Raft River Subbasin Assessment
and
Total Maximum Daily Loads

FINAL
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Cover photo by Mike Etcheverry.

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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

µg/L microgram per liter

µmhoms/cm microhom per centimeter

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

7Q2 lowest seven day average flow in a two year period.

AFO Animal feeding operation

AMP Allotment Management Plan

BAER Burned Area Emergency Rehabilitation

BLM United States Bureau of Land Management

BMP best management practice

BOD biochemical oxygen demand

BOR United States Bureau of Reclamation

BURP Beneficial Use Reconnaissance Program

C Celsius, Centigrade

C&H Cattle and Horse

CAFO Confined Animal Feeding Operation

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

cfs cubic feet per second

col Colonies

CWA Clean Water Act

DEQ Department of Environmental Quality

DO dissolved oxygen

EA Environmental assessment

E. coli *Esherichia coli*

EPA United States Environmental Protection Agency

ESA Endangered Species Act

F Fahrenheit

ft feet

GIS Geographical Information Systems

H_a Alternative hypothesis

HIP Habitat improvement project

H_o Null Hypothesis

HUC Hydrologic Unit Code

IDA Idaho Department of Agriculture

IDT Idaho Department of Transportation

IDAPA Refers to citations of Idaho administrative rules

IDFG Idaho Department of Fish and Game

IDL Idaho Department of Lands

IDWR Idaho Department of Water Resources

ISCC Idaho Soil Conservation Commission

km kilometer

km^2 square kilometer

kwh/m^2/day Kilowatt per hour per square meter per day

LA load allocation

LC load capacity

m meter

m^3 cubic meter

m^3/s cubic meter per second

MDEQ Montana Department of Environmental Quality

Mg Megagram or Metric Ton

Mg/y Metric ton per year

mg/L milligrams per liter

mg/m^2 milligram per square meter

mi mile

mi^2 square miles

ml milliliter

mm millimeter

MOS Margin of safety

N Nitrogen

n.a. Not applicable

nc Not collected

NO_x General symbol for nitrite and nitrate in a solution

NB natural background

NH_3 Ammonia

PLS pure live seed

NPDES National Pollutant Discharge Elimination System

NRCS Natural Resources Conservation Service

P Phosphorus

RM River mile

S&G Sheep and Goat

SBA subbasin assessment

SCC Soil Conservation Commission

SCD Soil Conservation District

SCS Soil Conservation Service

SMZ Streamside Management Zone

SPCC Spill Prevention Control and Countermeasures

SR-HC Snake River Hells canyon TMDL

TDS total dissolved solids

TFRO Twin Falls regional Office

TMDL total maximum daily load

TN Total nitrogen

TP total phosphorus

TSS total suspended solids

TSI Trophic State Index

t/y tons per year

U.S. United States

USC United States Code

USDA United States Department of Agriculture

USFS United States Forest Service

USFWS United States Fish and Wildlife Service

USGS United States Geological Survey

WBAG Water Body Assessment Guidance

WLA wasteload allocation

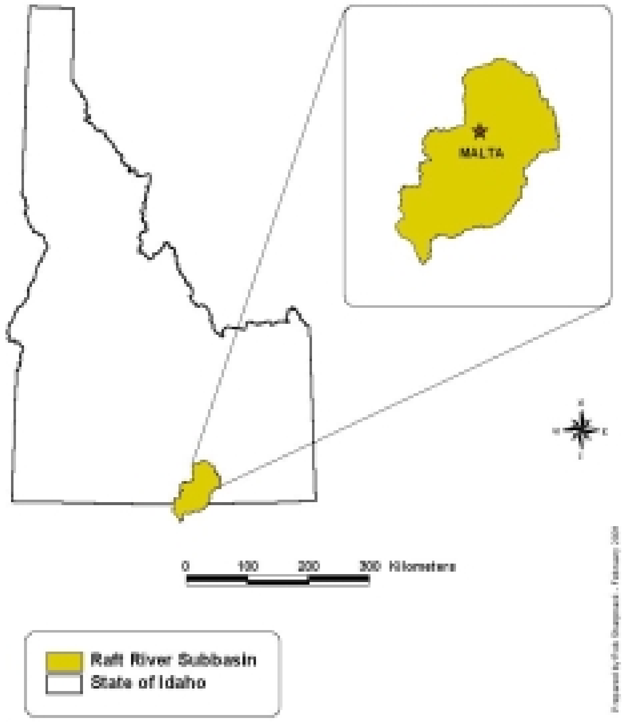
Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters (33 USC § 1251.101). States and tribes, pursuant to section 303 of the CWA are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must 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 Raft River Subbasin that have been placed on what is known as the "303(d) list."

This subbasin assessment (SBA) and TMDL analysis has been developed to comply with Idaho's TMDL schedule. This assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Raft River Subbasin located in south central 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. Only six segments of the Raft River Subbasin were listed on this list (DEQ 2001). The SBA portion of this document examines the current status of §303(d) listed waters and defines the extent of impairment and causes of water quality limitation throughout the subbasin. The loading analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

The general physical and biological characteristics of the Raft River Subbasin (Figure 1) have a strong influence on the water quality of the subbasin. Land use in the subbasin is predominantly rangeland (≅ 43 percent). Irrigated agriculture (cropland and pastures) also exists in the subbasin where water is either pumped from the ground or diverted from Raft River. The major population center of the basin is the town of Malta. The subbasin contains two different water sources. The first of these is runoff from the snowpack and other precipitation events in the mountainous regions that surround the subbasin to the south, east, and west. The second is the Raft River Aquifer below Malta and Almo, which is part of the Eastern Snake River Plain Aquifer. These sources affect water quality to varying degrees. The water from the local aquifer has caused significant changes in the water quality of many of the streams of the subbasin, because in part, it is often the only water source to many streams throughout most of the summer. As a result, some of the streams and rivers maintain high quality water with sufficient flows to provide for fully supported cold water aquatic life (i.e., Raft River near The Narrows), while other streams and rivers throughout south central Idaho are dry. In the Sublett Range the karst geology leads to low amounts of runoff water from precipitation events being delivered to the streams, while large amounts of water are delivered to the streams from the aquifer.

Subbasin at a Glance



Hydrologic Unit Code	17040210
Subbasin Drainage Size	3,196.1 km^2 in Idaho 3,919.1 km^2 Total
Total Streams *Perennial Streams*	3,861.0 km 901.9 km
Total ListedSstream Length	159.95 km
Applicable Water Quality Standards	• IDAPA 58.01.02.200- General Surface Water Quality Criteria • IDAPA 58.01.02.250- Surface Water Quality Criteria for Aquatic Life Use Designations
Beneficial Uses Affected	Cold Water Aquatic Life Salmonid Spawning Secondary Contact Recreation
Pollutants of Concern	Sediment Nutrients (Total phosphorus) Bacteria

Figure 1. Raft River in relationship to the state of Idaho.

The subbasin land forms, vegetation, topography, and precipitation can be defined by two ecoregions. The predominant ecoregion of the subbasin is the Northern Basin and Range. The Northern Basin and Range ecoregion is predominantly sagebrush-steppe, juniper-mountain lands. Most of the surface streams are intermittent or ephemeral in nature due to evaporation and low annual precipitation. Consequently, limited riparian habitat exists within the subbasin. Those streams that remain perennial usually form from spring sources in the more mountainous regions of the subbasin. Along these stream courses some riparian habitats persist.

Nutrients, bacteria, and sediment are the most common listed pollutants in the subbasin. These pollutants were listed on the six 1996 §303(d) listed water bodies within the subbasin. Other listed pollutants and stressors include dissolved oxygen, flow, temperature, ammonia, salinity, habitat alteration, and unknown. The SBA portion of the SBA-TMDL determines the current amount of each particular pollutant in each of the watersheds of the §303(d) listed water bodies. The SBA also determines what impacts to the beneficial uses each pollutant may have.

Key Findings

In general, the impacts to the beneficial uses were determined by assessing the biological communities and the limited water chemistry data available. When these two data sets were in agreement with one another, appropriate actions, such as completing a TMDL or delisting the stream, were undertaken.

The water quality of the Raft River Subbasin, in some areas, is of high quality. In other areas of the subbasin flow alteration is the most dominant cause for beneficial use impairment. Nutrients are a listed pollutant in Sublett Reservoir. It was determined that, to effectively reduce the amount of excess nutrients entering the reservoir, TMDLs should be developed on Lake Fork and Sublett Creeks, the two tributaries of the reservoir. However, in these reaches it was determined that total phosphorus (TP) was not in excess impairing the beneficial uses of the creeks. In the Raft River and other watersheds nitrogen compounds are not in excess of U.S. Environmental Protection Agency (EPA) "Blue Book" recommendations (*Water Quality Criteria 1972.* [EPA 1975]). Background TP concentrations at a Utah sampling site of Raft River averaged 0.101 milligrams per liter (mg/L) for the period of record. Total phosphorus concentrations near the end of the reach averaged 0.077 mg/L. In the reservoir, TP concentrations averaged 0.028 mg/L for the data set. Total phosphorus concentrations in the Sublett Creek Watershed averaged 0.061 mg/L over the period of record, while in the Lake Fork Creek tributary, TP concentrations averaged 0.098 mg/L for the data set. The target selected for the reservoir TMDL (0.050 mg/L TP) was used to assess the two streams feeding the reservoir. These guidelines were set by the EPA for TP concentrations in rivers flowing into lakes and reservoirs. A 49 percent reduction in TP will be required for nonpoint sources within the Lake Fork Creek Watershed and an 18 percent reduction will be required for Sublett Creek.

Flow and habitat alteration issues were not discussed in the SBA-TMDL due to current DEQ policy. It is DEQ policy that flow and habitat alterations are pollution, but not pollutants requiring TMDLs. The EPA considers certain unnatural conditions, such as flow alteration, a lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutants as "pollution." TMDLs are not required for water bodies impaired by pollution, but not specific pollutants. These forms of pollution will remain on the §303(d) list; however, TMDLs will not be completed on segments listed with altered flow or habitat as a pollutant at this time.

Temperature, under the current standards, is a listed pollutant on Raft River. In other areas of the state bioassessment data conflict with current temperature information and water quality standards. This is likely the result of the state's current water quality standards being derived from an outdated understanding of the cold water aquatic life's temperature requirements. However, DEQ is proceeding with a temperature TMDL on Raft River. Currently, DEQ is participating in a regional review of temperature criteria, which is being organized by EPA Region 10. Following the conclusion of the temperature review, the temperature exceedance documented now in the Raft River will be reassessed and, if needed, temperature TMDLs will be completed on other segments or updated on the Raft River segment. To facilitate the development of temperature TMDLs based upon solar pathfinder information, streams with fully supported beneficial uses and the average shade component of those streams, as measured by the solar pathfinder, will be used to develop temperature TMDLs within the Raft River Subbasin. These reference streams will be used to set the shade and thermal load components for temperature TMDL developed and presented in this document.

The following Tables (1-3) summarize the TMDLs to be completed, streams and pollutants retained on the §303(d) list, and recommended delisting actions as a result of the Raft River SBA.

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

Segment	TMDL-pollutant	TMDL-pollutant	TMDL-pollutant
Raft River	Temperature	Bacteria	Sediment –Bed load
Sublett Creek	Nutrients – TP[a,b]		
Cassia Creek	Nutrients – TP[a]	Sediment –Bed load	
Fall Creek	Nutrients – TP[a]	Bacteria	
Lake Fork Creek	Nutrients – TP[a,b*]		
Sublett Reservoir	Nutrients – TP[a,b]		

[a] TP = total phosphorus
[b] completed to satisfy reservoir TMDL

Table 2. Delistings in the Raft River Subbasin.

Segment	TMDL-pollutant	TMDL-pollutant	TMDL-pollutant	TMDL-pollutant	TMDL-pollutant
Raft River - Utah to Malta	Sediment – TSS[a]	Dissolved Oxygen	Salinity		
Raft River - Malta to Snake River	Nutrients – TP[b]	Bacteria	Sediment	Ammonia	Dissolved Oxygen
Sublett Creek	Nutrients	Bacteria	Sediment	Dissolved Oxygen	
Fall Creek	Unknown				
Sublett Reservoir	Sediment	Dissolved oxygen			

[a] TP = Total Phosphorus
[b] TSS = Total Suspended Solids

Table 3. Stream/pollution combinations retained on the §303(d) list.

SEGMENT	TMDL-POLLUTANT
Raft River	Flow Alteration
Sublett Creek	Flow Alteration
Sublett Reservoir	Flow Alteration
Cassia Creek	Flow Alteration
Cassia Creek	Habitat Alteration

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 (33 USC § 1251.101). States and tribes, pursuant to section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must 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 Raft River Subbasin that have been placed on what is known as the "§303(d) list."

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

1.1 Introduction

In 1972, Congress passed public law 92-500, the Federal Water Pollution Control Act, more commonly called the CWA. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Pollution Control Federation 1987). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the county. 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, with EPA approval, water quality standards and to review those standards every three years. Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish TMDLs for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses. These requirements result in a list of impaired waters, called the "§303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. A SBA and TMDL provide a summary of the water quality status and allowable TMDL for water bodies on the §303(d) list. *The Raft River Subbasin Assessment and Total Maximum Daily Loads* provides this summary for the currently listed waters in the Raft River Subbasin.

