067.9			
10	6.63	660	4376.8			
		1947	13240.4 Total Area			

$E = [A_E*R_{LR}*D_B]/2000$

116.5	tons/year	Bank erosion rate at sampled reach
315.97	tons/mile/year	Bank erosion rate per mile
183.26	tons/year	Total erosion from segment per year
87.4	tons/year	Target erosion rate at sampled reach
236.98	tons/mile/year	Target bank erosion rate per mile
137.45	tons/year	Target total erosion from segment per year

78.99 tons/mile/year *Load Reduction achieved if restored to functioning C4*

25.00 Percent Reduction

Slope Heights

Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 9	Seg 10
7	8	8.3	4.6	4.3	11.4	6.8	10.4	3.5	7.1
8.2	8	9.7	9.2	5.4	12.1	6.6	3.4	3.7	7.4
5.7	7.6	5.4	3.4	7.5	4.5	5.3	3.8	4.8	5.3
7.4	6.8	5.7	3.2	4.5	8.6	3.1	9.3	6.5	6.1
14	3.2	8.6	5.2	8.6	8.5	3	8	8.2	7.5
5.1	3.7	7.8	5	8.7	8.5	3	8.1	7.2	6.3

Little Canyon Creek (2)

T5S, R10E, Sec 18, SE 1/4 to Snake River, Baseline (Pre-TMDL) Conditions

Segment Length 5.25 miles

Segment #	Ave Slope HT (ft)	Bank Length (ft)	A_E (ft^2)	R_{LR}	D_B
1	4.13	285	1178.0	0.19	110
2	4.97	237	1177.1		
3	3.95	321	1268.0		
4	9.38	207	1942.4		
5	8.68	255	2214.3		
6	7.37	357	2629.9		
7			0.0		
8			0.0		
9			0.0		
10			0.0		
		1662	10409.6		
			Total Area		

$E = [A_E * R_{LR} * D_B]/2000$

108.8	tons/year	Bank erosion rate at sampled reach
345.58	tons/mile/year	Bank erosion rate per mile
1814.31	tons/year	Total erosion from segment per year

Slope Heights

Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6
4.5	3.5	3.9	11.5	15.5	8.2
4.7	3.2	3.9	12.2	17.5	6.4
3.5	2.9	3.7	8.9	3.2	5.5
3.2	4.3	4.1	9.7	2.8	8.1
4.1	8.3	4.3	5.4	5.6	8.1
4.8	7.6	3.8	8.6	7.5	7.9

Little Canyon Creek (2)

T5S, R10E, Sec 18, SE 1/4 to Interstate 84, TMDL Conditions

Segment Length 5.25 miles

Segment #	Ave Slope HT (ft)	Bank Length (ft)	A_E (ft^2)	R_{LR}	D_B	Target R_{LR}
1	4.13	285	1178.0	0.19	110	0.12
2	4.97	237	1177.1			*Rosgen C4*
3	3.95	321	1268.0			
4	9.38	207	1942.4			
5	8.68	255	2214.3			
6	7.37	357	2629.9			
7			0.0			
8			0.0			
9			0.0			
10			0.0			
		1662	10409.6 Total Area			

$E = [A_E * R_{LR} * D_B]/2000$

108.8	tons/year	Bank erosion rate at sampled reach
345.58	tons/mile/year	Bank erosion rate per mile
1814.31	tons/year	Total erosion from segment per year
68.7	tons/year	Target erosion rate at sampled reach
218.26	tons/mile/year	Target bank erosion rate per mile
1145.88	tons/year	Target total erosion from segment per year

127.32 tons/mile/year *Load Reduction achieved if restored to functioning C4*

36.84 Percent Reduction

Slope Heights

Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6
4.5	3.5	3.9	11.5	15.5	8.2
4.7	3.2	3.9	12.2	17.5	6.4
3.5	2.9	3.7	8.9	3.2	5.5
3.2	4.3	4.1	9.7	2.8	8.1
4.1	8.3	4.3	5.4	5.6	8.1
4.8	7.6	3.8	8.6	7.5	7.9

Appendix N. C.J. Strike Reservoir Total Maximum Daily Load Modeling Report

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Subject 1995 C.J. Strike Reservoir Model Simulations using Draft Subbasin Assessment Target of 75 ug/L

IDAHO POWER
An IDACORP Company

From Brian Hoelscher, Idaho Power Company
Jack Harrison, HyQual
Michael Kasch, HDR
Scott Wells, Portland State University (QC)

Memorandum

Date September 27, 2004

A total phosphorus (TP) target of 75 ug/L has been proposed for the Snake River (above C.J. Strike Reservoir) as part of the King Hill-C.J. Strike Reservoir TMDL (currently being developed). This TP target is being established to address a number of water quality problems in the Snake River related to excess nutrient levels, including the following:

- Nuisance algal conditions (water column and attached) that negatively affect recreational use, including swimming and boating
- Excess organic matter in sediments and subsequent oxygen demand reducing support of aquatic biota
- Potential toxic algal blooms similar to those that have occurred in other areas of Idaho where blue-green algal problems exist
- Production of macrophytes that drift downstream and results on organic matter loads on the reservoir downstream

Additionally, the Idaho Division of Environmental Quality (DEQ) is also proposing a “nutrient-related” dissolved oxygen (DO) allocation for C.J. Strike Reservoir. The intent of the DO allocation is to provide additional Reservoir water quality improvements beyond those that would occur by addressing nutrient related problems upstream. The DO allocation is directed toward increasing DO in the metalimnion.

In this memorandum, we compare the response of the 1995 C.J. Strike Reservoir Model (Harrison, et al, 2004) to the following conditions:

- TP Target—**Short-term improvements** resulting from implementation of the 75 ug/L TP target for the upstream Snake River.
- Improved Sediment Oxygen Demand (SOD) with TP Target—**Long-term water quality improvements**, including reduction in SOD resulting from implementation of TP target.

Methods

To simulate the TP target, we reduced dissolved phosphorus and organic phosphorus (i.e. organic matter, including algae) for the 1995 baseline boundary conditions such that inflowing phosphorus levels did not exceed 75 ug/L (see Attachment A). The DO boundary condition was modified such that DO does not drop below 6 mg/L (Attachment B). Finally, SOD improvements were simulated by replacing baseline SOD values estimated during model optimization with representative values of system with less organic matter loading (see Attachment C).

To facilitate analyses, C.J. Strike Reservoir was divided into three zones: riverine, transition, and lacustrine (Harrison, 2004). The lacustrine zone was further divided into three strata typical of stratified lakes and reservoirs: epilimnion, metalimnion, and hypolimnion (Wetzel, 2001). The locations of these zones are shown in Attachment D.

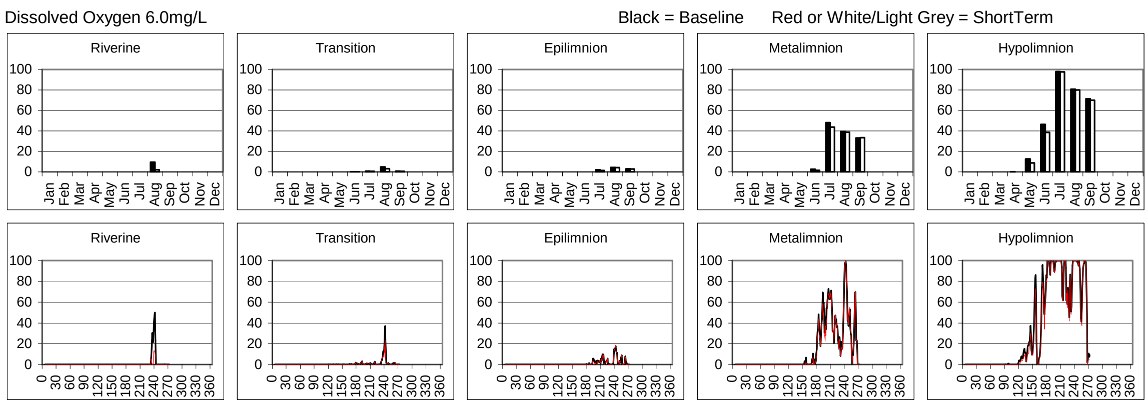
Changes in DO levels from each of the simulations were compared to baseline conditions using two methods: Comparison with DO Criteria and Volume-Weighted DO. Baseline conditions are represented by the C.J. Strike Model using 1995 measured boundary conditions and optimized to measured in-reservoir water quality data (Harrison, et al, 2004).

For each time-step, the DO in each cell is compared to the DO criteria of 6.0 mg/L, as proposed in the draft Subbasin Assessment (IDEQ, 2004). If the value was below the criteria, the volume of the cell is added to the “low” volume for its respective zone. The results are then averaged for daily and monthly output. The percent below the criteria is then calculated by dividing the volume below the criteria by the total volume of the zone.

Volume-weighted DO was calculated for the Reservoir and the five zones. The model simulates a DO value for each cell in the model grid. These values were weighted by the volume of the model cell and averaged. The volume-weighted DO calculated for baseline are compared to the simulations for improved conditions and provided in Attachment E.

Simulation Results

Short-Term Improvements: TP Target
This simulation shows C.J. Strike Reservoir’s initial response to reductions in TP and organic matter loads based on the TP target of 75 ug/L (Figure 1). When the TMDL is first implemented, SOD will be unchanged from baseline conditions. This limits the initial level of improvement (i.e., increase in DO) in the downstream end of the transition zone and in the lacustrine zone where SOD levels are highest.



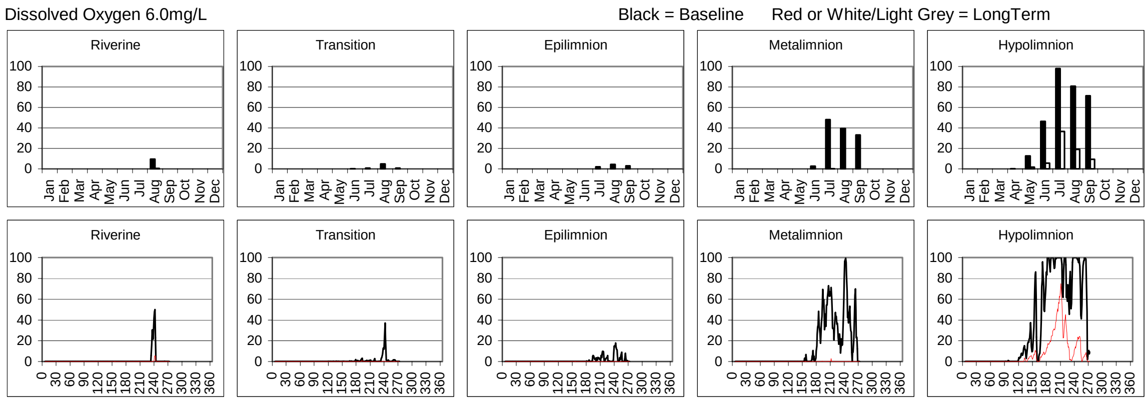
Y-Axis is percent of zone/strata volume below 6 mg/L, X-Axis is Julian day.