The SBA section of this report includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the Raft River Subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (40 CFR part 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also includes individual pollutant allocations among various sources discharging the pollutant. The EPA considers certain unnatural conditions, such as flow alteration, a lack of flow, or habitat alteration, that are not the result of the discharge of specific pollutants as "pollution." TMDLs are not required for water bodies impaired by pollution, but not specific pollutants. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Idaho's Role

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

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

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

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

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 support status of the designated or default beneficial uses of a water body (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the water body, particularly the identity and location of pollutant sources.

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

1.2 Physical and Biological Characteristics

The Raft River SBA is a problem assessment conducted at the geographic scale of fourth field hydrologic units (cataloging units of the U.S. Geological Survey [USGS]), also referred to as a subbasins (Figure 2). This SBA describes those water bodies in fourth field Hydrologic Unit Code (HUC) 17040210 listed on DEQ's 1998 §303(d) list. This SBA describes the Raft River Subbasin and addresses the water quality concerns and status of beneficial uses of §303(d) water bodies, the nature and location of pollution sources, and past and ongoing pollution control activities on §303(d) water bodies. Six watersheds, or fifth field HUCs, in the subbasin contain the §303(d) listed streams are listed in Table 4 and shown in Figure 3.

Table 4. DEQ 1998 §303(d) list, HUC No. 17040210.

Water Body	Boundaries	Stream Length
Raft River	Malta to Snake River	54.6 kilometers
Raft River	Utah Line to Malta	67.9 kilometers
Sublett Creek	Sublett Reservoir to lower boundaries	13.3 kilometers
Sublett Reservoir	The Reservoir	0
Cassia Creek	Conner Creek to Raft River	20.5 kilometers
Fall Creek	Headwaters to Lake Fork	3.7 kilometers

For a Map View, See Figure 3. Raft River Subbasin 1998 §303(d) listed water bodies

Information concerning U.S. Forest Service (USFS) lands (Figure 4) contained in the following descriptions was obtained from the United States Department of Agriculture Forest Service *Sawtooth National Forest Draft Land Management Plan* (USFS 2000).

The Raft River Subbasin is located in the eastern part of Cassia County, Idaho, and the northern part of Box Elder County, Utah. Raft River originates in USFS lands in the Raft River Mountain Range, which lies just south of the Idaho-Utah border. About 70 percent of the area drains north into the Raft River Subbasin through the Junction Creek, Barnes-Wildcat, and Upper Clear Creek Watersheds. The Raft River flows in a northeasterly direction from its headwaters in Utah, terminating at Lake Walcott on the Snake River. The city of Burley lies 56 kilometers (km) (35 miles) to the west of the mouth of the Raft River with the city of Pocatello lying 76 km (47 miles) to the east.

Other USFS management areas besides the Raft River area that drain into the Raft River Subbasin are part of HUC 17040210 and include Black Pine, Sublett, and Independence Lakes. The Black Pine USFS lands in the Black Pine Mountain Range lie in the western end of Cassia County, Idaho. The area is an estimated 31,080 hectare (76,800 acres), which includes several small private holdings totaling 1,174 hectare (2,900 acres). Private ranches or U.S. Bureau of Land Management (BLM) lands border most of the area. The primary uses and activities in the area are livestock grazing, timber management, dispersed recreation (mainly hunting), and mining. Pegasus Gold, a large gold mine, operated on the east side of the Black Pine Mountains for several years. The western half of the area drains west into the Raft River Subbasin. The eastern portion of the area drains east into the Curlew Valley Subbasin and then south into the

Great Salt Lake Basin. Two perennial streams exist, both in the western portion of the area: Eightmile Creek and Sixmile Creek. Sixmile Creek flows into a small reservoir that is used for irrigation below the USFS boundary. Most canyons feature intermittent streams that flow only during spring snow melt and periods of severe or sustained thunderstorms in the summer months. Neither of the two streams, Eightmile Creek or Sixmile Creek, reaches the Raft River nor are they listed on the §303(d) list.

The USFS management unit of Sublett lies in Cassia and Power Counties, Idaho. This area is an estimated 31,667 hectares (78,250 acres), which include several small private holdings totaling 251 hectares (620 acres). Most of the bordering lands are private ranches and BLM lands. The majority of the private land has been converted to agriculture. The primary uses and activities in the forestlands have been livestock grazing, public recreation, and timber management.

The majority of irrigated lands lie very near Sublett Creek, while dry farming agriculture predominates elsewhere in the Sublett Watershed. The Sublett USFS area is comprised of portions of six watersheds that drain into three separate subbasins. About 70 percent of the area drains west into the Raft River Subbasin through the Sublett Creek. This subbasin will be addressed in this SBA. The eastern portion of the area drains east into the Lake Walcott Subbasin through the Rockland area and has been addressed in the Lake Walcott TMDL on the Rock Creek Subbasin. The southern tip (less than 1 percent) drains south into the Curlew Valley Subbasin through the Juniper Valley Watershed. The main perennial streams in the area are the Lake Fork, North Fork, and South Fork of Sublett Creek. There are no natural lakes in the area. Most of the other streams run intermittently. Sublett Reservoir is located at the south end of the area; most of the reservoir is contained on private lands. Sublett Reservoir, Sublett Creek below the reservoir, and Fall Creek are listed on the 1998 §303(d) list.

The last of the USFS lands that drain into the Raft River Subbasin are the Independence Lakes area on the east side of the HUC. The land is on the eastern side of the Albion Division of the Minidoka Ranger District. The entire area is in Cassia County and is estimated at 69,685 hectares (43,300 acres), including one private land holding of 1,006 hectares (625 acres), and a patented mining claim in the Connor Creek drainage. The City of Rocks National Reserve lies adjacent to the southern portion of the management area. The area is bordered by the Sawtooth National Forest to the west and north and primarily private ranch lands to the east. The primary uses and activities in this management area are livestock grazing and dispersed recreation. At 3,170 meters (m) (10,399 feet[ft]), Cache Peak is the highest mountain in Idaho south of the Snake River. Portions of the Mountain Harrison and Cache Creek Natural Inventoried Roadless Areas lie within the management area. The Mount Harrison Research Natural Area (154 hectare, 381 acres) has been established in the northwest corner of the management area to preserve rare plant species and to serve as a representation of relatively undisturbed subalpine vegetation. Segments of Clyde Creek, Stinson Creek, and Almo Creek are potentially eligible for Wild and Scenic River designation (USFS 2000).

The Cassia Creek, Edwards Creek, and Grape Creek Watersheds drain east into the Raft River Subbasin. The main streams in the area are Green Creek, Clyde Creek, New Canyon Creek, Stinson Creek, Almo Creek, Conner Creek, and Cassia Creek. Cassia Creek is listed on the 1998 §303(d) list.

For the USFS lands surrounding the Raft River Subbasin (Idaho and Utah) the two dominant subsections are the Humboldt River High Plateau and Jarbidge High Mountain Ranges. The dominant landforms are glaciated mountains, fluvial mountains, plateaus, escarpments, and depositional lands. Slope gradients average 40 to 70 percent on the glaciated mountains and the fluvial mountains, 0 to 30 percent on the plateaus and depositional lands, to near vertical on the escarpments. The surface geology is predominantly granitic, with minor intrusions of basalt and sandstone. Soils generally have moderate erosion potential and moderate productivity. Shallow soils at higher elevations (2,591-3048 m [8,500-10,000 ft]) are susceptible to impacts from livestock grazing. Geomorphic integrity is at high risk due to impacts from roads, livestock grazing, and dispersed recreation. Impacts include accelerated erosion, upland compaction, and stream bank and channel modification (USFS 2000).

Subbasin Ecoregion Description

The Raft River Subbasin is also described according to its ecoregion (or ecozone). An ecoregion is an ecological area that has similarities in plant and animal species, climate, soil, and the general topography of the landscape. The ecoregion is also a broad description of the subbasin. The Raft River ecoregions are described by the Omernik-Gallant method (EPA1986). The Omernik-Gallant method characterizes the Raft River Subbasin as two ecoregions: the Northern Basin and Range ecoregion and the Snake River Basin/High Desert ecoregion. The Snake River Basin/High Desert ecoregion makes up 17.5 percent (68,700 hectares; 169,761 acres) of the subbasin, whereas the Northern Basin and Range ecoregion makes up 82.5 percent (323,106 hectares; 793,467 acres) of the subbasin (Figure 5). The Snake River Basin/High Desert ecoregion has Sawtooth National Forest lands under four distinct management areas, with BLM, state, and private lands dispersed throughout the ecoregion. The Northern Basin and Range ecoregion on the north end of the subbasin includes BLM, private, and state lands and borders the Snake River/Lake Walcott Subbasin. The Bailey/McNab-Avers method (USFS 1986) characterizes the Raft River Subbasin similarly: the Intermountain Semidesert ecoregion (Province 342) and the Northwestern Basin and Range (Province 342B) (Tables 5 and 6).

Table 5. Compilation of the Omernik-Gallant and Bailey/McNab-Avers ecoregions.

Typical Land Form	Typical Vegetation	Typical Land Use	Soils
Northern Basin and Range Ecoregion			
Plains with low to high mountains and open high mountains. Nearly level basins and valleys are bordered by long, gently sloping alluvial fans with north-south trending mountain ranges	Great basin sagebrush, sagebrush steppe, wheat grass, saltbush, greasewood, shrub-grass, sedges and forbs line the riparian zone.	Livestock grazing of desert shrubland, agriculture uses include dryland farming, some irrigation farming, and recreation.	Aridisols and aridic Mollisols, along with xeric and aridic soil moisture regimes.
SNAKE RIVER BASIN/HIGH DESERT			
Tablelands with moderate to high relief, plains with hill or low mountains, north-south trending mountains	Sagebrush-steppe (sagebrush, wheat-grass) saltbrush, wheatbrush. North and east aspects support aspen and subalpine fir communities with a Douglas fir component.	Grazing on the desert shrubland and lower open forest lands, dry and irrigated farming, recreation, some mining.	Aridsols

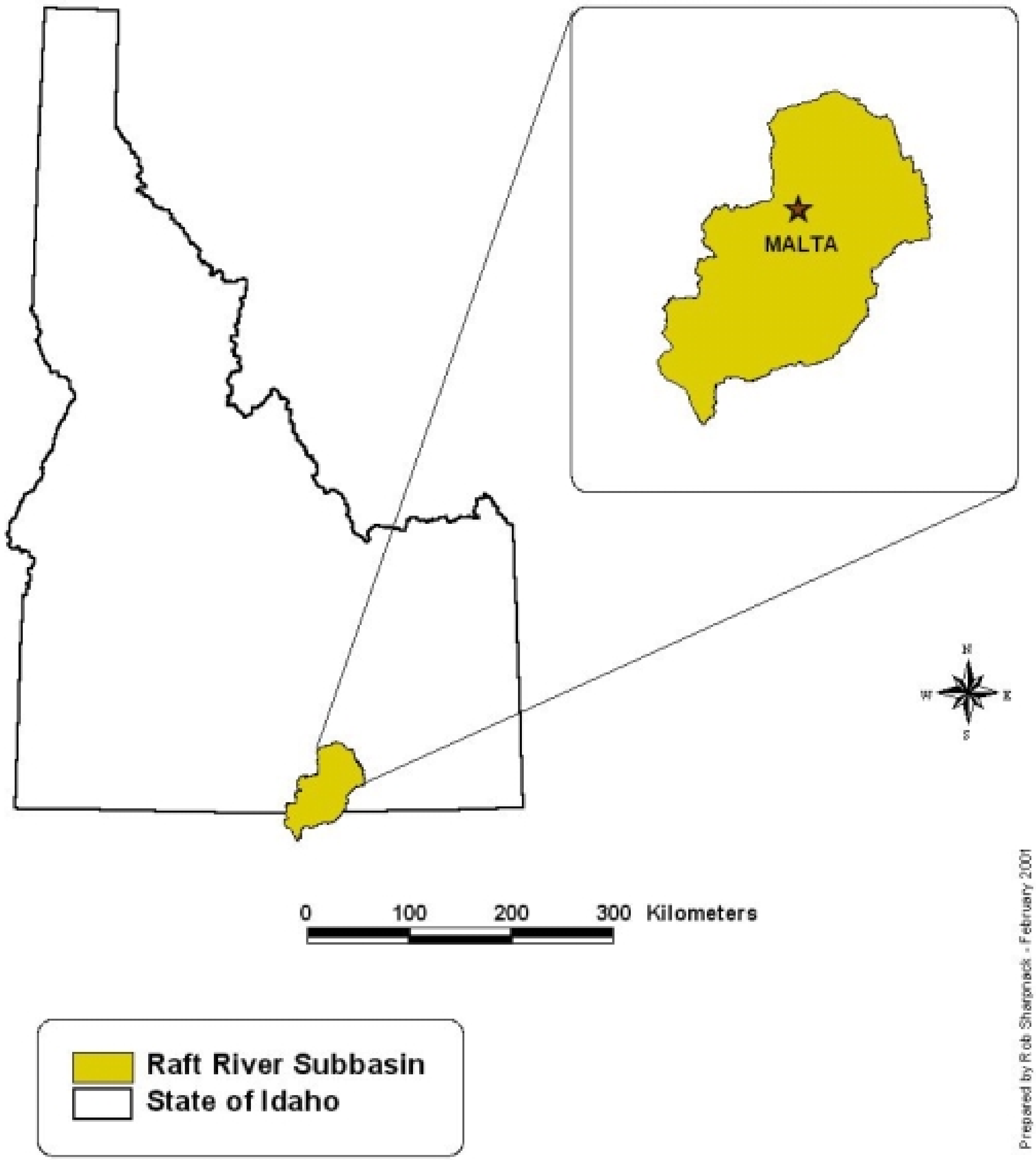


Figure 2. Raft River in relationship with the state of Idaho.