Figure 1. Percent of volume below 6 mg/L after short-term improvement resulting from implementation of the 75 ug/L TP target for the Upstream Snake River. Dark line shows percent DO below criteria (6.0 mg/L) for Baseline and light (red) line shows percent DO after TP target implementation.

Long-Term Improvements: Improved SOD with TP Target

Sediment oxygen demand (SOD) is caused by decay of organic matter in bottom sediments. Factors that affect SOD include water temperature (Cole and Wells, 2002) and oxygen content of overlaying waters, and organic matter content sediments (Chapra, 1997). SOD values can range from 0.05 g $m^{-2}d^{-1}$ for mineral soils to 10 g $m^{-2}d^{-1}$ in heavily loaded areas such as near sewage outfalls (Chapra 1997). This is somewhat broader than the range of 0.3 to 5.8 g $m^{-2}d^{-1}$ given in the CE-QUAL-W2 Users Manual (Cole and Wells 2002).

Once the TMDL is implemented, it is anticipated that organic matter loads and sedimentation will decrease. As the loads decrease and existing organic matter decays through natural processes, SOD will decrease. The response to these long-term improvements was simulated by reducing SOD to 0.1 g m^{-2} day^{-1} throughout the Reservoir (Figure 2). This SOD is more typical of levels observed in mineral soils (Chapra 1997). The inflowing boundary conditions are unchanged from the short-term simulation as presented above.



Y-Axis is percent of zone/strata volume below 6 mg/L, X-Axis is Julian day. Metalimnion has a small spike about Julian day 220.

Figure 2. Percent of volume below 6 mg/L after long-term improvements resulting from implementation of the 75 ug/L TP target for the Upstream Snake River and resulting decrease in SOD to 0.1 g m^{-2} day^{-1}. Dark line shows percent DO below criteria (6.0 mg/L) for Baseline and light (red) line shows percent DO with SOD improvement.

The simulation results, as shown above, demonstrate improving conditions from short-term conditions without SOD improvements to long-term conditions with SOD improvements. In general, the simulations show an increase in DO in all zones. The DO improvement is greatest in the metalimnion and hypolimnion.

DO below Criteria with Long-Term Improvements

The mass of DO below the criteria of 6 mg/L with long-term improvements was calculated (Attachment F) to determine DO needed to meet the DO criteria in the metalimnion. The long-term results show a DO mass of 2.2 tons/yr is below the 6 mg/L criteria assuming:

1. Inflow loads are reduced to meet the 0.075 mg/L TP target
2. DO inflow concentrations (e.g. the Snake River boundary conditions) do not fall below 6 mg/L
3. SOD improves over the long-term resulting in a sediment oxygen demand of 0.1 g/m3/day

Conclusions and Recommendations

These simulations show substantial improvements in water quality in C.J. Strike Reservoir will occur through implementation of the 75 ug/L TP target proposed for the upstream Snake River after SOD reductions occur (Figure 2). Preliminary simulation results indicate the additional oxygen (approximately 2.2 tons oxygen·yr^{-1}) could further improve DO levels in the metalimnion and increase likelihood of meeting the reservoir DO criteria (6 mg/L) established by Idaho.

References

Chapra, S.C. 1997. Surface Water-Quality Modeling. McGraw-Hill, New York, NY. 844 p.

Cole, T. and S. Wells. 2002. CE-QUAL-W2: A Two Dimensional, Laterally Average, Hydrodynamic and Water Quality Model, Version 3.1. User Manual. Instruction Report EL-02-1. U.S. Army Corp of Engineers. August 2002.

Harrison, J.R. 2004. Memorandum on C.J. Strike Reservoir Zones. Memo to Idaho Power Company.

Harrison, J.R., M.S. Kasch, and S.A. Wells. 2004. C.J. Strike Reservoir CE-QUAL-W2 Water Quality Modeling. Status report to Idaho Power Company.

IDEQ. 2004. Draft Subbasin Assessment for C.J. Strike Reservoir. IDEQ.

Wetzel, R. 2001. Limnology, Lake and River Ecosystems. Academic Press, San Diego, CA.

Attachment A – TP boundary condition (TP less than 75 ug/L)

The baseline boundary condition was developed based on Idaho Power Company (IPC) data as documented in the Water Quality Modeling Report (Harrison, et al, 2004). The reduced boundary condition (Figure A-1) was calculated as follows:

- Calculate total organic matter (TOM) as the sum of LDOM, RDOM, LPOM, RPOM, and Algae
- Calculate organic phosphorus (OP) as TOM divided by 50
- Calculate total phosphorus (TP) as the sum of PO4 and OP
- Find the maximum TP value in the time series
- Divide the target, 75 ug/L by the maximum TP to find the percentage
- Multiply the PO4, LDOM, RDOM, LPOM, RPOM, and Algae in the baseline boundary condition by the percentage to create the reduced boundary condition

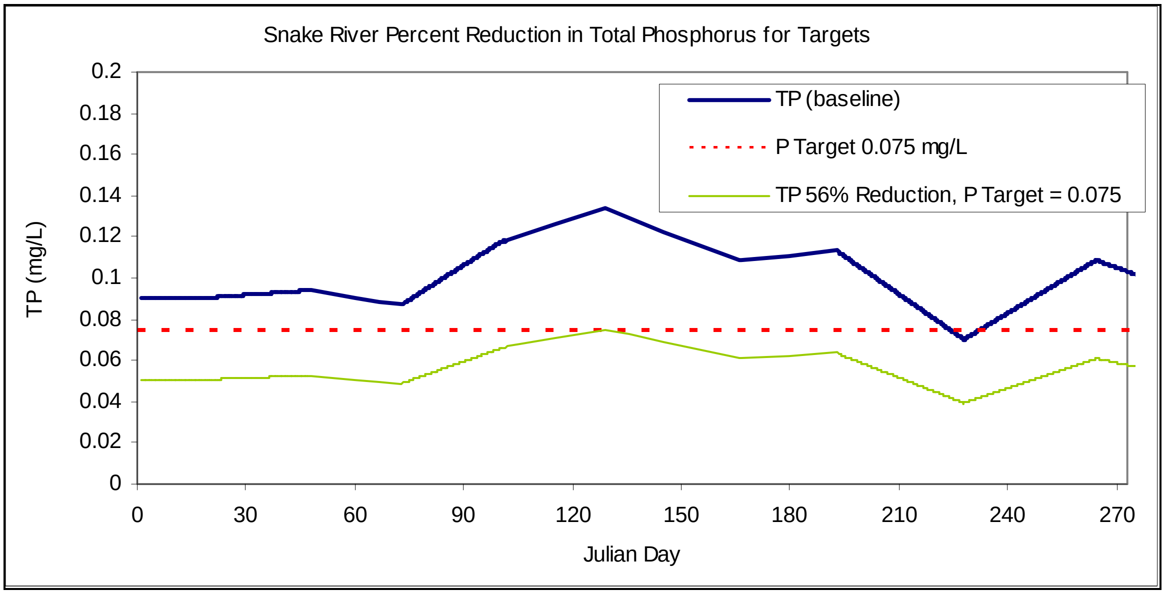
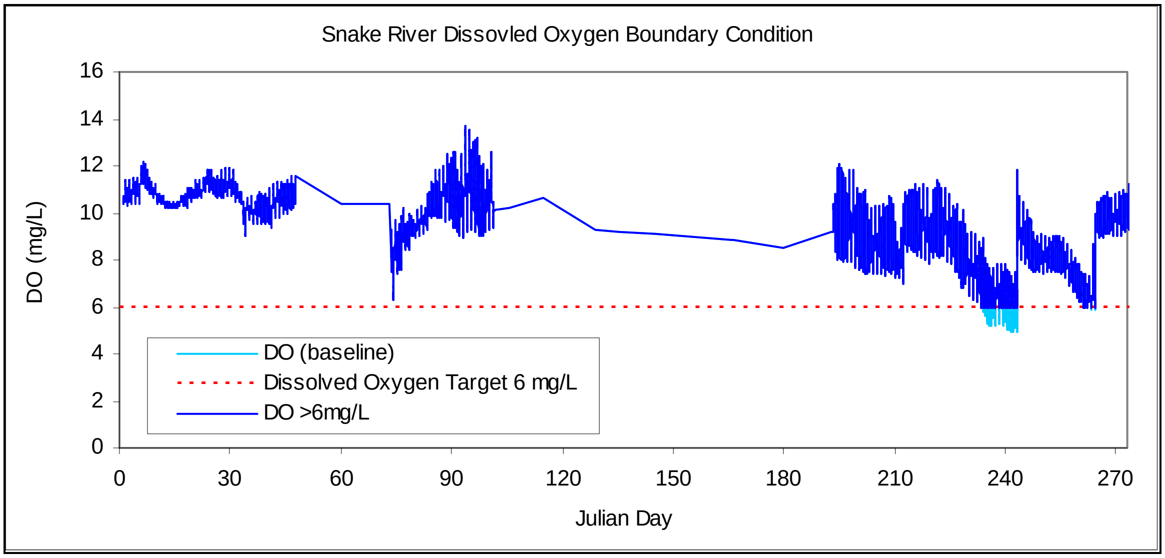


Figure A-1. Snake River Total Phosphorus Reductions

The model boundary conditions and period extends to September 30th. Reservoir profiles, used to optimization kinetic coefficients, are not available after this time. The March through September data are included in this period when temperature and sunlight drive the highest levels of organic matter production and nutrient processing. The January and February data are need to initiate model simulations.

Attachment B – DO Boundary Condition



The short-term and long-term improvements assumed that the inflowing DO would meet the criteria of 6 mg/L.

Attachment C – Optimized Sediment Oxygen Demand

The zero-order model used in the C.J. Strike Reservoir application of CE-QUAL-W2 was set during model optimization based on measured DO levels near the bottom sediment. The optimized (baseline) SOD values (g $m^{-2}d^{-1}$) for each segment, including the Bruneau Arm, are:

S DEMAND	SOD	SOD	SOD	SOD	SOD	SOD	SOD	SOD	SOD
	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	0.50	0.50	0.50	0.50	0.50	0.50	0.60	0.70	0.80
	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	0.50	0.50	0.50	0.50	0.50	0.50			

In the optimized model, a multiplier (FSOD) was used to increase each SOD by a factor of 5, resulting in a variable maximum SOD ranging for 2.5 to 5.0 g $m^{-2}d^{-1}$. The rate applied during the model run is also a function of temperate, as shown in Table C-1. SOD for a FSOD of 1 would range from 0.14 to 0.28 g $m^{-2}d^{-1}$ at 10^{o}C.

Table C-1. SOD for Various Water Temperatures

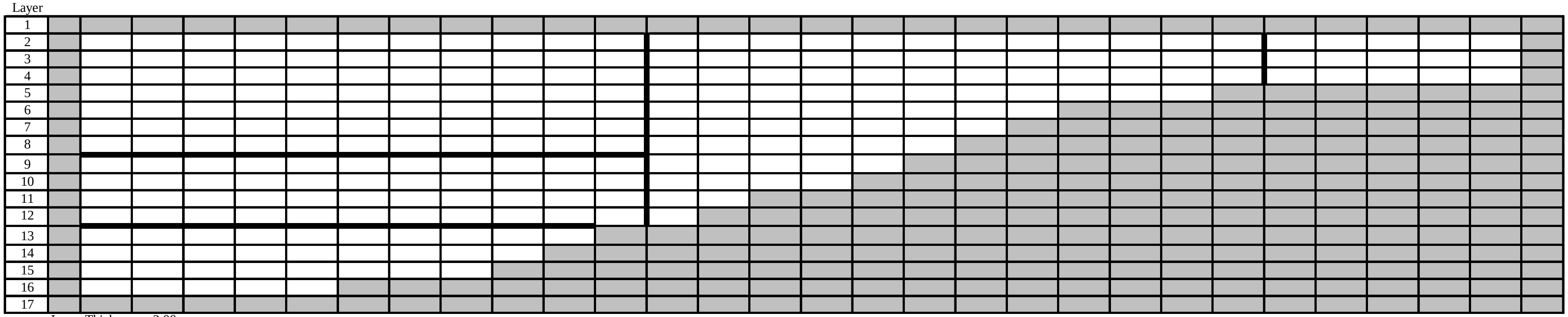
	SOD	SOD at various temperatures		
Segment	Maximun	5	10	15
Snake River	g O2 / m2-day	g O2 / m2-day	g O2 / m2-day	g O2 / m2-day
2	2.5	0.25	0.70	1.14
3	2.5	0.25	0.70	1.14
4	2.5	0.25	0.70	1.14
5	2.5	0.25	0.70	1.14
6	2.5	0.25	0.70	1.14
7	2.5	0.25	0.70	1.14
8	2.5	0.25	0.70	1.14
9	2.5	0.25	0.70	1.14
10	2.5	0.25	0.70	1.14
11	2.5	0.25	0.70	1.14
12	2.5	0.25	0.70	1.14
13	2.5	0.25	0.70	1.14
14	2.5	0.25	0.70	1.14
15	2.5	0.25	0.70	1.14
16	3	0.30	0.83	1.37
17	3.5	0.35	0.97	1.60
18	4	0.40	1.11	1.82
19	4.5	0.45	1.25	2.05
20	5	0.50	1.39	2.28
21	5	0.50	1.39	2.28
22	5	0.50	1.39	2.28
23	5	0.50	1.39	2.28
24	5	0.50	1.39	2.28
25	5	0.50	1.39	2.28
26	5	0.50	1.39	2.28
27	5	0.50	1.39	2.28
28	2.5	0.25	0.70	1.14
29	2.5	0.25	0.70	1.14

Attachment D – C.J. Strike Reservoir Zones and Strata

- Snake River

RM beginnin		494	495	496	497	498	499	499	500	500	501	501	502	503	504	505	506	506	507	508	509	510	511	512	513	513	514	516	518	520
egment	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Length:	0.0	2414.0	1609.3	1609.3	841.2	847.3	911.4	992.1	681.2	940.3	1040.9	1152.1	1444.8	1281.7	1249.7	1543.8	752.9	888.5	1609.3	1609.3	1609.3	1609.3	1609.3	1609.3	720.9	923.5	4252.0	3223.3	3223.3	

Layer

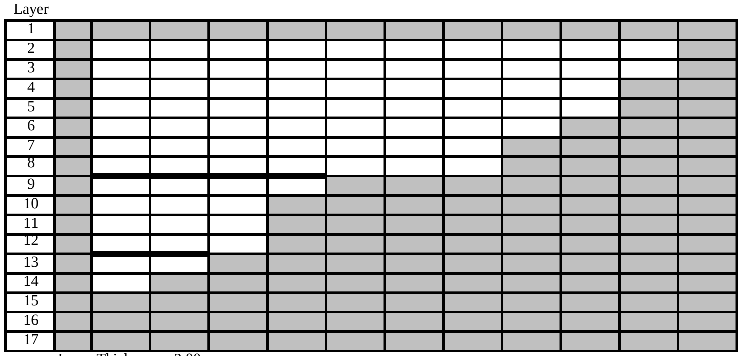


Layer Thickness = 2.00 m

Bruneau Arm

RM beginnin		0	0.6	1.0	1.6	2.5	3.3	4.0	5.0	6.0	6.7	7.4
egment	42	41	40	39	38	37	36	35	34	33	32	31
Length:		969.3	640.1	966.2	1379.2	1379.2	1103.4	1609.3	1609.3	1050	1219.2	

Layer



Layer Thickness = 2.00 m

Proposed

Zone Limits (rm)	Begin	End
Riverine	520	513
Transition	513	502
Lacustrine	502	494

Strata Limits (ft-msl)	Top		Depth to top	
	ft	m	ft	m
Epilimnion	2455	748.3	0	0.0
Metalimnion	2415	736.1	40	12.2
Hypolimnion	2390	728.5	65	19.8

Elevations (msl)	Feet	Meters
Normal maximum pool	2455	748.3
Penstock top	2436	742.5
Penstock centerline	2431	741.0
Penstock bottom	2425	739.1
Reservoir bottom	2316	705.9
Depths (from NMP elevation)		
Maximum depth	139	42.4
Penstock top	19	5.8
Penstock centerline	24	7.3
Penstock bottom	30	9.1

Attachment E – Volume Weighted DO Results

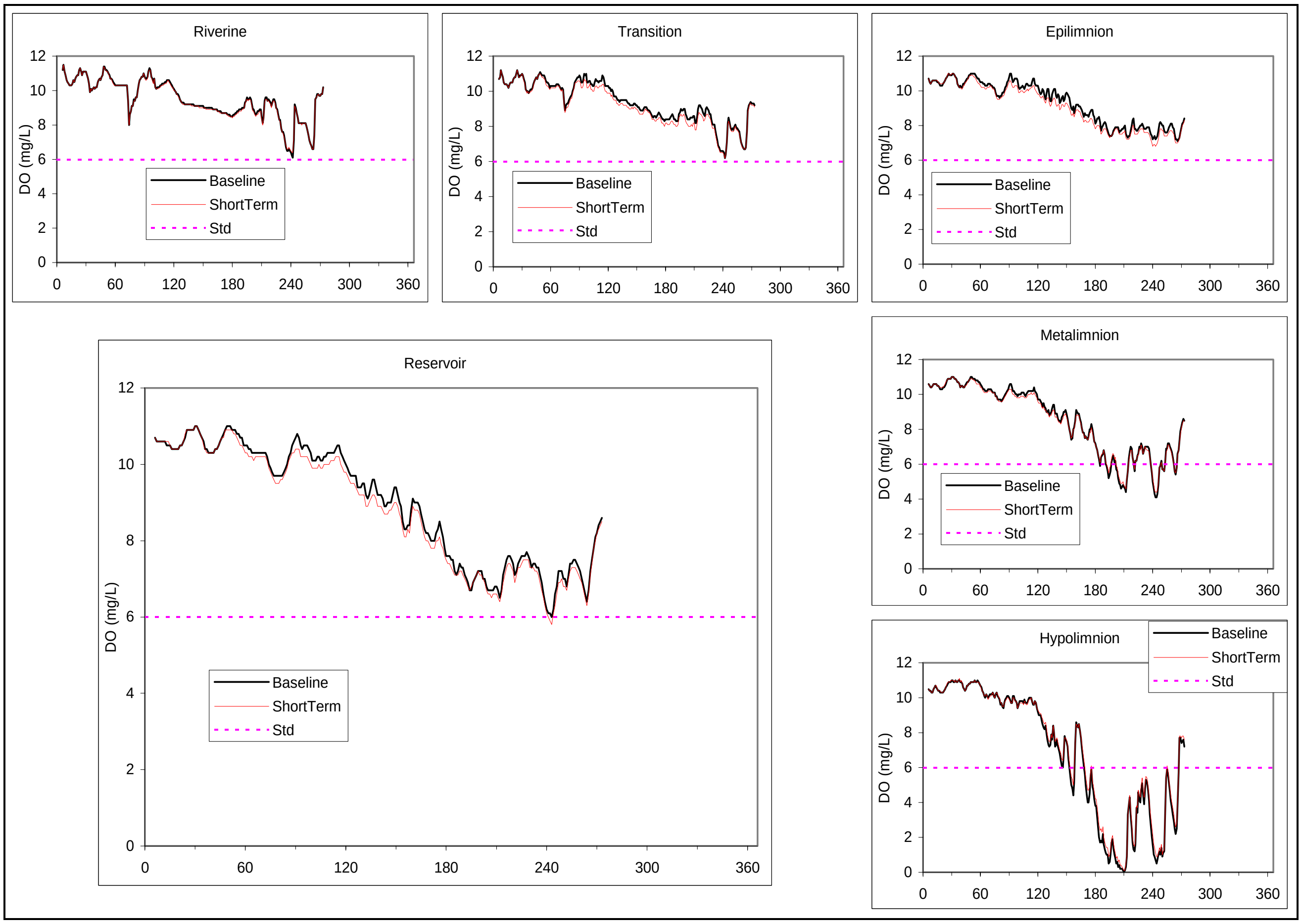


Figure E-1. Simulation results showing short-term improvement resulting from implementation of the 75 ug/L TP target for the Upstream Snake River. Dark line shows volume weighted DO for Baseline and light line shows TP target.