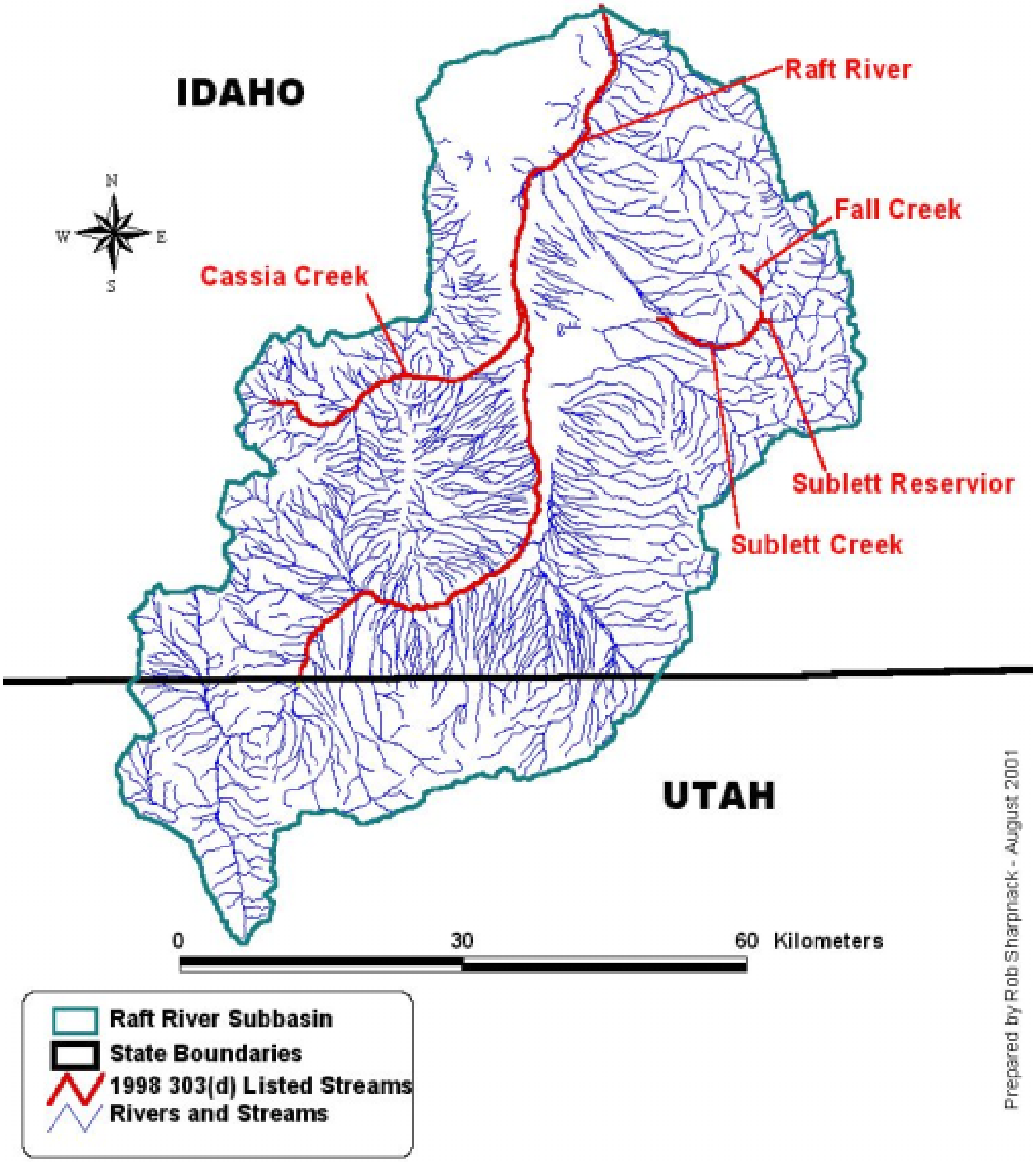
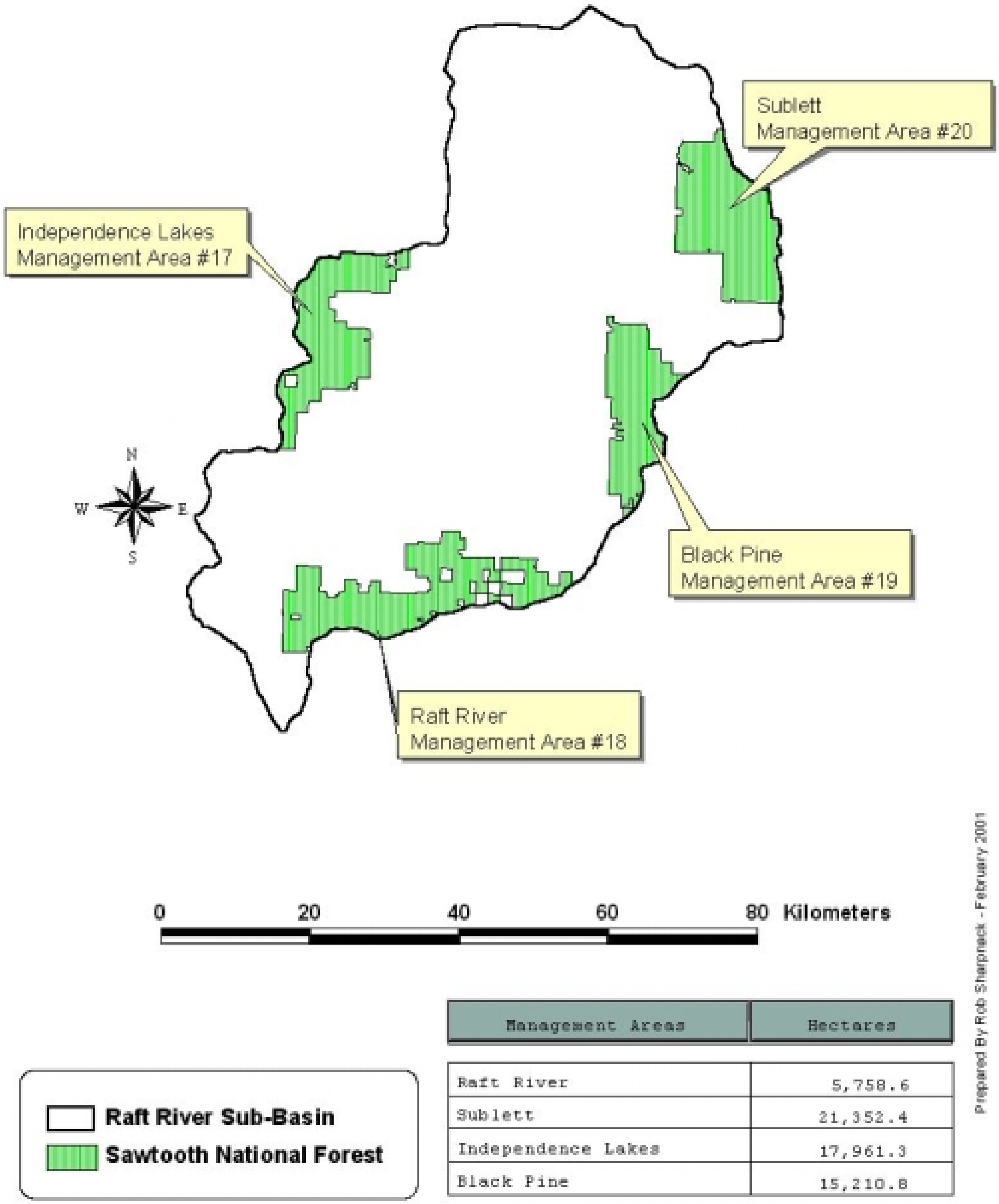
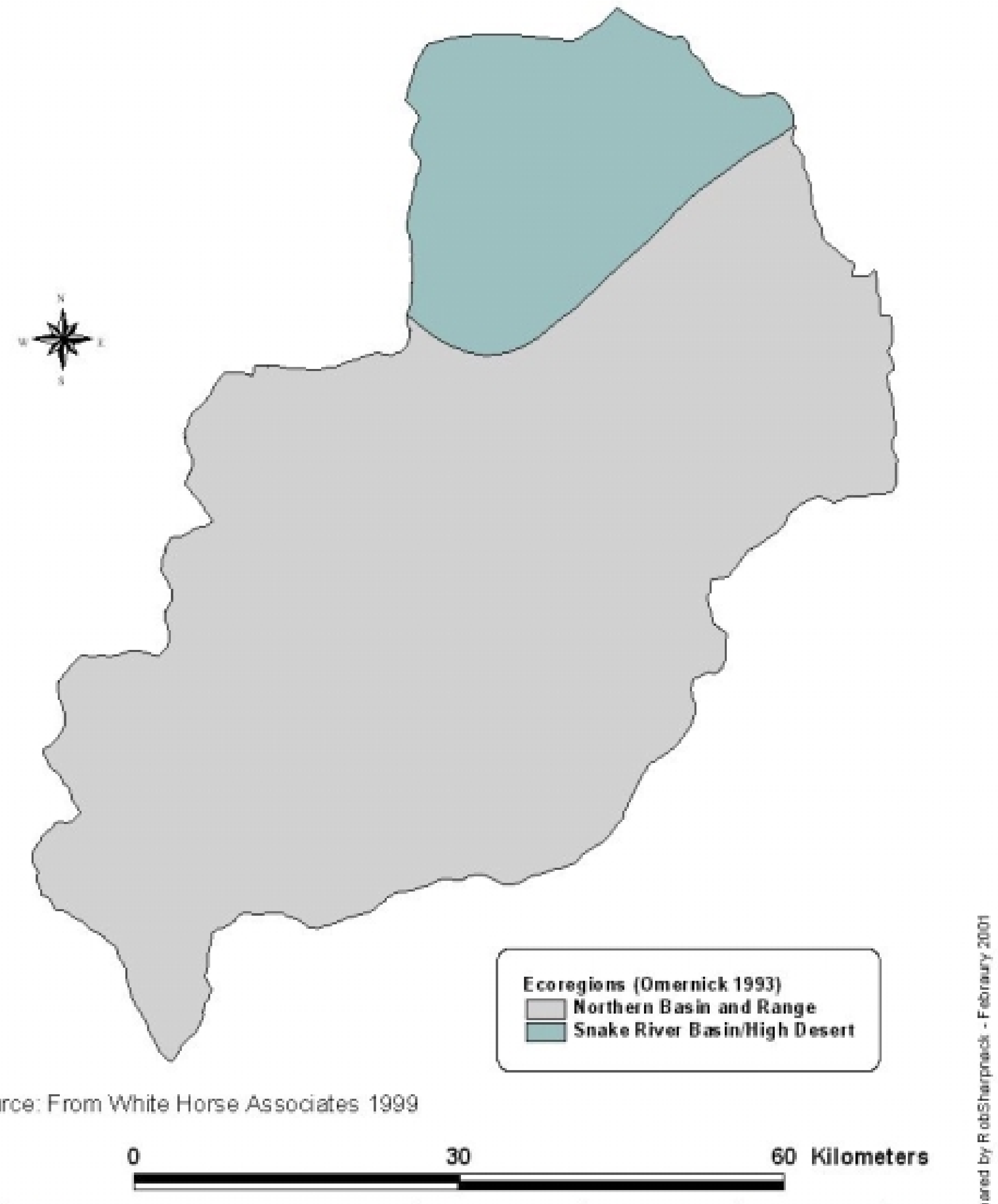


Figure 3. Raft River Subbasin 1998 §303(d) listed streams and reservoirs.



Management Areas	Hectares
Raft River	5,758.6
Sublett	21,352.4
Independence Lakes	17,961.3
Black Pine	15,210.8

Figure 4. U.S. Forest Service Sawtooth management areas in the Raft River Subbasin.



Ecoregion	Hectares	Sq. Km	% of Area
Snake River Basin/High Desert	68,700.0	687.0	17.5
Northern Basin and Range	32,3105.4	3,231.1	82.5

Figure 5. Raft River Subbasin ecoregions.

Table 6. Percent of subbasin within each ecoregion.