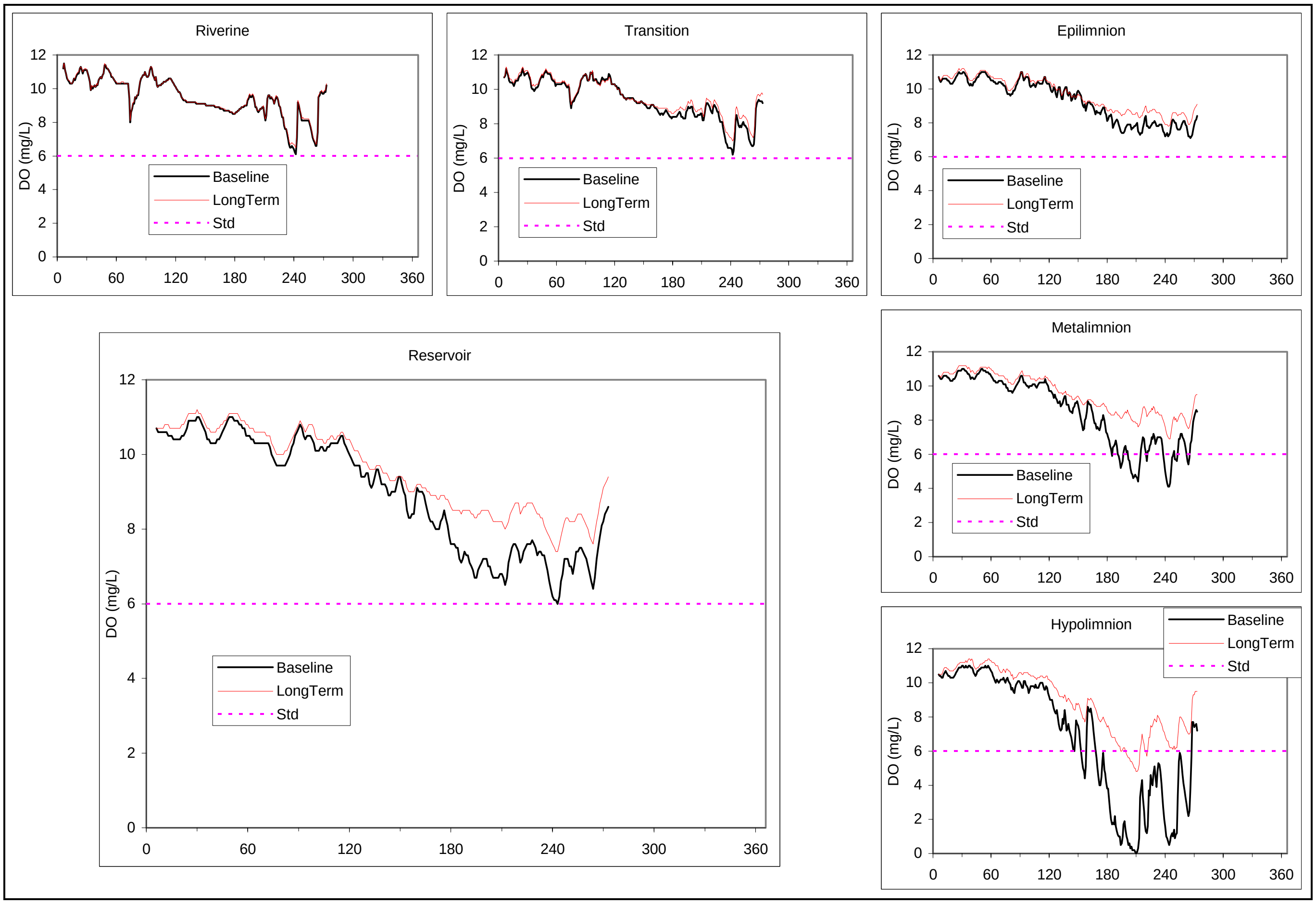


Figure E-2. Simulation results showing long-term improvement resulting from implementation of the 75 ug/L TP target for the Upstream Snake River and resulting decrease in SOD. Dark line shows volume weighted DO for Baseline and light line shows TP target with SOD improvement.

Attachment F – Estimation of DO Needed to Meet Target

The volume of the DO below a criteria of 6 mg/L was calculated and used to estimate the mass of DO below 6 mg/L in the metalimnion of C.J. Strike Reservoir. The process involves checking the DO concentration in each cell of the model within the metalimnion and comparing the concentration to the criteria. If the DO concentration is below the criteria, then the volume is summed.

The volume below the DO criteria DO was calculated at 0.5 mg/L increments. The volume difference between each increment is the volume below the different DO concentrations. An example is shown in Table F-1. The volume of DO below the concentration increments is shown in Figure F-1.

Table F-1. Incremental DO Volume Differences July 31,1995 C.J. Strike Metalimnion

DO Conc. (mg/L)	Long-Term (SOD 0.1)	
	Volume Below Conc. (ac-ft)	**Difference (ac-ft)**
6.0	892.7	686.2
5.5	206.5	116.29
5.0	90.21	90.2
4.5	0	0

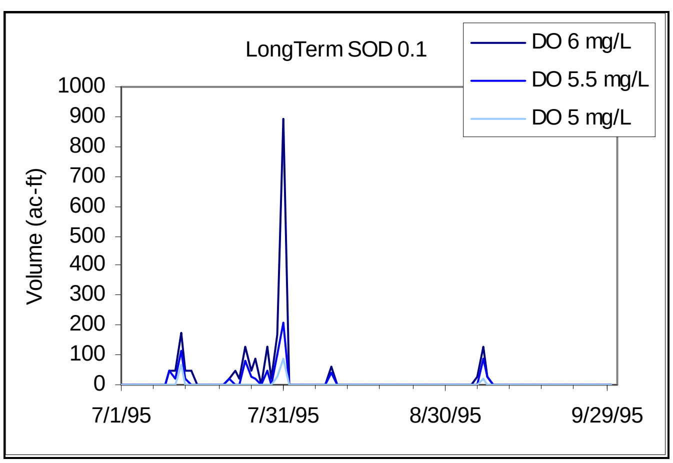


Figure F-1. Metalimnion Volume of DO below each Concentration Increment (ac-ft) for Long-Term (SOD 0.1)

Using this method the DO mass in the epilimnion below the 6 mg/L criteria was estimated for model simulations by multiplying the volume by the DO of increment (i.e., 6, 5.5 and so on). This was then converted to mass of DO in tons per year, with the process applied to various model simulations (Table F-2).

Table F-2. Estimate of C.J. Strike DO Mass

Simulation	Mass of DO (tons/yr)
Baseline	789
Short-Term	750
Baseline (SOD 0.1)	48
Long-Term (SOD 0.1)	2.2
Long-Term (SOD 0.1) with Metalimnion extended down 2m	14.8

Appendix O. Public Comments and Responses

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Comments From: US Environmental Protection Agency Received via email: December 10, 2004	Response
41 Several undesignated streams in Table 13 are identified in Figure 6 and in discussion on pp. 84 – 106 as containing redband trout, including young of the year. As a result, we believe that Table 13 should reflect salmonid spawning as an existing use in Bennett, Cold Springs, Little Canyon, and Ryegrass creeks.	Table 13 will be modified to include Salmonid Spawning as an existing use in Bennett Creek, Cold Springs Creek, and Little Canyon Creek. The stream specific discussions for each of these streams show that salmonid spawning is fully supported.
47 Pesticides discussion. In this discussion, it might help to identify and discuss the specific pesticides of concern in CJ Strike Reservoir.	DDT and dieldrin will be identified in the primary pesticides of concern discussion on page 47. Additional information for each pesticide is located in the pesticides loading analysis.
54, 123, 168 Target flow condition. A Snake River flow of 11,407 cfs was used to develop the sediment and nutrient TMDLs for the Snake River and CJ Strike Reservoir, because it is an average flow representative of the expected flow range. However, for nutrients, average flow years are not the most critical conditions. Low flow years, or a series of low flow years are more critical for nutrient/algae/DO problems. The TMDL should evaluate alternative low flow scenarios in order to ensure the nutrient TMDL will be protective during these periods.	DEQ agrees that for nutrients average flow years are not always the most critical. However, while the derivation of 11,407 cfs as the target flow is mathematically based (Figures 17 & 18), the underlying intent was to develop a flow target in a manner similar to other nutrient TMDLs in the Snake River (Mid Snake, Mid Snake/Succor, and Snake River-Hells Canyon TMDLs all use a similar method to determine a target flow).
56 Substrate sediment will be further assessed “when the chance arises”. Given the importance of substrate sediment both in terms of direct impacts to fish spawning and indirect effects exacerbating macrophyte growth, a more definitive plan to assess substrate sediment conditions would appear to be warranted. Perhaps this is something which could be addressed in more detail in development of the implementation plan.	Unfortunately, the necessary time and data were not available to fully address this issue in the TMDL. However, DEQ agrees that a more definitive strategy to address the substrate sediment issue is necessary. The intent is to identify these details in the TMDL implementation plan.
65, 83, 153 We strongly support the need for additional substrate sediment work after high flow years in order to establish a baseline sediment conditions. We also think that surveys of sediment conditions pre-high flow years are important, in order to quantify the before-after effect high flows have on deposited sediment. In addition, it might be useful to evaluate the extent to which other factors are also limiting macrophyte growth post-high flow events. EPA would be interested in working collaboratively on such a research project.	DEQ agrees with this comment and will seek input from EPA during development of the TMDL implementation plan to identify possible sources of funding and technical expertise.

66 We believe IDEQs choice to write a protective sediment TMDL for the Snake River at this time is a good one. While it may be possible to justify not writing a TMDL, sediment is clearly a major issue in terms of nutrient loading, and we support limiting sediment increases to the system until these issues are better understood.	Comment noted.
68, 170 Phosphorus target. Please clarify whether the 0.075 mg/l target is intended to apply at any time (instantaneously), or whether some averaging period is to be used, e.g. daily, weekly, monthly.	The 0.075 mg/L total phosphorus target is intended to be an instantaneous target. The target discussion on Page 68 will be clarified to make this clear.
76 While it is clear that the Glenns Ferry WWTP nutrient load is very low compared to the current load in the Snake River, given the high effluent TP concentration, has IDEQ evaluated whether there are any localized adverse impacts from the outfall such as DO sags, periphyton or macrophyte growth? If such impacts exist, they may warrant further nutrient reductions than may otherwise be needed to achieve targets in the Snake River.	The City of Glenns Ferry WWTP impact analysis did not include a direct evaluation of localized impacts. The analysis only evaluated the increase in river load due to plant operations (Appendix J). This increase is conservatively estimated to be 0.0006 mg/L, which is well below the laboratory detection limit for total phosphorus. While some level of increased localized aquatic plant growth may be attributed to these nutrients, it is unlikely that the increase would further impair beneficial uses. In addition, the facility currently has an NPDES permit (#ID-002200-4) allowing the discharge total phosphorus to the river.
76 Nutrient surrogates. We agree with using total phosphorus, DO and chlorophyll-a as targets or surrogates for the TMDL. However, we think some consideration should be given to setting a macrophyte target as well, since macrophytes appear to be the factor most directly impairing recreational uses.	DEQ considered establishing a macrophyte target as part of the TMDL. However, with the available data the determination of a baseline macrophyte condition was not readily achievable. It may be possible to establish such a target as part of the TMDL implementation plan, and more specifically, as part of the additional substrate sediment work described above. DEQ sees EPA as a possible source of funding and technical expertise for this project.
77 Chlorophyll-a targets. It is not clear from the discussion how the target of 30% exceedance of 30ug/l chlorophyll-a was derived, particularly given the growing season mean target of 14 ug/l. Please further explain how this portion of the target was derived, and how this target will ensure nuisance algae levels will be prevented.	The use of “30% exceedance” is a typographic error. The allowable exceedance should be 25%. This bullet will be corrected on page 77. These targets were in part derived based on the rationale outlined in the Snake River-Hells Canyon TMDL, where literature showed that frequency exceedances of 30 ug/l for up to 25% of the time were protective for recreational uses.

151 Pollutant source inventory. CAFOs and stormwater should also be identified as point sources within the watershed. The Department of Agriculture should be able to provide a list of regulated CAFOs in the watershed, and these should receive a WLA in the TMDL. The only stormwater discharges in the subbasin required to have NPDES permit coverage at this time are construction and industrial sources. These should also be assigned a WLA in the TMDLs.	Using GIS coverage provided by the Department of Agriculture, DEQ identified the placement of CAFOs in the HUC. There are no active CAFOs located within loading distance of the 303(d) listed segments. The CAFOs that are active are located on the rim above C.J. Strike Reservoir and do not contribute a pollutant load to the reservoir. Thus, DEQ does not believe that these operations are candidates for wasteload allocations. The City of Glenns Ferry is not identified as a Phase I or II NPDES community for storm water permitting, nor is storm water a factor in pollutant loading within the watershed.
153 Revisions to the TMDL. We appreciate the discussion of additional data collection to fill data gaps, and that minor changes to the TMDL could appropriately be handled as addenda. However, we want to clarify that if changes to the TMDL involve revisions to the targets, load capacity or allocations, EPA would need to review and approve such changes.	Comment noted.
170 Reserve for growth. The discussion in the second paragraph is not clear. If nutrients currently exceed the load capacity, then including a 5% reserve for growth would appear to be less conservative than including a 10% reserve for growth.	DEQ agrees that this section is not clear and will revise the reserve for growth discussion. However, increasing the reserve for growth to 10% does not necessarily make the TMDL more conservative. It simply allows for even more growth, and uncertainty, than a 5% reserve. Either way, the river can eventually be loaded back to 1992 kg/day, which is the load capacity minus the MOS.
171 Glenns Ferry WWTP nutrient WLA. We agree that the WLA should be revised once better data is collected to characterize phosphorus levels. Revising the WLA is the type of change which would necessitate EPA review and approval, per the comment on p. 153.	Comment noted.
172 Reservoir simulation. Total phosphorus and DO upstream boundary conditions were established for the simulations. It is not clear what assumptions were made regarding upstream BOD loading, e.g. the mass of macrophytes which is carried into the reservoir. This would appear to be a significant source of BOD loading which would effect hypolimnion and metalimnion DO and sediment oxygen demand.	While the CE-QUAL-W2 model does not explicitly model macrophytes, stoichiometric proportions of the incoming coarse organic matter were calculated as part of the total organic matter in the model using the chlorophyll-ά and nitrogen data. The total organic matter stoichiometric relationship is summarized in Attachment A of Appendix N and used further ratios, including:

Please clarify how this source was accounted for in the modeling.	• chlorophyll-ά/C = 3% • C/OM = 45% • chlorophyll-ά/om = 1.4% From monitoring data, the organic nitrogen/organic carbon ratios ranged from 5 to 9 throughout the reservoir. The total organic matter was then partitioned into dissolved organic matter, particulate organic matter, and coarse particulate organic matter. Idaho Power Company is working to better characterize the coarse organic matter representing detached instream macrophytic mats, which could not be sampled by traditional methods. Preliminary results show potential oxygen demand from macrophytes can create an oxygen demand of about 4 tons per day in June. Horizontal velocities and nutrient data throughout the reservoir indicate that this additional nutrient load is dropped to the bottom of the reservoir in the transition zone, and remains there during the stratification period lasting approximately from May through October. Therefore, this heavy BOD loading contributes mainly to the reservoir sediment oxygen demand and only secondarily to the water column oxygen demand.
The TMDL indicates that for the long term simulation, an assumption is made that sediment oxygen demand (SOD) in the reservoir reaches a long term baseline representing naturally occurring SOD levels (0.1 g/m^3/day). This level is typical of mineral soils, and less than the range identified in the CE-QUAL-W2 Users Manual (0.3 g/m^3/day). What is the basis for assuming that this level of SOD will be achieved in the future? Given the discussion earlier in the document that reservoirs inherently are more nutrient enriched than natural lakes, and the fact that the nutrient TMDL will have little effect on macrophyte growth, and macrophytes appear to provide a significant source of BOD loading, such an assumption would not appear to be realistic.	Idaho Power consultants developed the CE-QUAL-W2 model based on SOD = 0.1 g/m^3/day as a standard value used by developers of the model in the absence of other data or literature values. Although the model of current conditions in the C.J. Strike Reservoir shows that SOD ranges from 2.5 to 5.0 g/m^3/day in different segments of the reservoir, there were no literature values found to show a "clean" eutrophic SOD value for a reservoir condition with no dissolved oxygen depletions in the metalimnion. Sediment oxygen demand of 0.1 g/m^3/day was used to model the Brownlee Reservoir in the Snake River-Hells Canyon TMDL. Since this TMDL had gone through extensive development and public comment, the CE-QUAL-W2 model developers were reluctant to assign another value in the absence of target reservoir SOD values from the literature. Upon requests from DEQ to change the SOD value from 0.1 g/m^3/day, the consultants ran a sensitivity

	analysis for three SOD ranges with the corresponding number of days that dissolved oxygen falls below the criteria of 6.0 mg/L in the metalimnion: • SOD of 0.05 – 0.1 g/m^3/day = 19 days DO violations • SOD of 0.25-0.5 g/m^3/day = 31 days DO violations • SOD of 0.5-1.0 g/m^3/day = 48 days DO violations The sensitivity analysis does show sensitivity to changes in SOD. However, until further monitoring of reservoir SOD in the literature shows the value that will exist in a reservoir that fully supports beneficial uses, we will not know the target SOD value.
175 Allocations. To simplify how the allocations are presented you might consider combining Tables 46 and 47 into one table. In addition to the gross NPS allocations shown in these tables, specific allocations should be included for other point sources including CAFOs and stormwater.	The data analysis presented in the subbasin assessment is structured into an analysis of the tributaries, and analysis of the river, and an analysis of the reservoir. To remain consistent with this format, DEQ chose to separate the allocation tables. See comment above regarding CAFOs. There are no NPDES permitted storm water sources in the HUC, as such no storm water WLAs are necessary. Furthermore, storm water is not an issue in terms of non-point pollutant loading in the watershed
It is not clear who receives the allocation to increase dissolved oxygen by 2.2 tons/year. We assume this is assigned to Idaho Power as the operator of the dam, but this should be specified, and included as a specific allocation in the table. We agree that there may be options for achieving this increase in dissolved oxygen, and the TMDL suggests that equivalent reductions in total phosphorus or organic matter loading could be used to achieve these increases. However, given that a TP level of 0.050 mg/l showed very little improvement in DO conditions in the reservoir compared to 0.075 mg/l (p. 171), we wonder how realistic this option might be. For clarity, we recommend that specific total phosphorus and organic matter loading which would achieve the 2.2 ton/year DO increase be identified.	The 2.2 tons/year dissolved oxygen allocation is a gross allocation. Without being explicitly stated in the TMDL, the expectation is that Idaho Power Company will facilitate meeting the allocation via the TMDL implementation plan. The TMDL states *"It should be noted that the direct oxygenation of the metalimnion is not required. The additional 2.2 tons/year can be accomplished through equivalent reductions in total phosphorus or upstream organic matter, or other appropriate mechanisms that can be shown to result in the required improvement of dissolved oxygen in the metalimnion. Direct oxygenation can be used but should not be interpreted as the only mechanism available. Cost effectiveness of both reservoir and upstream BMP implementation should be considered in all implementation projects."* This statement infers that upstream BMPs resulting in a decrease in organic matter will aid in achieving the additional

	2.2 tons/year DO, regardless of who installs the BMPs.
177 Implementation strategy and plan. In general the discussion of implementation is very well done. Regarding the list of "designated agencies" on p. 177, BLM would seem to be a key agency to identify, given their significant land management responsibilities within the subbasin.	The bulleted "designated agencies" list shown on page 177 is a list of state agencies. The federal partnerships key to TMDL implementation are discussed in the paragraphs above, including the BLM.
Integrated Report (303(d)) Comments	
49, 105, 106, App F Intermittent streams. Intermittent streams and segments of Snake River tributaries are discussed on pp. 84 - 107 and in Appendix F. Discussion on p. 236 of Appendix F indicates that water quality standards only apply during times of optimum flow. However, the relevant portion of IDAPA 58.01.02.070.06 reads: "… *Numeric* water quality standards only apply to intermittent waters during optimum flow periods sufficient to support the uses for which the water body is designated. For recreation, the optimum flow is equal to or greater than five (5) cubic feet per second (cfs). For aquatic life uses, optimum flow is equal to or greater than one (1) cfs…"	For clarification, DEQ will revise the second paragraph on page 236 in (Appendix F) to say: "*IDAPA 58.01.02.070.07* states that water quality standards shall only apply to intermittent waters during optimum flow periods sufficient enough to support the beneficial uses for which the water body has been designated. The optimum flow for contact recreation is equal to or greater than five (5.0) cfs. The optimum flow for aquatic life is equal to or greater than one (1.0) cfs. <u>When streams fall below the optimum flow period, the narrative water quality standards may still apply."</u>
This provision makes it clear that numeric standards do not apply below optimum flow levels, however narrative standards, such as sediment, still apply to these waters even when flows are below optimum. As a result, in order to de-list such waters for a given pollutant, an evaluation of whether the pollutant is impairing beneficial uses is still needed, beyond simply establishing that the stream is intermittent.	DEQ has not documented water in the listed segments of Browns, Sailor, and Deadman Creeks. Additionally, local stakeholders (WAG members) have indicated that the streams often go years without water, only to flow during stochastic flow events. Given this information, DEQ feels an evaluation of whether sediment is impairing uses is not warranted and they should be candidates for de-listing without question.
We recognize the difficulty in assessing and writing TMDLs for such waters, and offer to have our relevant technical staff meet with you to discuss options for addressing these intermittent streams, and developing a basis for delisting or writing TMDLs.	DEQ appreciated EPA recognize the difficulty in assessing the beneficial use support status of streams that flow for a few weeks in the late winter and early spring, only to go dry later in the year. DEQ's current aquatic life support status surrogate, the Stream Macroinvertebrate Index (SMI) is not structured to detect a reduction in diversity and abundance due to flow, nor is DEQ aware of such a tool.

106 Several 303(d) listed tributaries or portions of tributaries are identified in Table 22 as having no impaired uses based on fish (redband) and substrate particle size information (Bennett, Cold Springs, and Little Canyon creeks), or substrate particle size information alone (Ryegrass, Alkali creeks). Concluding that beneficial uses are fully supported based on this information alone appears to be inconsistent with the flow chart in Figure 15 (p. 42) drawn from WBAG II Second Edition, which suggests that at least two complete indices (SMI, SHI, SFI) are needed to assess beneficial use support status. It is not clear that sufficient information is available to calculate two indices for these streams. It would appear that additional data or justification are warranted to support the beneficial use status calls.	Given the unpredictable flow regime and the difficulty of collecting data when water is present, DEQ used the best physical, chemical, and biological data available to perform the beneficial use support status analysis. Even so, in most cases the approach used to propose sediment de-listing or develop a sediment TMDL is more rigorous (from a sediment assessment standpoint) than the approach outlined in Figure 15. This is because the analysis focuses on sediment specifically, as opposed to using surrogate metrics that only detect impairment, not a specific pollutant. In all cases, substrate sediment data in the form of particle size distributions were available. These data are <u>directly</u> comparable to the <30% fines substrate sediment target. In some streams water column sediment data were available in addition to the substrate sediment data. Again, these data are <u>directly</u> comparable to 50/80 mg/L targets, lessening the uncertainty out of using surrogate measures to predict pollutant specific impairment. Where the data are available, DEQ prefers using pollutant specific data in lieu of surrogate measures. Additionally, the use of salmonid age class distribution data showing young of the year redband trout is a <u>direct</u> indicator of a fully supported cold water aquatic life community.
Comments From: Dorian Duffin and Susie Vader (WAG members) Received via email December 6, 2004	
We have the following comments on the King Hill-CJ Strike TMDL: 1. We support the .075 mg/l total phosphorus target and ask that you keep this level or make it more stringent. 2. River temperature is extremely important in controlling aquatic growth and we believe that a temperature TMDL needs to be established for the reach between King Hill and CJ Strike reservoir. 3. The phosphorus target has reserves built in for future long-term development. We would like to see some sort of limits or controls placed on this to	DEQ does not anticipate changing the total phosphorus target to something less stringent than 0.075 mg/L. DEQ agrees that water temperature is important in terms of aquatic plant growth. However, DEQ feels that sediment and nutrient levels play an even larger role in plant growth, and has addressed them in the TMDL. Since DEQ is legally compelled to first address the §303(d) listed pollutants, the agency feels it made the best effort possible given the time and resources available. This possibility will need to be addressed on a contributor by contributor basis and is beyond the scope of the TMDL process.

prevent a single future contributor from consuming all of the reserves.	
4. We feel the oxygen situation in CJ Strike needs to be further addressed and solutions implemented.	The TMDL shows that after the effects of long-term implementation are recognized the dissolved oxygen conditions in C.J. Strike Reservoir should meet the *Idaho Water Quality Standards and Wastewater Treatment Requirements*. Furthermore, the TMDL implementation plan will provide a monitoring mechanism to track changes in the C.J. Strike Reservoir dissolved oxygen conditions as management practices are implemented.
Thank you for the opportunity to comment.	DEQ appreciates the time and effort put into providing comments.