Ecoregion	Acres	SqMiles	% of Area
Snake River Basin/High Desert	169,761.4	265.3	17.5
Northern Basin and Range	798,410.8	1,247.5	82.5

Subbasin Meteorology

The climate in the Raft River Subbasin is semi-arid with cool, moist winters and warm, dry summers. Three climate stations of the Western Regional Climate Center (Western Regional Climate Center 2001), along with the U.S. Department of Agriculture Natural Resource Conservation Service (NRCS) Howell Canyon, ID SNOTEL site best characterize the meteorological characteristics of the subbasin. The average annual precipitation ranges from 11 inches in the valley at the Malta and Strevell climate stations to nearly 40 inches in the mountains as measured at the automated Howell Canyon SNOTEL site. The Malta and Strevell sites were used to approximate the meteorological characteristics of the lower elevation area in the southern part of the subbasin. The Malta elevation is 1,300 m [4,589 ft] above sea level, the Strevell Site Elevation is 1,609 m [5,279 ft] above sea level, and within the higher elevation area the Howell Canyon SNOTEL site is at 2,432m [7,980ft] above sea level. This site was used to approximate meteorological characteristics of the higher elevations of the subbasin (SCS et al. 1991). The Minidoka Dam site elevation is 1,269 m, [4,163 ft] above sea level and is located in the Snake River Basin/High Desert ecoregion area. The northern area of the HUC along the Snake River is best described by the meteorological data from that site, Table 7.

Table 7. Climate description of which is shown in the Raft River Subbasin by ecoregion[a].

PRECIPITATION RANGE (Inches)	PRECIPITATION MEAN (Inches)	MOST PRECIPITATION (by season)	MEAN ANNUAL AIR TEMPERATURE RANGE	GROWING SEASON[b] (Days)
Snake River Basin/High Desert (Province 342): Lower Elevation				
Minidoka Dam Site: 9 to 12 in[c]	9.54	Fall, winter, spring	1.89 ºC (35.4 ºF) to 15.9 ºC (60.7 ºF)	60 - 120
Northwestern Basin and Range (Province 342b):Southern Plains And Higher Elevations				
Malta 2 E Site:	10 - 15	11.28 in	32.3 ºC (62.4 ºF) to 0.19 ºC (0.17 ºF)	70 - 100
Howell Canyon Snotel Site: 28 - 45 inches	37.6	Fall, winter spring	-9.4 ºC (15 ºF) to 23.9 ºC (75 ºF)	Not applicable

[a] Natural Resource Conservation Service 2001, and Western Regional Climate Center 2001.
[b] These figures are based on the 50% probability of a killing (-2.2ºC or 28ºF) freeze occurring on or after a particular date in the spring or on or before a particular date in the fall (IDWR 1972). Frost-free precipitation is based on frost-free period of record.
[c] in = inches.

Subbasin Precipitation/Snowfall

The average annual precipitation is approximately 11 inches in the valley at the Malta and Strevell climate stations. The GIS coverages (Figure 6) also indicate that the valleys average between 11 to 15 inches per year. Use of the Strevell station was discontinued in 1986. However, the Malta site is still in use. Precipitation is evenly distributed throughout the year at the lower elevations with a slight increase in spring and summer. At higher elevations, winter precipitation predominates, while the summers are typically dry and cool. This is due to the importance of summer convectional storms in the valley as contrasted with the strong orographic effects of the mountains on winter frontal systems (SCS et al. 1991). Normal precipitation during the growing season (April-September) averages about 7 inches at the two valley stations.

In the subbasin, snowfall is a major component of total precipitation. Over half the precipitation falls as snow in the months of November to mid-April. Except for the wettest months of December and January, the monthly mean precipitation is evenly distributed throughout the year. Along with the USDA NRCS Howell Canyon SNOTEL site, nine manually measured snow courses have provided data on the depth and water equivalence of the winter and spring snowpack. The mountain snowpack usually reach their maximum water content in early April before the melting season begins. The long term average snow depth on April 1 for the nine snow courses ranges from 25 to 86 inches, and the average April 1 water content for these sites ranges from 7.4 to 29.9 inches. There is an 80 percent chance that the April 1 snow water content will be approximately 75 percent or more of the average April 1 values. In some years the May 1 snow water content is the maximum, mainly at the higher elevation sites in above normal snow years (SCS et al. 1991).

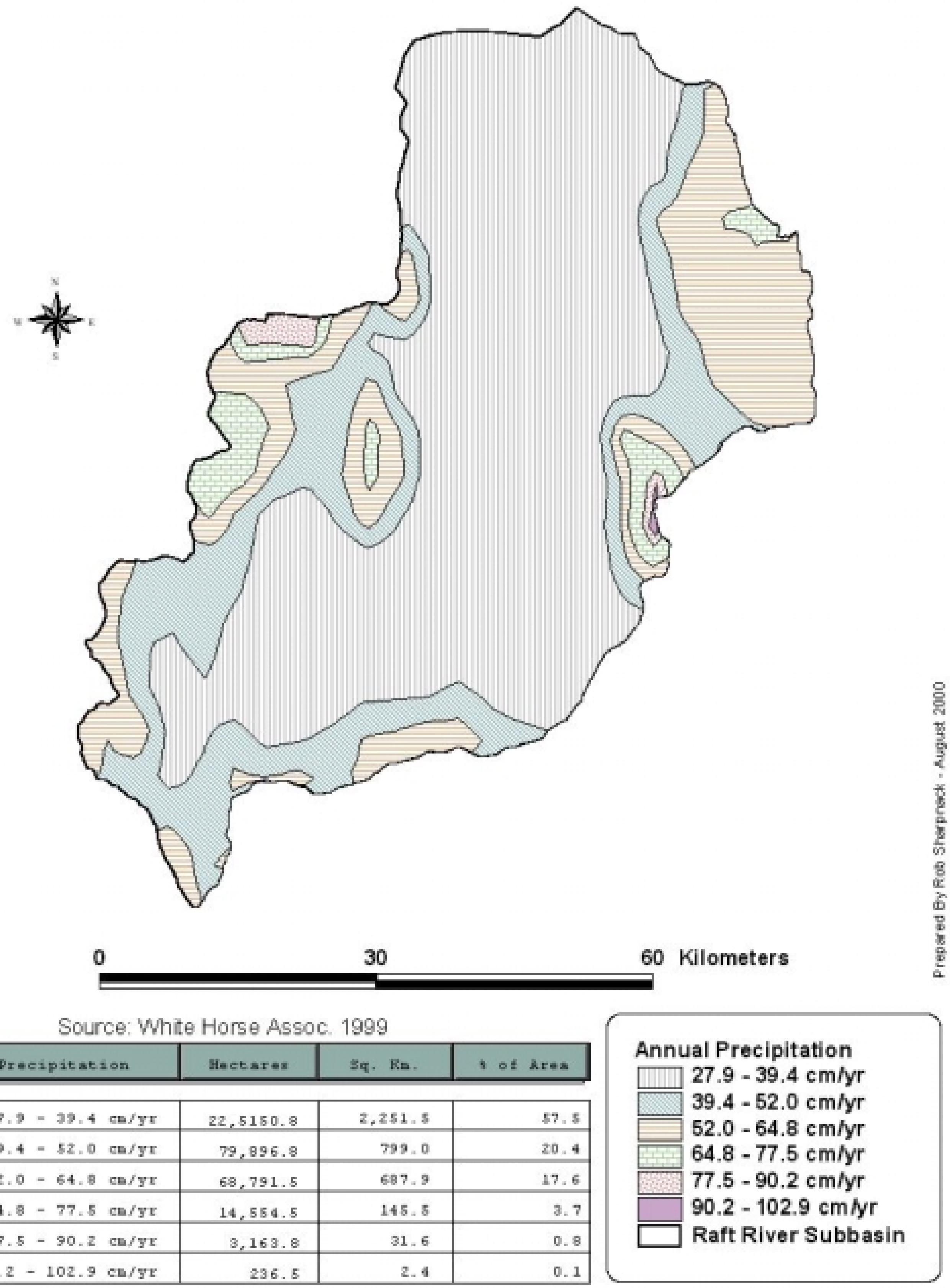
Subbasin Air Temperature

For this report, ambient temperature is reported in three ways: monthly maximum daily average, minimum monthly average, and the calculated average monthly mid-range. As a whole, ambient monthly temperatures increase from the Sawtooth National Forest areas towards the valley and agriculture areas (Figure 7). In general, the highest monthly average temperatures and the highest mid-range average temperatures occur during the months of June through September. The average lowest monthly temperatures and the lowest mid-range average temperatures occur during the months of November through March (Table 8).

Table 8. Average annual temperatures by general elevation area. White Horse Associates 1999.

GENERAL ELEVATION AREAS	AVERAGE ANNUAL TEMPERATURE RANGE[a]	
	CELSIUS °C	FAHRENHEIT °F
Sawtooth National Forest, highest elevation	-1.1 - 1.6	30 - 34.9
Highlands, forest and hills	1.7 - 4.39	35 - 39.9
Uplands to valley floors	4.4 - 7.17	40 - 44.9
Floodplains and valley floors	7.2 - 9.9	45 - 49.9

[a] The average annual temperature range as calculated for the various elevations ranges and areas by White Horse Associates 1999. See Figure 7.



Source: White Horse Assoc. 1999

Precipitation	Hectares	Sq. Km.	% of Area
27.9 - 39.4 cm/yr	22,5150.8	2,251.5	57.5
39.4 - 52.0 cm/yr	79,896.8	799.0	20.4
52.0 - 64.8 cm/yr	68,791.5	687.9	17.6
64.8 - 77.5 cm/yr	14,554.5	145.5	3.7
77.5 - 90.2 cm/yr	3,163.8	31.6	0.8
90.2 - 102.9 cm/yr	236.5	2.4	0.1

Figure 6. Raft River Subbasin annual precipitation.

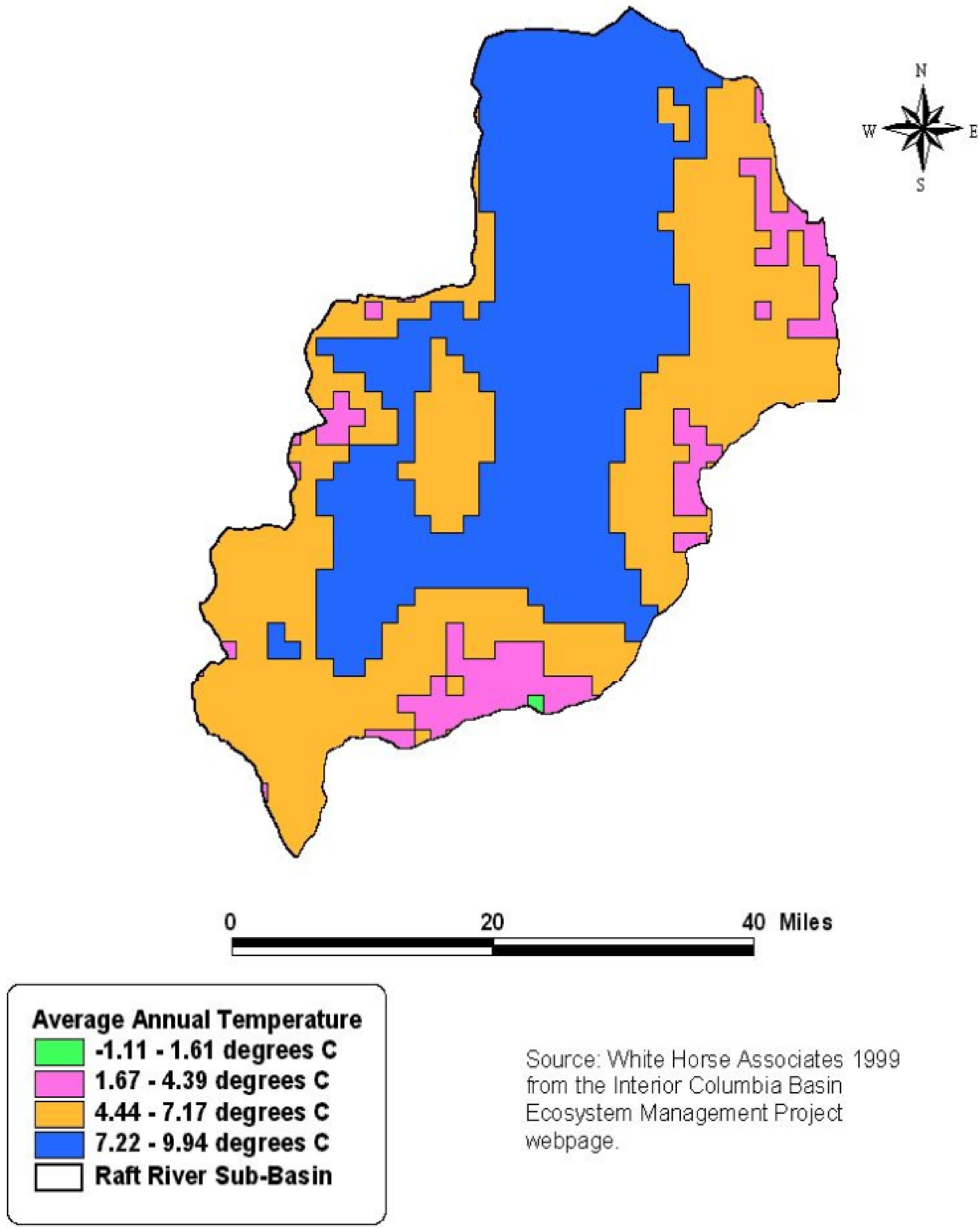


Figure 7. Average annual temperature, by various elevation ranges and areas.