Comments From: Brian Hoelsher, Idaho Power Company **Received December 9, 2004**	
Idaho Power Company (IPC) appreciates the opportunity to comment on the draft King Hill-C.J. Strike Reservoir Subbasin Assessment and Total Maximum Daily Load (draft King Hill-C.J. Strike TMDL). We further appreciate the opportunity to work collaboratively with the Department of Environmental Quality (DEQ) both as a Watershed Advisory Group member and as a concerned stakeholder with interests served and affected by the Snake River. We believe the DEQ has appropriately identified pollutant sources in the draft King Hill-C.J. Strike TMDL and particularly compliment the DEQ on acknowledging substrate sediment in the Snake River and the effect of Snake River aquatic macrophytes on water quality in C.J. Strike Reservoir. We believe, however, the draft King Hill-C.J. Strike TMDL does not allocate nutrient loads accurately and fairly. IPC supports the watershed approach used to develop the draft King Hill-C.J. Strike TMDL as an appropriate mechanism to improve water quality of the Snake River. Implementation of controls and thus water quality improvements within a timely schedule can only occur if all identified pollutant sources are allocated an accurate and fair load. IPC is providing general comments relative to four aspects of the draft King Hill-C.J. Strike TMDL: the total phosphorus load and wasteload allocations, the total phosphorus reserve for growth, Snake River organic matter and IPC's load allocations for C.J. Strike Reservoir. We will then proceed to specific comments. **1. Total phosphorus load and wasteload allocations** IPC commends DEQ on an appropriate nutrient source analysis, yet believes the sources were not accurately and fairly allocated. The DEQ estimated tributaries increase the Snake River total phosphorus load, depending on river flows, from 1.0-2.5% (pg. 74), and the City of Glenns Ferry Wastewater Treatment Facility increases the Snake River total phosphorus load an additional 0.9% (pg. 75). [It must be noted that the Snake River is listed as impaired by nutrients and currently exceeds nutrient targets.] The DEQ concluded from this analysis that the increase in total phosphorus in the Snake River as a result of the tributaries and the	Comment noted. Additional responses to IPC's comments can be found below. By establishing a target concentration of 0.075 mg/L TP for the tributaries to the river, DEQ feels the stakeholders within those tributary subwatersheds are responsible for reductions. DEQ agrees that allocations within the watershed should be accurate and fair and attempted to develop allocations along those lines. The City of Glenns Ferry Wastewater Treatment Facility nutrient loading analysis was performed using extremely conservative assumptions (maximum design flow, an effluent concentration likely 2x actual levels, lowest flow on record in the Snake

City of Glenns Ferry are negligible (pg. 76) and their relative contribution is diminutive when compared to the overall river load (pg. 83). However, DEQ indicated that the chlorophyll-a concentration increased in the Snake River from King Hill to Indian Cove (Figure 36) and frequently exceeded the mean growing season target of 14 *µg*/L (Table 19). DEQ states it is likely that the *de minimus* increase in total phosphorus in the Snake River is in part balanced by the consumption of the nutrients by algae (pg. 74). [DEQ does not account for nutrients consumed by macrophytes and benthic algae as discussed below in Snake River organic matter.] The DEQ has, however, proposed a generalized no-net-increase allocation for the tributaries and not-to-exceed design capacity allocation for the City of Glenns Ferry Wastewater Treatment Facility (pg. 170 and Table 46). All other identified nutrient sources have loads calculated on a not to exceed 0.075 mg/L total phosphorus concentration. IPC believes any identified nutrient source that increases concentrations and loads above the target in impaired water, as determined by approved guidance and policy, warrants a load or wasteload allocation. IPC contends failure to appropriately allocate loads to these identified sources constrains the ability to attain water quality improvements in a timely schedule and unfairly saddles other stakeholders with the load. **2. Reserve for growth** IPC is not opposed to economic growth nor does IPC disagree with a reserve when pollutants are below existing standards or targets. IPC does, however, believe reserve for growth when a pollutant exceeds existing standards or targets should be by the advice of the Watershed Advisory Group. The DEQ states that waters are required to have total maximum daily loads (TMDLs) developed to bring them into compliance with water quality standards (pg. 35). Further, the DEQ states, "the TMDL analysis quantifies pollutant sources and allocates responsibility…to return listed waters to a condition **of meeting** water quality standards" (pg. 1). The DEQ has proposed a reserve for growth for both sediment and nutrients. Nutrients, however, currently exceed the draft King Hill-C.J. Strike TMDL target while water column sediment does not. IPC advocates an accurate and fair approach to water quality management in the watershed, and as such, does not support a reserve for growth when a pollutant exceeds the standard or target. Accounting for a reserve, when the pollutant	River). Even using these conservative assumptions, the estimated increase in the Snake River load was less than 1.0%. DEQ does not feel this increase attributes to localized degradation in beneficial uses. This approach is consistent with EPA's reasonable assurance analysis as part of the NPDES permitting process. Furthermore, DEQ states in the TMDL that if the Glenns Ferry Wastewater Treatment Facility exceeds its design capacity in the future, no additional nutrients may be discharged to the Snake River. The inclusion of a reserve for growth in the nutrient and sediment TMDLs should not be interpreted as allowing pollutant loading above the assimilative capacity of the river. The reserve for growth is calculated by removing the respective reserve load from the assimilative capacity load; as such water quality is fully protected. While the final decision to include a reserve for growth lies with DEQ, DEQ agrees that the decision should be made cooperatively with the stakeholders in the watershed. DEQ presented the draft total phosphorus allocations, including the reserve for growth component, to the King Hill-C.J. Strike Watershed Advisory Group and proceeded under the impression the reserve for growth was accepted. If the Watershed Advisory Group and other pertinent stakeholder within the watershed would like to reconsider the reserve for growth, this option can be discussed as part of the TMDL revision schedule in the forthcoming implementation plan.

exceeds standards or targets, requires water quality be ameliorated by existing watershed stakeholders for the benefit of future stakeholders.	
3. Snake River organic matter IPC commends DEQ for acknowledging the effect of Snake River aquatic macrophytes on water quality in C.J. Strike Reservoir, however, does not believe DEQ adequately evaluated the effect of macrophytes and benthic algae on the Snake River (pg. 74). IPC has recently been evaluating macrophytes and benthic algae in the Snake River inflow to C.J. Strike Reservoir. It has been estimated that the macrophyte total phosphorus load to C.J. Strike Reservoir is an additional 2-3% of the water column load. Total phosphorus estimates in macrophytes would be greater because sampling only accounted for macrophytes that had broken free and were available for transport. Falter et al. (1992) reported that attached benthic algae chlorophyll-a was a better indicator of enrichment than was total phosphorus. Synder et al. (2002) reported an ambient benthic algae chlorophyll-a density of 80 mg/m^2 in the Snake River near King Hill. IPC research corroborates this finding, indicating that there are 'luxuriant' growths of benthic algae at Glenns Ferry. Benthic chlorophyll-a exceeded 100 mg/m^2 throughout 2002 with an average of about 350 mg/m^2. Welch et al. (1988) hypothesized attached benthic algae chlorophyll-a densities greater than 100-150 mg/m^2 may represent a critical level for an aesthetic nuisance in streams. IPC does not agree with DEQ's statement that dissolved oxygen does not significantly drop below the criteria (pg. 79). Diel dissolved oxygen data for the Mid Snake reach that is upstream from King Hill, indicated there were instances within the heavily weeded areas when dissolved oxygen concentrations fell far short of 6.0 mg/L, especially in late summer as the macrophytes became senescent (Falter and Carlson 1994). Recent IPC research indicates diel dissolved oxygen sags well below the standard occur below King Hill. The DEQ concludes that macrophytes are impairing contact recreation and aesthetics (pg. 83). IPC recommends the Cold Water Aquatic Life use be added to the list of uses impaired by macrophytes, epiphyton and periphyton in the Snake River.	Paragraph 5 on page 79 acknowledges the limitation of the available data in terms of evaluating potential diel DO sags. DEQ acknowledges the likelihood of diel sags by stating… *"Unfortunately, the data shown in Figure 39 were all collected during the daytime hours. As mentioned above, DO sags are expected to occur during the night when respiration is occurring. These data do not allow for the investigation of nighttime sags."* DEQ attempted to partially fill this data gap by evaluating the data collected before 9:00 a.m. separately (DO is expected to be lowest in the pre-dawn and dawn hours). Diel DO conditions is also listed as a data gap in Table 38 of the subbasin assessment, thereby making it a priority for additional monitoring resources as part of the TMDL implementation. While DEQ agrees that diel DO sags may be partially impairing coldwater aquatic life (based on the corresponding mass of aquatic plants in the river), no discrete diel DO data were available during TMDL development. As such, DEQ hesitates to state that cold water aquatic life is conclusively impaired by low DO. Idaho Power Company states that *"recent IPC research indicates diel dissolved oxygen sags well below the standard occur below King Hill."* DEQ suggests that these data be made available during the implementation phase of the TMDL so that they can be considered during potential future revisions.