Subbasin Wind Erosion

In the Snake River Basin of southern Idaho wind erosion occurs most frequently on single-grain textured soils where there are smooth surface conditions and a lack of crop residue or cover from fall planted crops. Wind erosion primarily occurs during the spring months when wind velocities are highest in the Snake River Plain area (NRCS 1998) of the Raft River Subbasin. It is the maximum wind speeds and gusts that move the loessal soil particles through the air to eventually settle on new territory, streams, and vegetation. It is uncertain to what extent erosion seasonally affects water quality on the §303(d) streams in the Raft River Subbasin. Based on regional estimates of uncovered single-grain textured soils, soil texture, and wind velocities, wind erosion's effect on water quality is not significant beyond a minimum amount of suspended sediment affecting water quality on an annual average basis. A localized problem with wind erosion as a resource problem; however, has been evident as related to Interstate 84 that passes through the area. Numerous deadly accidents have been related to blowing snow and soil. The section of Interstate 84 in the watershed has been considered one of the deadliest stretches of interstate in the country (SCS et al. 1991). Living snow fences and automated interstate warning signs have been installed, and soil conservation best management practices (BMPs) on land adjacent to the interstate have been implemented to help reduce the wind related problems.

Subbasin Hydrology

The natural hydrology of the Raft River Subbasin is related to its climate regime, topography, and geology. Many physical processes such as rainfall, streamflow, erosion, and sedimentation interact within the watershed boundaries to shape and form the landscape. The various watersheds in the Raft River Subbasin are natural divisions of the landscape and the basic functioning units of hydrologic systems. These watersheds are also hierarchical – smaller ones nest within larger ones. Landforms are also hierarchical; the valleys nest within watersheds and their natural form is part of the geologic history and physical and biological characteristics of the watershed. The hydrologic cycle links atmospheric water, surface water, and ground water control the distribution and movement of water in an ecosystem (USFS 1997). The history of natural and human disturbances along with environmental changes in the Raft River Subbasin has effected the hydrology of the region. Among the more observable changes, disturbance, compaction of soil, and changes in riparian areas are altering the relationships between infiltration, soil moisture storage, ground water recharge, surface runoff, flood control, and stream flows (USFS 2000). Depending on the location, one of these components may have a greater effect over another on the water quality and quantity of the Raft River, Cassia Creek, and Sublett Creek area tributaries. In general, water bodies within the Raft River Subbasin may be categorized into perennial, intermittent, or ephemeral water bodies.

A perennial stream is one that flows year-round in most years. Idaho's administrative ruiles do not define perennial streams, but by default a perennial stream is a stream that is not ephemeral or intermittent. An intermittent stream, as defined in IDAPA 58.01.02.003.50, is a stream that has a period of zero flow for at least one week during most years. Where flow records are available, a "stream with 7Q2 hydrologically based design flow of less that one-tenth (0.1) cfs is considered intermittent. Streams with perennial pools, which create significant aquatic life uses, are not intermittent." Ephemeral streams are streams that function as drainage channels that are normally dry but carry water in response to storms or annual snowmelt (Figure 8).

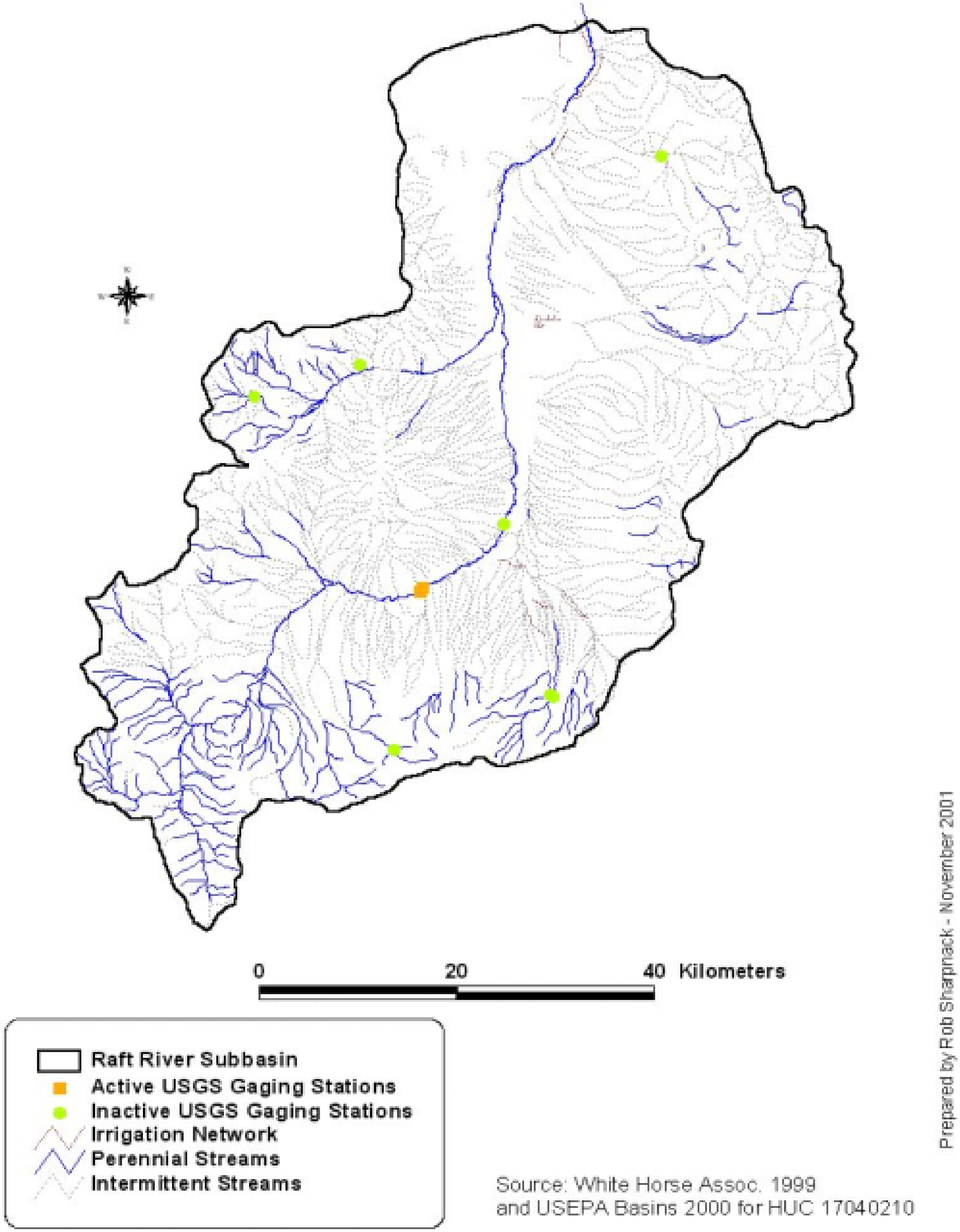


Figure 8. Raft River Subbasin hydrology.

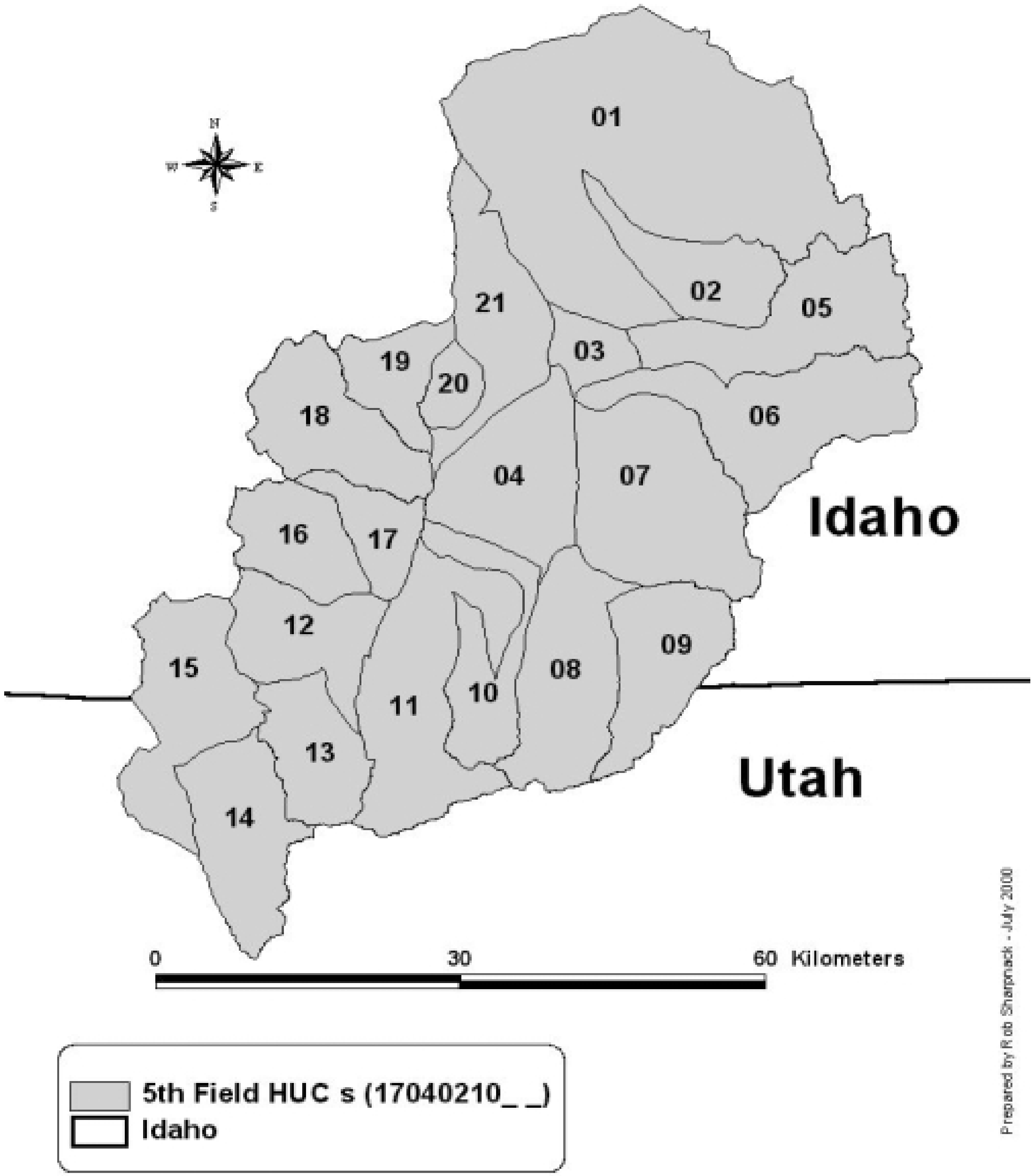


Figure 9. Fifth field HUCs within the Raft River Subbasin.

Subbasin Fifth Field HUC Characteristics

The Raft River Subbasin is hydrologically subdivided into 21 watersheds (or fifith field HUCs). These are listed in Table 9 with their appropriate number, name, and size and shown in Figure 9.

Table 9. Fifth field HUCs of the Raft River Subbasin 17040210.