4. IPC's load allocations for C.J. Strike Reservoir IPC agrees that the protection of aquatic life and the reduction of macrophytes are appropriate water quality goals for the Snake River and C.J. Strike Reservoir. While water quality conditions in the reservoir are discussed, the link between the nutrient target of 0.075 mg/L total phosphorus and the protection of beneficial uses is not fully described. DEQ has developed a total phosphorus load capacity for the reservoir based on the total phosphorus target concentration and Snake River and Bruneau River inflows. DEQ further discusses volumetrically weighted total phosphorus and dissolved oxygen concentrations in the reservoir. While IPC agrees that volume weighting C.J. Strike Reservoir data is the most technically defensible analysis, based on the method the data were collected, IPC believes the relations do not appropriately describe the processes and the link to the protection of aquatic life. Figure 67 (pg. 137) indicates, that if extrapolated, a total phosphorus concentration of 0.075 mg/L in the metalimnion would result in hypoxic conditions. Conversely, water devoid of total phosphorus would be needed to achieve the dissolved oxygen criteria of 6.0 mg/L. Neither of these relations is accurate. IPC proposes the reservoir load allocation be linked not only to upstream total phosphorus reductions needed to protect beneficial uses in the Snake River and reduce eutrophication of C.J. Strike Reservoir but also the dissolved oxygen demand from organic matter. This can be demonstrated using inflow organic matter loads and typical stoichiometry, as demonstrated in the *Snake River-Hells Canyon Total Maximum Daily Load* (DEQ and ODEQ 2003). Additionally, CE-QUAL-W2 model results indicate dissolved oxygen criteria in the reservoir, and thus the protection of aquatic life, will be met with the proposed Snake River water quality targets, long-term reductions in oxygen-demanding materials, and a reservoir dissolved oxygen load allocation of 2.2 tons per year (Appendix N). Improving inflow water column water quality, by reducing nutrient loads, can improve dissolved oxygen concentrations in C.J. Strike Reservoir yet alone was not sufficient to meet the dissolved oxygen criteria. Long-term reductions in organic matter, mainly described by macrophytes, are needed to reduce the oxygen demand in the reservoir, as well as, an additional dissolved oxygen load allocation. While the objective is to improve dissolved oxygen in the metalimnion to attain the goal of the protection of aquatic life, the allocation	Please see the response below for a full explanation of the volumetric analysis, but Idaho Power Company's interpretation of extrapolation to 0.075 mg/L total phosphorus is flawed. The volumetric concentrations in each grid cannot be extended to the total reservoir for analysis; i.e. a weighted concentration of 0.01 mg/L total phosphorus within 3% of the reservoir does not equate with an average concentration of 0.01 mg/L in 100% of the reservoir. *The volume-weighted analysis of the empirical relationship between total phosphorus (TP) and dissolved oxygen (DO) data in the reservoir is not meant to be used in setting a total phosphorus target or load allocation for the reservoir; the TP/DO relationship is too complex to be described with a strictly empirical method. The volume-weighted empirical relationship between the TP and DO data in the reservoir is meant to illustrate that there is some relationship between TP and DO in the metalimnion and hypolimnion where little mixing from wind or wave action occurs. There is no relationship between TP and DO in the epilimnion and transition zone, where mixing from wind and wave action is common. This analysis supports the vertical temperature profile data that show stratification throughout the year. Since the vertical temperature profiles show a very weak stratification that would not be a stratification as defined by Idaho Rules, this additional analysis was required to support the fact that the reservoir does have a strong enough stratification to exhibit a resistance to mixing. The Idaho Water Quality Standards define the hypolimnion as the deepest zone in a thermally-stratified body of water, but further requires that the hypolimnion exhibit a rapid temperature drop of at least one degree per meter. By a strict interpretation of this definition, the C.J. Strike Reservoir sometimes stratifies too weakly to be defined as stratified. That is, there is no zone that shows a temperature drop as large as one degree per meter. Although the reservoir behaves as a strongly stratified system—as displayed by the relationship between TP and DO, volumetrically weighted according to zones that could be described as the epilimnion, metalimnion, and hypolimnion according to the TP/DO relationship—by a strict interpretation of the Idaho Water Quality Standards it would have to be evaluated as an isothermal system.* The importance of describing the strong

should remain flexible allowing for implementation of upstream total phosphorus or organic matter reductions. Additionally, DEQ reported an average total phosphorus concentration of 0.083 mg/L inflow to C.J. Strike Reservoir (pg. 73) and an average total phosphorus concentration of 0.071 mg/L outflow from the reservoir. The reality is that total phosphorus targets are met in the Snake River below the reservoir. IPC recommends that the draft King Hill-C.J. Strike TMDL more clearly articulate that while the reservoir is listed for nutrients, the total phosphorus load entering the reservoir is greater than the load leaving the reservoir. Even though a nutrient TMDL was developed, there is no nutrient allocation for the reservoir.	stratification of the C.J. Strike Reservoir becomes apparent when it is shown by the CE-QUAL-W2 model that sediment oxygen demand is the highest oxygen-demanding process occurring within the reservoir. With the current sediment oxygen demand of 2.5 g/m^3/day in the sediments of the reservoir, the incoming total phosphorus levels could be set to practically zero and still show no dissolved oxygen improvement in the metalimnion where DO violations occur. It is only after setting the SOD to a "clean" number of 0.1 g/m^3/day, that any improvement can be shown in the metalimnotic dissolved oxygen. A clean SOD number reflects decades of improvement in the nutrient levels of the waters coming into the reservoir. In the meantime, whatever excess nutrients come in to the reservoir will continue to sink to the bottom sediments in the transition zone and be held in the enriched organic sediments by the strong stratification exhibited in the reservoir until the spring and fall turnover occurs. If this situation were not reversed, the zone of dissolved oxygen depletion in the metalimnion would increase every year until there would be no habitat left for aquatic life in the reservoir.
IPC has noted several technical inaccuracies. Additionally, we forward these editorial suggestions.	
● (Page xx; paragraph 4) Dissolved oxygen sags in C.J. Strike Reservoir are not directly related to excess total phosphorus in the water column. Please replace "total phosphorus in the water column" to "decaying organic matter, including macrophytes,".	This paragraph will be modified to include decaying organic matter, including macrophytes and contributing factors.
● (Page xx; paragraph 5) Please change the first sentence to read"…0.075 mg/L total phosphorus (TP) and 6.0 mg/L dissolved oxygen were met in the Snake River and a SOD of 0.1 gm^{-2} day^{-1} was met in the reservoir."	This paragraph will be modified according to the comments.
● (Page 15; paragraph 1) It is correct to state that white sturgeon in the King Hill-C.J. Strike Reservoir subbasin are prevalent in the upper reaches of the reservoir. It is also worthy to note that the viability of this population is dependant on the canyon reach of the Snake River from Bliss Dam to King Hill-Glenns Ferry.	This information will be inserted into paragraph 1.

• (Page 15; paragraph 1) The Idaho Springsnail was listed as endangered in 1992. Please elaborate on the terminology "historic times" and "dams". The statement that "dams", if intended to mean existing hydroelectric facilities, have further reduced snail habitat is premature. The purpose of the Mid Snake River Offer of Settlement is to determine if operation of the hydroelectric facilities negatively affect the listed snails, including their habitat.	The term "historic times" was used in error. DEQ intended to use "recent times". Also, the term "dams" is intended to mean existing hydroelectric facilities. DEQ agrees that the Mid Snake River Offer of Settlement is to determine if hydroelectric operations negatively affect the listed snails. The paragraph will be modified accordingly.
• (Page 15; paragraph 3) The new C.J. Strike Federal Energy Regulatory Commission license requires IPC to stock rainbow trout annually. It is yet undetermined whether the IPC stockings will be supplemental to Idaho Department of Fish and Game's or replacement of their stockings.	This paragraph will be modified to include Idaho Power Company's stocking efforts.
• (Page 32; paragraph 2) Total spill capacity through the eight bays is 99,200 cfs. The current discharge capacity of the three existing units at the C.J. Strike project is 15,500 cfs. Therefore, spill flows occur when total Snake River flows exceed discharge capacity.	This paragraph will be modified according to the comment.
• (Page 39; Table 26) IPC recommends Cold Water Aquatic Life be included as a use affected by Nuisance Algae. This ties directly to the narrative standard "…be free from oxygen-demanding materials in concentrations that would result in an anaerobic water condition."	While DEQ agrees that nuisance alga, and the associated oxygen demand, may be affecting cold water aquatic life, no discrete DO data indicating such impairment were available during TMDL development. As such, DEQ hesitates to state that cold water aquatic life is impaired by low DO.
• (Page 40; paragraph 2) Please add "…if salmonid spawning occurred on or after November 28, 1975 as determined by the *Water Body Assessment Guidance*, second edition…" after "…that could support salmonid spawning…"	This paragraph will be modified according to the comment.
• (Page 50; paragraph 2) IPC used CE-QUAL-W2, Version 3.1.	This sentence will be modified according to the comment.
• (Page 72; paragraph 1) DEQ reported a mean total phosphorus concentration at King Hill of 0.084 mg/L. This is different than the mean concentration of 0.086 mg/L reported on Page 70. "As such, the [TP] target is exceeded and reductions are necessary from the upstream segment of	The 0.086 mg/L is a typographic error. The correct concentration should be 0.084 mg/L. The sentence on page 70 will be corrected. Additional language will be inserted into this paragraph saying that the intent of the Upper Snake Rock TMDL is to meet 0.075 mg/L TP at King Hill.

the Snake River to meet the target concentration at King Hill." IPC recommends additional narrative that states the Mid Snake analysis indicated that full implementation of the Upper Snake Rock TMDL would result in meeting the 0.075 mg/L target at King Hill. ● (Page 72; paragraph 2) IPC discontinued water quality monitoring at Indian Cove in March 2003. Continued water quality monitoring at King Hill is voluntary. ● (Page 107, paragraph 1) C.J. Strike Reservoir is only about 7,650 surface acres at full pool, yet has a volume of about 226,800 acre-feet. ● (Page 118; paragraph 1) DEQ states, "…it is important to note that the values causing the mean concentrations to exceed the aldrin, heptachlor and heptachlor epoxide standards all occurred in 1966 and 1967." Figure 16 indicates that mean Snake River flows at King Hill decreased from the early 1950s with a sharp increase in the mid to late 1960s. This increase in flows may have suspended these compounds; the cumulative effect of years of deposition. ● (Page 141; paragraph 1) DEQ states, "There is a very high internal loading of phosphorus being released from the sediments." DEQ, however, does not provide a quantification of internal loads or a comparison of external loads to internal loads. IPC has commented above, in load allocations for C.J. Strike Reservoir, that phosphorus loads entering the reservoir are greater than loads discharged from the reservoir. IPC does not believe that phosphorus being released from the sediments in the hypolimnion of C.J. Strike Reservoir can be significant in relation to external loads while nutrient loads discharged from the reservoir are less than inflow. ● (Page 153; Table 38) IPC recommends that quantification of macrophytes or coarse particulate organic matter and the effect on water quality and beneficial uses be added as a data gap.	This paragraph will be modified according to the comment. This paragraph will be modified according to the comment. The sharp increase in flows may have been the reason or may be a contributing factor to the observed increases in aldrin, heptachlor and heptachlor epoxide. DEQ appreciates this insight. Comment noted. Table 38 will be modified according to the comment. This paragraph will be modified according to the