Fifth Field Number	Watershed Name	Total Hectares	Fifth Field Number	Watershed Name	Total Hectares
[17040210] 01	Lower Raft River	78,126	[1700210]12	Upper Raft River	13,847
02	Shirley-Warm	12,062	13	Circle-Wildcat	11,983
03	Sublet Creek	5,002	14	Junction Creek	17,089
04	Clear Creek	19,167	15	Cottonwood Creek	20,173
05	Sublett Creek	20,853	16	Edwards Creek	11,585
06	Meadow Creek	24,254	17	Grape Creek	7,466
07	Kelsaw-Point Spring	28,149	18	Upper Cassia Creek	16,802
08	Clear-Holt	20,337	19	Cassia-Blacksmith	8,394
09	Round Mountain Creek	15,611	20	Upper Cassia Creek	3,905
10	Barnes-Onemile	12,576	21	Lower Cassia Creek	16,888
11	Johnson-George	27,426			

The Raft River System

The Raft River is the major stream draining the subbasin (HUC 17040210). It was once considered a perennial stream that was fed during periods of high runoff by numerous intermittent, ephemeral, and perennial streams. The natural surface outflow from the basin, based on measurements of the Raft River as early as 1910, is estimated to have averaged about 17,000 acre-feet per year (Walker et al. 1970). Considerably greater amounts of flow also occurred in the subbasin east of the Cotterel Range. That flow included an average annual inflow of about 18,000 acre-feet from Cassia Creek, 24,000 acre-feet from the Raft River at The Narrows, 8,400 acre-feet from creeks draining the Raft River Mountains, and 5,400 acre-feet from creeks rising in the Sublett Range. This average total inflow was about 56,000 acre-feet. Most of this water contributed to recharge of the ground water reservoir or was consumed by natural riparian ecosystems. However, certain reaches of the Raft River and its tributaries are now intermittent due to flow diversions for irrigation purposes (Walker et al. 1970). Flow into the Lake Walcott Subbasin from the Raft River are no longer considered perennial. Landowners and managers within the Raft River Subbasin have noted that the Raft River, near the Snake River, does not flow in a majority of years during the summers due to irrigation demands (SCS et al. 1991)

Raft River Tributaries and Their Watersheds

Two main tributaries form the headwaters of Raft River in Junction Valley, Utah. The southern parts of the Middle Mountain range and the Albion Mountain range feed into southern flowing

Junction Creek. The Middle Mountain range ranges from a high elevation of 2,469 m (8,100 ft) to 1,745 m (5,725 ft) at the confluence with Raft River. The northern sections of both the Middle Mountain and Albion Mountain ranges feed a northerly flow into Birch Creek of the Goose Creek HUC (17040211). The southern section of the Albion Mountain range ranges from a high elevation of 2,703 m (8,868 ft) at Graham Peak to 1,740 m (5,709 ft) at the confluence with Raft River. The western flows of the City of Rocks and Cedar Hills areas have small intermittent or ephemeral flows into Junction Creek. The South Fork of Junction Creek flows north to the confluence of Junction Creek to form Raft River. The Grouse Creek Mountains feed into Raft River on the west and south. Elevations range from 2,075 m (6,807 ft) to 1,740 m (5,709 ft) at the start of Raft River. From the east water comes from the Dove Creek Mountains which range north into the Raft River Mountains of the Sawtooth National Forest. Marble Canyon Peak at 2,544 m (8,346 ft) and George Peak at 2,926 m (9,600 ft) are some of the higher elevations. Several small intermittent or ephemeral tributaries feed into the South Fork of Junction Creek or into the Raft River itself.

Major natural tributaries to the Raft River (using a 1:100,000 scale GIS coverage) are listed in Table 10 according to their river mile (RM) location on the Raft River in Idaho and from which bank they enter the Raft River.

Table 10. Natural tributaries to the Raft River.

Tributary Name	Bank Inputs	River Mile[a]	Elevation Levels		Headwater Area
			Confluence (meters)	Headwaters (meters)	
Junction Creek	Confluence	Utah	1,745	2,469	Middle Mountains
Junction Creek	Confluence	Utah	1,745	2,703	Albion Mountains
South Fork of Junction Creek	Confluence	Utah	1,745	2,926	Raft River Mountains
Lynn Creek	Right	Utah	1,742	2,230	Raft River Mountains
Big Pole Creek	Right	Utah	1,738	2,313	Raft River Mountains
Wild Cat Creek	Right	Utah	1,736	2,250	Raft River Mountains
Circle Creek	Left	70.8	1,570	1,804	Albion Mountains
Johnson Creek	Right	68.8	1,564	2,250	Raft River Mountains
Edwards Creek	Left	68.6	1,560	2,316	Albion Mountains
Grape Creek	Left	68.2	1,559	2,500	Albion Mountains
George Creek	Right	67.2	1,530	2,250	Raft River Mountains
Onemile Creek	Right	60.6	1,520	2,650	Raft River Mountains
Cottonwood Creek	Left	51.5	1,450	1,870	Jim Sage Mountains
Cassia Creek	Left	32.0	1,350	1,780	Albion Mountains

[a] Raft River Rivermile, Idaho Side Only

Tributaries to Cassia Creek That Flow from the Albion Mountains to the Raft River

Natural tributaries to Cassia Creek (using a 1:100,000 scale coverage) are listed in Table 11 according to the RM location on Cassia Creek.

Table 11. Named tributaries that feed into Cassia Creek.

Tributary Name	Bank Inputs	River Mile	Elevation Levels		Headwater Area
			Confluence (meters)	Headwaters (meters)	
New Canyon Creek	Left	22.5	1,814	2,000	Albion Mountains
Flat Canyon Creek	Right	22.5	1,814	2,000	Albion Mountains Headwaters of Cassia Creek
Stinson Creek	Right	20.5	1,752	2,365	Albion Mountains
Clyde Creek	Left	17.5	1,713	2,450	Albion Mountains
Conner Creek	Left	12.4	1,498	2,310	Albion Mountains

Tributaries to Sublett Creek Reservoir

Natural tributaries in the Sublett Reservoir/Creek area (using a 1:100,000 scale coverage) are listed in Table 12 according to the RM location on Sublett Creek.

Table 12. Named tributaries to Sublett Reservoir.

Tributary Name	Bank Inputs	River Mile	Elevation Levels		Headwater Area
			Confluence (meters)	Headwaters (meters)	
Fall Creek listed	Right	1.5 on Lake Creek	1,647	1,829	Flows to Lake Creek
Van Camp Creek	Right	0.5 on Lake Creek	1,638	1,750	Flows to Lake Creek
Lake Creek	-		1,627	1,836	Flows to Sublett Reservoir
South Fork of Sublett Creek	Left	0.0	1,661	1,989	Forms Sublett Creek
North Fork of Sublett Creek	Right	0.0	1,661	2,109	Forms Sublett Creek
Sublett Creek	-	2.0	1,630	1,661	Flows to Sublett Reservoir
Sublett Creek below Sublett Reservoir	-	-	-	1,613 Headgate elevation at Sublett Reservoir.	Flows from RM[a] 3.5 to approximately RM 12

[a] RM = River Mile

Raft River Subbasin Stream Lengths

It is estimated that approximately 504 km (313 miles) of perennial streams exist in the Raft River Subbasin. Various irrigation practices and diversions have changed parts of the Raft River so that much of the lower sections no longer flow as a perennial stream. Irrigation networks of canals and streams channels vary with availability of runoff flows and may not be used every year (Figure 10). Estimates based upon ArcView coverages provided by the Idaho Department of Water Resources (IDWR) and the EPA BASINS program indicate that there are 2,920.7 km (≅1,815 miles) of intermittent streams in the subbasin. Many of these streams are ephemeral and only function as drainage channels. These channels are normally dry and carry water only in response to storm events.

Subbasin Reservoirs and Natural Lakes

The Raft River Subbasin contains one man made reservoir developed primarily for agricultural water supply. In addition to this use the reservoir also supports recreation and aquatic life beneficial uses. The subbasin also contains several high mountain lakes. These lakes are primarily recreational water bodies as well as supporting aquatic life beneficial uses. Additional uses include grazing.

Sublett Reservoir

Sublett Reservoir is the only named reservoir in the Raft River Subbasin and is located in Management Area 20 of the Sawtooth National Forest lands in the Sublett Mountain Range. It is located in Cassia County and the area is administrated by the Sawtooth National Forest Minidoka Ranger District. The USFS lands are estimated at 78,250 acres. Less than 1 percent of this land is made of small private holdings, which are included in this total. The majority of the reservoir lies within these private land holdings. Private ranches and BLM lands surround the area US Forest Service administered lands. Most private lands have been converted to agriculture uses. Primary land uses in the USFS areas are livestock grazing, recreation, and timber management. The North and South Forks of Sublett Creek, along with Lake Fork, are the main perennial streams that feed Sublett Reservoir. Fall Creek feeds into Lake Fork and is listed on the §303(d) list. Most of the other streams run intermittently. Table 12, above, shows other tributaries in the area.

The elevation at the dam on Sublett Reservoir is 1,628 m, (5,341 ft.) the spillway is 1,626 m, (5,335 ft.) and the elevation at the headgate 1,613 m, (5,292 ft.). The reservoir covers approximately 80 acres. The reservoir offers fishing opportunities for rainbow trout, brown trout, cutthroat trout, and Kokanee salmon. Water storage in the reservoir provides irrigation water for downstream farms and ranches.

Rainbow trout and Yellowstone cutthroat trout are present in Sublett Creek, Lake Fork Creek, the North and South Forks of Sublett Creek, and Sublett Reservoir. Brown trout and kokanee salmon have been introduced to Sublett Reservoir and migrate up the streams to spawn. Fish habitat is limited elsewhere due to the small size and intermittent nature of area streams. Overall, aquatic habitat is functioning at low risk due to sedimentation impacts, grazing, and dewatering. Native cutthroat populations are at risk due to the presence of introduced fish species (USFS 2000).

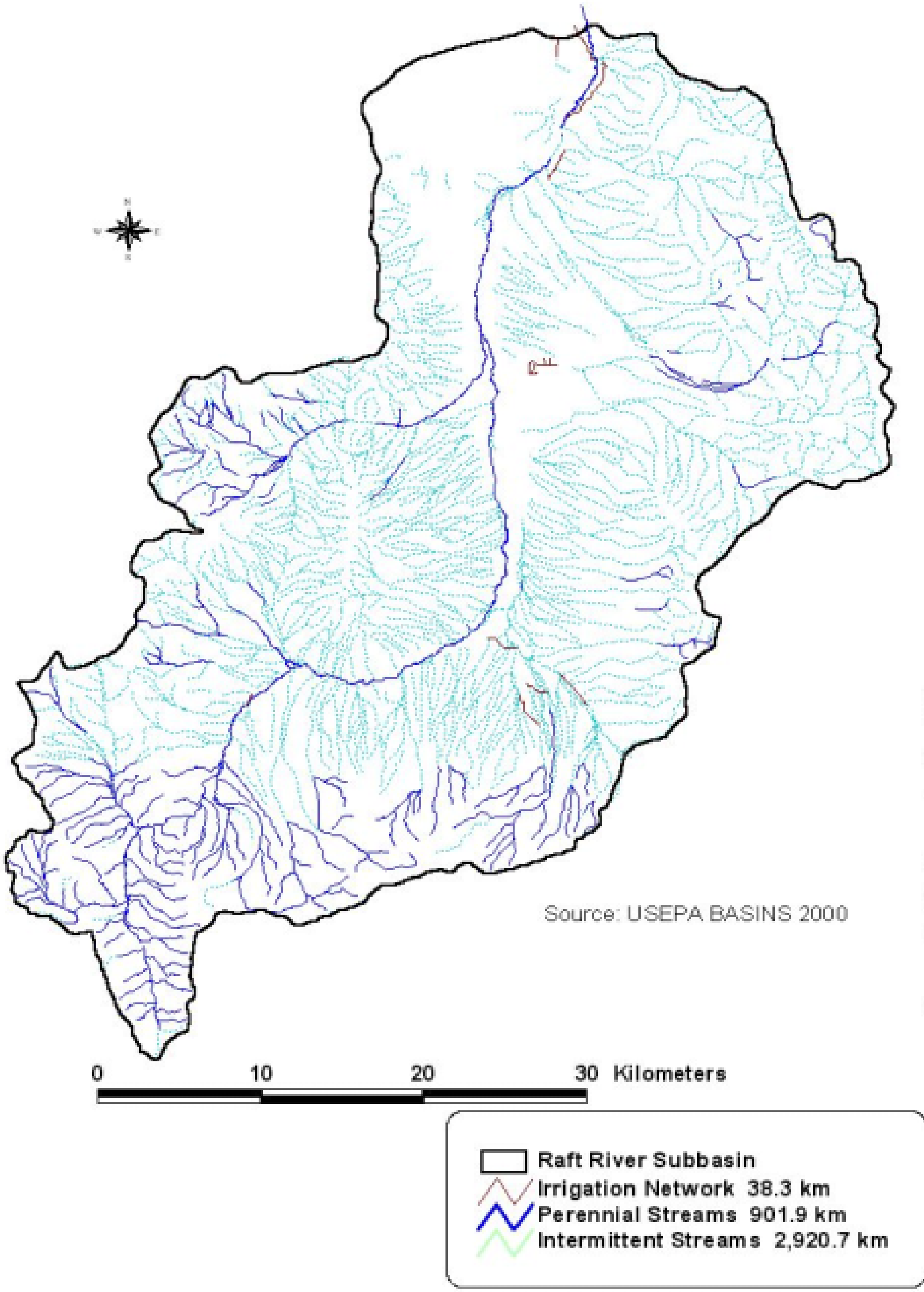


Figure 10. Raft River Subbasin stream lengths.

Independence Lakes

Four small natural lakes lie near Cache Peak, which, at 3,170 m (10,399 ft.), is the highest mountain in Idaho south of the Snake River. Their general location lies on USFS lands on the western side of the Albion Division of the Minidoka Ranger District. The drainage of the lakes is in the upper Green Creek area, comprising the only system of natural lakes in the entire southern division of the Sawtooth National Forest. The area lies within Cassia County and has an estimated 43,300 acres. The City of Rocks National Reserve borders the southern portion of the area. Livestock grazing and recreation are the primary land use activities in the area. The Independence Lakes area is a popular recreation destination. The lakes have been planted with rainbow trout, cutthroat trout, California golden trout, and Arctic grayling. The four small lakes vary in size from 3.64 acres (southern most lake) to 4.47acres (next southern most lake) to 14.47 acres (largest lake) to 5.20 acres (northeast lake).