• (Page 146; paragraph 3) DEQ states, "In low flow years, frequent spills beyond the spring are typically not necessary." In low flow years, IPC typically does not spill even in the spring. There is a strong correlation (r^2=0.96) between flow year and the number of days flow in the Snake River at Grand View is greater than the C.J. Strike generation capacity of 15,500 cfs. The relation suggests that there are no days of flow greater than the generation capacity, that is no spill, in years represented by 74% or less period of record flows. Additionally, C.J. Strike generation capacity is 15,500 cfs.	comment.
• (Page 147; paragraph 1) "The relationship between total flow and flow weighted TDG shown in Figure 56…" This is an incorrect citation. Figure 56 depicts a stratified lacustrine zone.	This is a typographic error; the reference should be to Figure 75. This sentence will be corrected.
• (Page 148; Table 35) IPC recommends restating the conclusion forwarded on Page 119, "…and recommends de-listing pesticides as a pollutant of concern from the next available §303(d) list" in Table 35. IPC additionally recommends DEQ revise comments relative to nutrients. IPC believes conclusions stated in Table 36 more accurately describe proposed actions in C.J. Strike Reservoir.	Comment noted.
• (Page 170; Table 45) C.J. Strike Reservoir is not listed for sediment nor has it been proposed for a sediment TMDL. IPC requests DEQ correct Table 45 to accurately reflect pollutants and load allocations applicable in C.J. Strike Reservoir.	The last sentence of the last paragraph on page 169 as well as Table 45 will be modified to accurately reflect the TMDL critical periods.
• (Page 176; paragraph 1) IPC concurs that the C.J. Strike Reservoir dissolved oxygen load allocation should be addressed using the most cost effective method. Also, DEQ states, "Water column dissolved oxygen monitoring is also expected to continue." IPC does not agree that the company be responsible for continuing C.J. Strike Reservoir water column monitoring. IPC agrees that monitoring related to dissolved oxygen addition, or other equivalent implementation measures, is appropriate. Appropriate monitoring will be discussed as part of TMDL	DEQ assumes the comment refers to the first paragraph of page 175, not page 176. DEQ states: "Water column dissolved oxygen monitoring is also expected to continue." The use of this statement is not intended to imply that Idaho Power Company is responsible or required by IDEQ to continue monitoring water column DO in C.J. Strike Reservoir. This statement is based on conversations with Idaho Power Company staff indicating that that company expects to continue this monitoring on a voluntary basis.

implementation…" specify monitoring needed to document actions and progress…" (pg. 176). IPC appreciates the opportunity to provide comments on the draft King Hill-C.J. Strike TMDL. IPC commends DEQ on acknowledging the effect of Snake River macrophytes on C.J. Strike Reservoir water quality. We also support an accurate and fair allocation of pollutant loads to all identified pollutant sources, as determined by approved guidance and policy. It is only through a unified watershed approach that water quality improvements can be realized.	DEQ appreciates the time and effort put into providing comments.
Comments from: Dick Rogers, BAG member **Received: December 9, 2004**	
This document needs to add another pollutant in addition to sediment and nutrients. That pollutant is floating organic matter. This pollutant impacts the following beneficial uses, Recreation primary and secondary, water supply and aesthetics. Also as this material enters a reservoir it creates a significant oxygen demand as it degrades and represents a significant nutrient load at that time. Most of this material enters the reservoir over a short period of time 90 days and is estimated to have a total annual P load of 2-3%. However in this short time period some 90 days give or take the equivalent load is 8-12%. Also when this material is deposited on the stream bank or on gravel bars it creates a serious odor problem (aesthetic). The only way to deal with this problem is to make it a pollutant of concern and address the problem. Also since this pollutant has been quantified it is now possible and required according to this report to develop a TMDL. You can not begin to solve this problem if it is not identified in the TMDL. If it is not addresses now I am afraid it will continue to be a water quality problem for years to come and violations of the water quality standards will continue.	DEQ agrees that excess floating organic matter is contributing to the impairment of contact recreation beneficial uses and provides oxygen demanding material to the reservoir. *IDAPA 58.01.02.200.06* contains the narrative standard for excess nutrients. The standard says "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." Additionally, *IDAPA 58.01.02.200.05* says "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 non-point source activities." The use of these standards is documented in Table 12 of the TMDL. Since the nutrient and sediment TMDLs for the Snake River from King Hill to Indian Cove are largely based on reducing the floating organic matter (macrophytes and algae) load in the Snake River, DEQ feels that these standards sufficiently address floating organic matter as a pollutant.
With respect to abundant weed growth, algae growth etc that is discussed in several areas of this document and implies that this is a problem because there is no significant storm events occurring on the river to move the sediment. I feel this statement is too general and fails to address the problem because it is my belief regardless of high water or lack there of the problem will persist. I base this statement on my personal observation on several stream I have	DEQ agrees that the roots of many nuisance aquatic plants will remain in the sediment, even after flushing flows. This is evident in the data. However, by establishing a water column sediment TMDL in the river and proposing to collect the data to establish a substrate sediment TMDL, DEQ is addressing the issue that is impairing beneficial uses such as primary and secondary contact recreation and aesthetics.

fished over the last 50 years all of which are free flowing and the weed problems persist after significant storm events up to 100 year floods. I believe the roots remain in the gravel or sediment and only the material suspended in the water column is removed. Thus I suggest the discussions on aquatic weed growth/algae be revised to be more proactive to address the issue that they impair beneficial uses such as primary and secondary contact, recreation and aesthetics.	
Page 2 Bottom of the page, contact recreation statement needs to be expanded beyond the 2 examples shown, swimming and boating to include all protected uses. The way this information is presented the concerns are limited to the 2 examples. Please list all uses.	The contact recreation discussion at the bottom of page 2 will be expanded help explain the differentiation between primary and secondary contact recreation. However, it is not practical to list all types of water-based recreation in this section.
Tributaries: why isn't Jack's creek considered in this study as it discharges into the Bruneau arm of C.J. Strike. This is an intermittent stream but has the potential to add significant nutrient, bacteria and sediments to the reservoir.	The 2001 Bruneau River TMDL, which included Jacks Creek, established an in-stream total phosphorus target of 0.05 mg/L. Since this target is more stringent than the reservoir boundary condition target of 0.075 mg/L, no additional reductions are required from Jacks Creek.
Pages 38 and 39 this section on water quality standards should be expanded to include section 100.02 recreation primary and secondary, 100.03 water supply domestic, agricultural and industrial, 100.04 wildlife habitat, 100.05 aesthetics, section 200.03 deleterious materials.	Where they are applicable, primary and secondary contact recreation as well as domestic water supply are addressed in Tables 11 and 12. The second paragraph on Page 38 will be modified to include agricultural and industrial water supply, wildlife habitat, and aesthetics. Deleterious materials were not added to Table 12 because DEQ feels the excess aquatic plant problem is suitably described by *the Excess Nutrients* and *Floating, Suspended, or Submerged Matter* narrative standards.
Page 25 in the discussion of ground water there needs to be some discussion with respect to Canyon Creek is a contributor to the city of Glenn's Ferry's drinking water spring. This thought needs to be continued in the Canyon Creek discussion of this document.	The intent of the Ground Water section in the subbasin assessment is to *generally* describe the ground water dynamics in the watershed. Specific discussions such the Canyon Creek/Glenns Ferry interactions are beyond the scope of the TMDL process.
Page 46 please show specific blue green algae occurrences on a map and the associated water quality violations. Should these areas be posted with warning signs?	The specific areas where blue green algae occurrences are evident are not available.
Page 86 the discussions on Sailor Creek, Deadman Creek and Browns Creek show a number of years where these streams were visited and no flows were observed. It should be noted that since the early	DEQ discussed the intermittence of Sailor Creek, Deadman Creek and Browns Creek with the King Hill-C.J. Strike Reservoir WAG, many of which have lived in the vicinity of these streams for 50+

90's this state has been in a drought with a few average years of precipitation. Flows may return to these creeks after several consecutive years of above average precipitation. If sailor creek drainage area ever becomes a bombing range I have a concern that perchlorate will be entering the snake as a result of runoff from the range.	years. All agreed with the intermittent classification of the stream.
There is a tendency to declare an act of God when these streams flow and caution should be used here as if there is an established creek or stream channel this would indicate at some time there was regular/seasonal stream flow during wet cycles. I would suspect all of these streams had flow back in the early 80's when we had an abundance of water. I suggest these streams have measurable quantities of pollutants and should not totally ignored. Knowing this, only a very aggressive and active land management plan for these streams can prevent the entrance of pollutants to the Snake.	DEQ states that if the streams are shown to be chronic pollutant loaders to the Snake River, additional management would be considered. However, these data do not exist. Furthermore, DEQ does not believe that scarce TMDL implementation resources should be allocated to streams that generate a pollutant load on a very infrequent basis. These dollars should be spent on chronic pollutant loaders.
I have similar concerns for the creeks on the North side of the Snake and they need to be addressed.	See comment above.
Page 101 the discussion on little canyon creek. I think the last paragraph needs to be changed as this stream is dewatered due to human activities, irrigation, stock water and flood storage. Flood storage is this Moreau reservoir? As per the definition on page 196 this stream does not cease to flow due to evaporation or seepage and thus it is not an intermittent stream. I would suggest it is a perennial stream that is dewatered by man.	DEQ acknowledges that the segment of Little Canyon Creek located in the upper valley is partially intermittent due to anthropogenic dewatering activities. However, given that other, much less managed streams with similar hydrology and land uses in the northern portion of the HUC are intermittent, DEQ is not prepared to say that Little Canyon Creek is not naturally intermittent.
I have observed a small CAFO facility located on the headwaters of this creek and it is a contributor of nutrient, organic matter and pathogens. I suggest a more aggressive approach for the lower section of Canyon Creek as protection is needed for the City of Glenns Ferry's drinking water spring. Additionally TMDLs for nutrients and floatable organic matter is needed, as many beneficial uses are severely impaired. Some of which are primary and secondary contact and aesthetics.	DEQ is legally compelled to complete TMDLs or propose de-listing for the §303(d) listed pollutants as a first priority. If sufficient amounts of data are available to evaluate additional pollutants, DEQ may do so during TMDL development. A sufficient amount of nutrient and organic matter data were not available during TMDL development. However, the forthcoming implementation plan presents an opportunity to integrate additional data and analysis into the TMDL.
Page 190. Definition for acre-foot please add the volume of water in an acre-foot so people can appreciate the overall quantity.	The number of cubic meters in one acre-foot will be added to the definition.
Page 192 definition for beneficial use you refer to water quality standards please provide the appropriate section of these standards 100.02, 03. 04, and 05. There may be other areas in the glossary where the water quality standards are mentioned but not referenced specifically if so	This reference is provided on page 38, under the discussion of "Applicable Water Quality Standards." The SBA and TMDL contain numerous sections where definitions or portions of IDAPA 58.01.02 are used. Where important, DEQ attempted to provide the standards reference.

please provide the correct reference.	Unfortunately, it is not practical to reference every section of IDAPA 58.01.02.
With respect to the City of Glenns Ferry they may be deriving part of their drinking water from the Snake River. If so some discussion is needed to protect this beneficial use from excess nutrients, floating organic matter and blue green if their intake is in located in an area where blue green algae has been found.	The Snake River is designated for Domestic Water Supply (Table 11). As such, the sediment and nutrient TMDLs for the river are aimed at reducing floating organic matter and nutrient levels that may hinder the use of river as a domestic water supply.