Subbasin Ground Water and Aquifers

The Raft River Subbasin includes subbasin aquifers, artesian springs, and various irrigation wells. Ground water in the Raft River Subbasin occurs in valley fill deposits, including the Pleistocene Raft Formation, the Holocene alluvium, and the upper part of the Apliocene Salt Lake formation. Most water is in the Raft River Valley, east of the Cotterell Range. The Raft River Subbasin is a major drainage subbasin tributary to the Snake River at Lake Walcott. Prior to development and use of its water resources by man, the basin contributed an estimated average 100,000 acre-feet of surface and subsurface flow to the Snake River system annually. Of the remaining estimated 140,000 acre-feet total annual water yield, about 40,000 acre-feet was consumed by riparian vegetation along stream channels (Walker et al. 1970). Some pumping of ground water for irrigation in the valley was started in the 1920s, but it was not until about 1950 that larger-scale pumping for irrigation developed. The ground water development was to supplement Raft River water shortages and to develop additional cropland. Mass production of deep wells for irrigation has adversely impacted the ground water supply. In 1963, IDWR declared the aquifer in the Raft River drainage a Critical Ground Water Area. The expansion of the area under protection continued until 1977, restricting deep well pumping. Studies indicated that annual ground water contribution from the basin (presumably to the Snake River) was 80,000 acre-feet/year, but that pumping withdrawals in excess of 105,000 acre-feet/year were endangering this flow and causing declining ground water tables (SCS et al. 1991). The Raft River Critical Ground Water Area of July 1977 is still current today (Harrington and Bendixsen 1999).

Most of the ground water suitable for irrigation development in the Raft River Subbasin occurs in the valley fill. The ground water is generally unconfined, and the several geologic formations constitute a single aquifer with a thickness exceeding 700 feet under most of the lowlands. Relatively impermeable rocks underlie this aquifer. West of the Cotterell Range, the same geologic formations are water bearing in the Yost-Almo and Elba watersheds. From these various watersheds there is outflow to the Raft River Valley through the alluvial valleys occupied by the Raft River and Cassia Creek as they traverse the Cotterell Range. The northern end of the subbasin is bordered by basalt which is highly permeable, but which includes massive impermeable rocks as well (Table 13) (EPA 2001).

Table 13. Raft River Subbasin aquifers.

Aquifer	Square Kilometers	Square Miles	Rock Type
Pacific Northwest basin-fill aquifers	2,481	958	Unconsolidated sand and gravel aquifers
No principal aquifer	730	282	N/A
Volcanic-and sedimentary-rock aquifer	251	97	Basalt and other volcanic-rock aquifers
Basin and Range aquifers	215	83	Unconsolidated sand and gravel aquifers
Snake River Plain aquifer system	158	61	Basalt and other volcanic-rock aquifers
Miocene basaltic-rock aquifers	18.1	7	Basalt and other volcanic-rock aquifers
Basin and Range carbonate-aquifers	2.59	1	Carbonate-rock aquifers

Major source: EPA 2001 Surf Your watershed (wysiwyg://2/http://www.epa.gov/surf2/hucs/17040210/).

Subbasin Geology

The Raft River Watershed is in the northern extension of the Basin and Range Province. The subbasin characteristically has steeply sloping mountain ranges and intervening wide, open valleys. As stated before, elevations range from 1,281 m (4,202 ft) at the confluence of Raft River with Lake Walcott to 3,150 m (10,335 ft) at the top of Cache Peak. The Raft River Valley is the largest in the watershed. Large, overlapping alluvial fans have developed along the surrounding mountains and extend to the valley floor. The Raft River floodplain is primarily located on the west side of the valley and varies in width from approximately 100 m wide in the southwest part in Utah to nearly 3 km in the Malta area. The Sublett and Blackpine Mountains on the eastern side of the watershed are primarily composed of limestone with some quartzite and sandstone. The central area Cotterel and Jim Sage Mountains are rhyolite and the western area Albion and Middle Mountain highlands have large components of mica schist, quartzite, and some granodiorite (SCS et al. 1991).

As stated before, the overall geologic structure of the area lies within the north to south oriented Basin and Range Province. The northern sections of the Raft River Subbasin are crosscut east to west by the Snake River Plain. Locally thick deposits of loess (wind-blown silt) overlie these rocks, particularly in the volcanic Snake River Plain (Alt and Hyndman 1989). The Basin and Range is an area of faulted metamorphic and sedimentary rocks uplifted into mountains, separated by basins deeply filled with alluvium. The Snake River Plain is a deep, wide, structural basin filled with a veneer of volcanic basalt deposits overlying rhyolite (Alt and Hyndman 1989). The rocks decrease in age, from west to east, due to migration of a magma source to the location of present-day Yellowstone National Park.

The northern section of the Raft River Subbasin lies on large basalt flows. Because less than one fourth of the surface area is bare rock, it probably belongs to the oldest group of the younger basalt flows. Geologists broadly classify the younger lava flows on the Snake River Plain into approximate age groups according to the amount of rock still without soil cover. These flows are described as, youngest flows, more than 75 percent exposed; intermediate flows between 25 and

75 percent exposed; and older flows, less that 25 percent exposed. The oldest flows are completely covered with soil and plants and are not usually exposed (Alt and Hyndman 1989).

The main valley of the Raft River Subbasin contains a deep fill of sedimentary and volcanic rocks, which likely accumulated during the latest Miocene and Pliocene Epochs. The deposits include silt, sand, gravel, mudflows, lakebed sediments, and volcanic ash. There are also areas of erupted rhyolite and basalt. The Miocene and Pliocene Epochs were 2.5 to 3 million years ago. During the Miocene Epoch, a giant meteorite struck southeastern Oregon, and the Basin and Range faulting began. The Columbia Plateau was formed and the Snake River Plain started across southwestern Idaho. The Pliocene Epoch that followed had volcanic hotspots migrating northeast, leaving the Snake River Plain in its wake. The valley-fill sediments in the Raft River Subbasin hold substantial geothermal energy likely from volcanic activity heating the rocks beneath the valley floor (Alt and Hyndman 1989). The area near the Idaho Raft River Narrows is considered volcanic plateau land. Above The Narrows, the area is mixed alluvial land. Current landscapes in the subbasin began developing in the middle and late Cenozoic period. "Late Tertiary events, largely the result of crustal extension, include folding and faulting to form the present mountains, sediment-filled basins, and local rhyolite volcanism. The folding produced the Sublett, Black Pine, Albion, Middle, and Cassia ranges"(SCS et al. 1991). The middle Cenozoic Era contains the Miocene (earlier) and the Pliocene (later) Epochs described above. The later part of the Cenozoic Era, in the period called Pleistocene, was when the Yellowstone volcano begin to erupt (about 1.8 – 0.6 million years ago). The later part of this period (considered the present) was the end of the desert climate, and modern streams began to flow in the region. Between this period to the present an early ice age existed, about 70,000 to 130,000 years ago. The last ice age ended about 10,000 years ago (Alt and Hyndman 1989).

As stated before, large alluvial fans exist throughout the Raft River Subbasin and are dissected by streams in some areas. Typically, in dry desert regions where sudden floods of runoff follow occasional heavy rains, enormous loads of sediment are deposited. This sediment is left behind in fans shaped like segments of cones laid out on the flanks of the mountains. This geology is evident on the Sublett and Black Pine Mountains and other areas in the watershed.

As climates change and wetter periods develop, increased plant cover helps prevent the catastrophic soil erosion and floods of surface runoff typical of deserts. Reduction of the rate of soil erosion by plants tends to foster clear streams that tend to erode their beds rather than deposit sediment. As the amount of rain and snowmelt increases, proportionally there is more water available to soak into the ground because of increased plant coverage. Consequently, there are expanded reservoirs of stored ground water. This stored ground water is then available to keep streams flowing throughout dry seasons. These perennial streams erode valleys in alluvial fans, instead of covering them with new blankets of sediment. The dissected alluvial fans indicate that the amount of rainfall has varied significantly over the recent geologic past. During dry periods, the fans probably grew and existed between ice ages. The various ice ages probably brought on wet periods, perennial streams, and head cutting through the fans.

The Cotterel and Jim Sage Mountains have rhyolite flows as their parent material. As uplifting occurred, the brittle rhyolite fractured allowing water to erode deep, V-shaped, narrow canyons. The canyons formed by this process are 300 to 400 feet deep in the Cotterel Mountains and some approach 1,000 feet deep in the Jim Sage Mountains. The Jim Sage Mountains have a pronounced fault scarp with exposed dark lava flows capping steep grassy slopes on pale rhyolite. The Black Pine and the Sublett Mountains, as stated before, are primarily of limestone with some sandstone and quartzite. These ranges have eroded rapidly causing numerous, V-shaped, steep-sided, narrow valleys. The Albion and Middle Mountains have large deposits of mica schist and quartzite. Because of slower weathering of these materials, the mountains are rounder and smoother in appearance. Narrow V-shaped valleys only exist along major drainages.

Table 14 has a geologic description for the various formations and Figure 11 gives a breakdown of the Idaho sections of the Raft River Subbasins geology.

Table 14. Geologic descriptions for various formations.

Formation	Raft River Subbasin Geologic Descriptions
Ms	Mississippian shallow-water coralline limestone interval of southern Idaho
O	Ordovician marine dolomite quartzite and limestone
OCm	Schist quartzite and other metasediments of probable Lower Ordovician
OW	Open Water
PC	Precambrian high-grade metamorphic rocks
PNs	Pennsylvanian beds; lowermost portion of southern Idaho sequence
PPNs	Lower Permian to Middle Pennsylvanian chert limestone and sandstone
PZu	Upper Paleozoic marine sediments in southern Idaho
Ps	Lower Permian beds; uppermost portion of southern Idaho sequence
QTb	Lower Pleistocene to Pliocene basalts with associated tuffs and volcanic detritus
Qa	Quaternary alluvium
Qd	Quaternary detritus
Qg	Quaternary colluvium fanglomerate and talus
Qpt	Pleistocene till moraines and similar unsorted glacial debris
Qpu2b	Upper Pleistocene Snake Plain lava flows
Qs	Quaternary surficial cover
TR	Triassic shallow-marine to non-marine sediments of eastern Idaho
Tei	Eocene intrusions
Tpd	Pliocene stream and lake deposits
Tpf	Pliocene silicic welded tuff ash and flow rocks
Tpv	Pliocene volcanic units

[a] GIS coverage changes at state lines due to different state descriptions for geological types.
Various agencies are working to have the descriptions the same for all areas.

The Albion Mountain Range is well known among geologists for its areas of sheared mylonites. This Cassia granite began as molten magma long after the Rocky Mountains formed, during early Tertiary period. They formed along fault zones at a level so deep within the continental crust that the rocks were hot enough to deform by flowing, like modeling clay, instead of through breakage. These mylonites appear to outline an area of deep-seated rock that rose as the overburden moved off along the mylonite fault zones. The Sublett and Black Pine Mountains probably contain the rocks that moved off the mylonite. If so, those rocks moved east at least 50 miles. Geologists call such structures metamorphic core complexes and their age is difficult to date. The mylonites in the area are probably somewhere between 20 and 40 million years old (Alt and Hyndman 1989).

Subbasin Soils and Soil Erosion

Soil orders within the ecoregions of the Raft River Subbasin are described in Table 15 with their corresponding erosion potential, which can effect the water quality of streams.

Table 15. Soil orders of the Raft River Subbasin[a].

NRCS[b] Soil Orders	Soil Genesis	Soil Development	Potential Natural Vegetation	Erosion Potential
Aridisols (Lower Elevations)	Arid soil (clayey soils)	Dry environments not subject to intensive leaching.	Sagebrush, desert shrub,shrubgrass, saltbush-greasewood, juniper-pinyon, woodlands, wheatgrass, buffalo grass, short grasses.	High potential to erode. Generally < 15% slope.
Entisols (Lower Elevations)	Recent soil (clayer soils)	Formed from natural events such as floods, landslides, or erosion. Occur in combination with Aridisoils.	Rangeland. They may be forested or used for cropland.	Steeper slopes are erodible. Generally < 20% slope. Lack of significant profile development.
Mollisols (middle Elevations)	Soft soil (clayer soils)	Formed and developed under prairie vegetation.	Grassland environments. They may be used for croplands and agricultural soils. Both short and tall grasses.	Low to moderate erosion potential. Generally < 20% slope
Inceptisols (Middle Elevations)	Beginning soil (clay soils)	Productive soils developed from volcanic ash.	Agricultural wheat lands developed from more productive grasslands and rangelands.	Generally < 25% slope. Profile development is more than Entisols by less than other orders
Alfisols (Higher Elevations)	Nonsense soil (cool to cool soils)	Formed under forest vegetation with significant weathering, although grass is the native vegetation in some areas.	Forest vegetation, tall grasses, some agricultural soils.	Generally < 10% slope. Low to moderate potential to erode.

[a] From USFS 1994 in consultation with BLM, NRCS, and the Big Wood River Subbasin Assessment (Buhidar 2001).
[b] U.S. Department of Natural Resource Conservation Service.

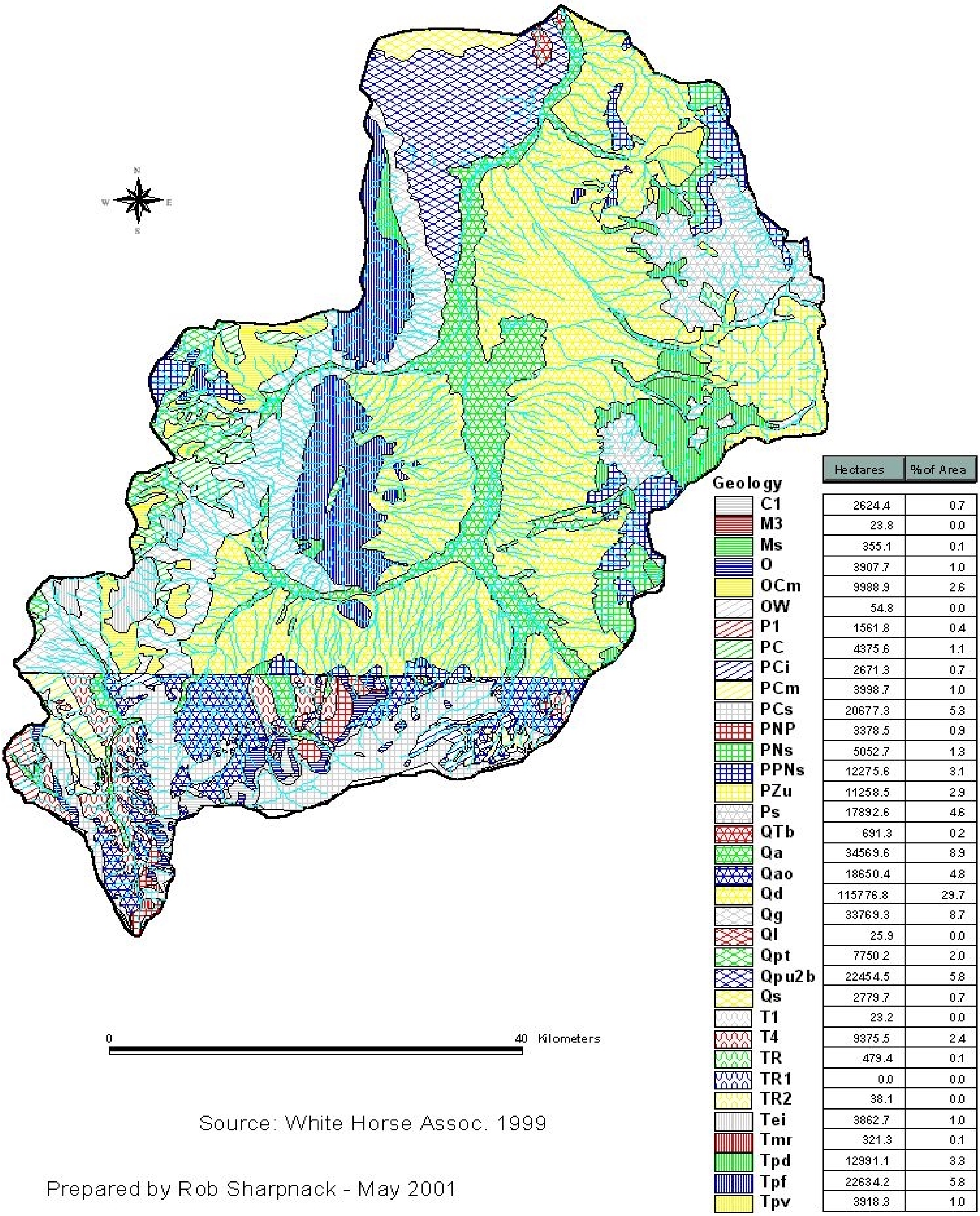


Figure 11. Raft River Subbasin geology.

The primary soil orders described in Table 15 provide a good description of the type of soil that may contribute erosional sediment to water bodies based on the extent of their disturbed conditions and their surface slope (Buhidar 2001).

Generally average soil slope provides a gage of the potential soil erosion, or risk erodibilty. The USGS topographic maps show that slopes are low (0-9 percent) in the valleys and plains and gradually increase as one approaches the bordering mountain ranges. Slopes are steep in the mountain ranges, exceeding 30 percent in places.

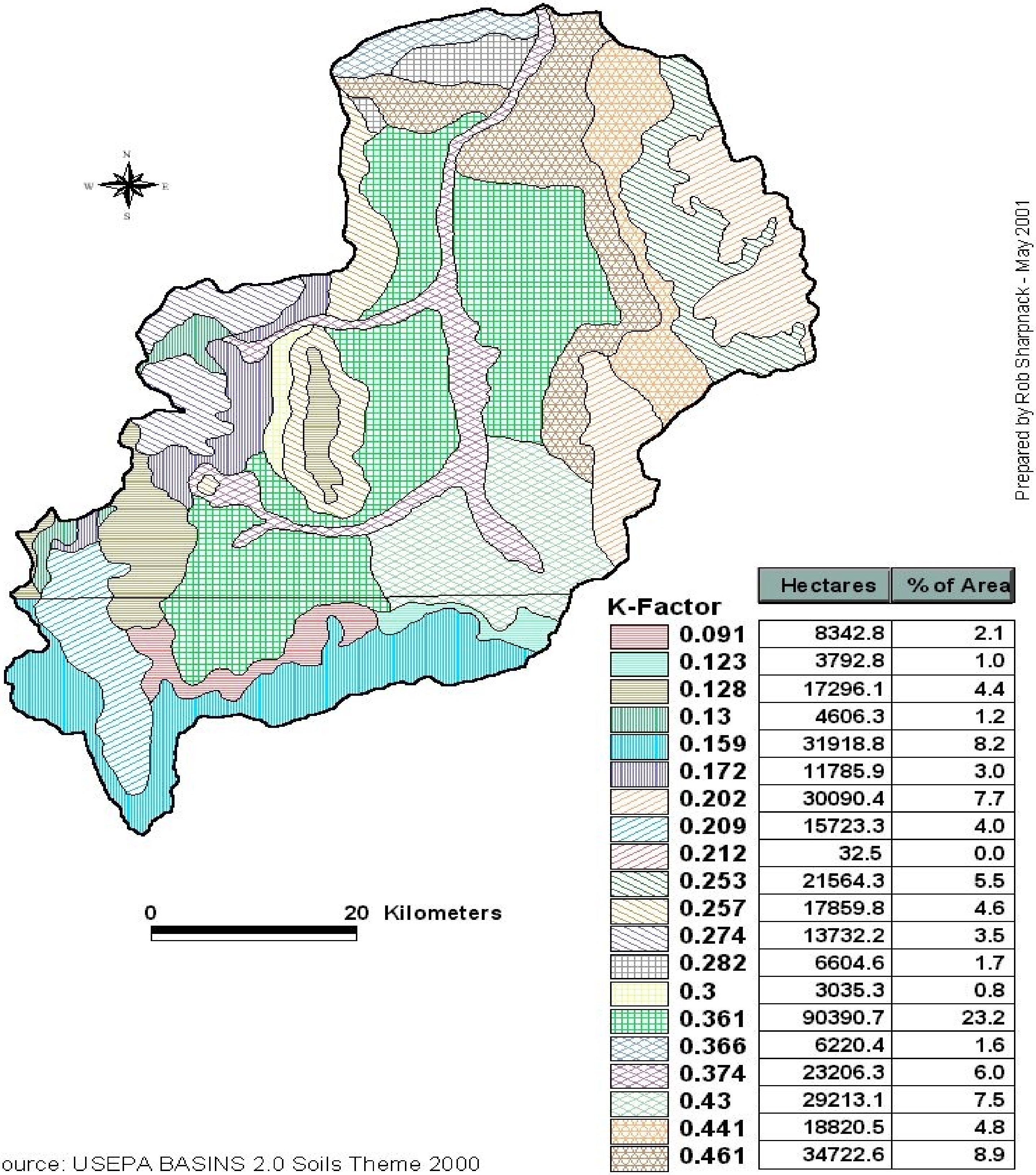
The K-factor is the soil erodibilty factor in the Universal Soil Loss Equation (Wischmeier and Smith 1965). The factor is comprised of four soil properties: texture, organic matter content, soil structure, and permeability. The K-factor values range from 1.0 (most erosive) to 0 (nearly non-erosive). As seen in Figure 12, the weighted average K-factors range from very low on the flat interior slopes of the plain, to quite high on the friable soils in the Heglar area. On the steeper, but rocky, unweathered slopes of the mountains the erosion potential is moderate.

The soils in the Raft River Watershed formed from residual, alluvial, colluvial, lacustrine, and eolian parent materials. These materials derive from rocks ranging in age from the late Precambrian Harrison series found in the Albion and Middle Mountain to recent alluvium along the Raft River. The soil in the Sublett Mountains developed in alluvium and colluvium which were derived from limestone of the Mississippian Age. On the foothills and at the base of the Sublett and Blackpine Mountains are seep deposits of loess and silty alluvium from the loess deposited on the adjacent mountains. The soils developed in this silty material are represented by the Heglar, Rexburg, and Ririe series. The soils in the Cotterel and Jim Sage Mountains developed in alluvium and colluvium derived primarily from rhyolite with some loess influence (SCS et al. 1991). See Figure 13 for basic Raft River Subbasin soil subsections.

The clayey soils found in the subbasin lend themselves to furrow erosion in middle and lower elevation agricultural areas in alluvial terraces and low plateaus. Three types of soil erosion occur in the subbasin: sheet, rill, and furrow. "Sheet and rill erosion occurs on cropland when rainfall or snow melt occurs on sloping fields that are unprotected by crop residues or rough soil surface conditions and is found on non-irrigated croplands. Much of the eastern side of the Raft River Valley is dry farmed with the exception of the Sublett Creek area and the north and eastern sections of the valley. Sheet erosion occurs when a thin layer of soil or rough is detached or separated from the soil surface by water moving over the surface and then transported down slope" (NRCS 1998). Irrigation in the valley can produce furrow (irrigation induced) erosion. This occurs primarily on surface or furrow-irrigated cropland with fine textured soils. This type of erosion can also occur under sprinkler irrigation. "When irrigation water is applied to crops it detaches soil particles from the soil surface and transports it off site. Proper management of irrigation water in terms of volume, length of time, and related agronomic practices influence erosion" (NRCS 1998).

Gully erosion, in cropland soils of the Raft River Watershed, predominantly occurs on the fan slopes of the valley floor. The process occurs during intense summer thunderstorms. Soil erosion is more common on croplands of bare soils, soils that are summer fallowed, or soils that are planted to winter wheat that have spring thaw runoff or frozen soil runoff.

Classic gullies occur in numerous areas in the watershed, most particularly in well-defined drainages such as the Heglar Canyon area, and form incised permanent channels. There are many miles of classic gullies and most originate on the steeper non-irrigated uplands then slice through the irrigated cropland fields. The resulting sediment load is deposited into the Raft River or other major tributaries in the subbasin (SCS et al. 1991).



K-Factor	Hectares	% of Area
0.091	8342.8	2.1
0.123	3792.8	1.0
0.128	17296.1	4.4
0.13	4606.3	1.2
0.159	31918.8	8.2
0.172	11785.9	3.0
0.202	30090.4	7.7
0.209	15723.3	4.0
0.212	32.5	0.0
0.253	21564.3	5.5
0.257	17859.8	4.6
0.274	13732.2	3.5
0.282	6604.6	1.7
0.3	3035.3	0.8
0.361	90390.7	23.2
0.366	6220.4	1.6
0.374	23206.3	6.0
0.43	29213.1	7.5
0.441	18820.5	4.8
0.461	34722.6	8.9

Figure 12. Raft River Subbasin soil K-factors.

The main Raft River channel exhibits frequent bank erosion, especially in areas where grazing and trampling occur along the stream. In these areas the riparian habitat no longer exists or is severely degraded. Bank erosion also occurs in areas that have had stream alteration, such as channel straightening or bank armoring. In many of the tributaries in the subbasin, little or no riparian habitat exists along the channels and stream banks. In many cases, farming operations continue directly into the channel area. Much of the Raft River that lies within the Utah section of the subbasin has good riparian areas, less stream bank erosion, and generally well vegetated shorelines that appear to be in stable condition (Etcheverry 2001). The Raft River Subbasin plateau is 38 percent of the total subbasin area. Most of the Idaho section of the Raft River flows through this plateau. Fluvial areas also contribute to the overall subbasin sedimentation (See Figure 11). Further breakdowns for the Raft River Subbasin subsection are shown on Figure 13.

The Raft River rarely contributes direct flow to the Snake River during the summer because of water consumption by upstream irrigation. These rare discharges; however, have been estimated to bring considerable sediment and nutrients to the Snake River when they do occur. It has been estimated that when discharges occur, an annual loading of 900 tons of phosphorus, 840 tons of nitrogen, and 10-35 tons of sediment/acre/year are deposited into the Snake River from the Raft River Subbasin (SCS et al. 1991).

Subbasin Topography

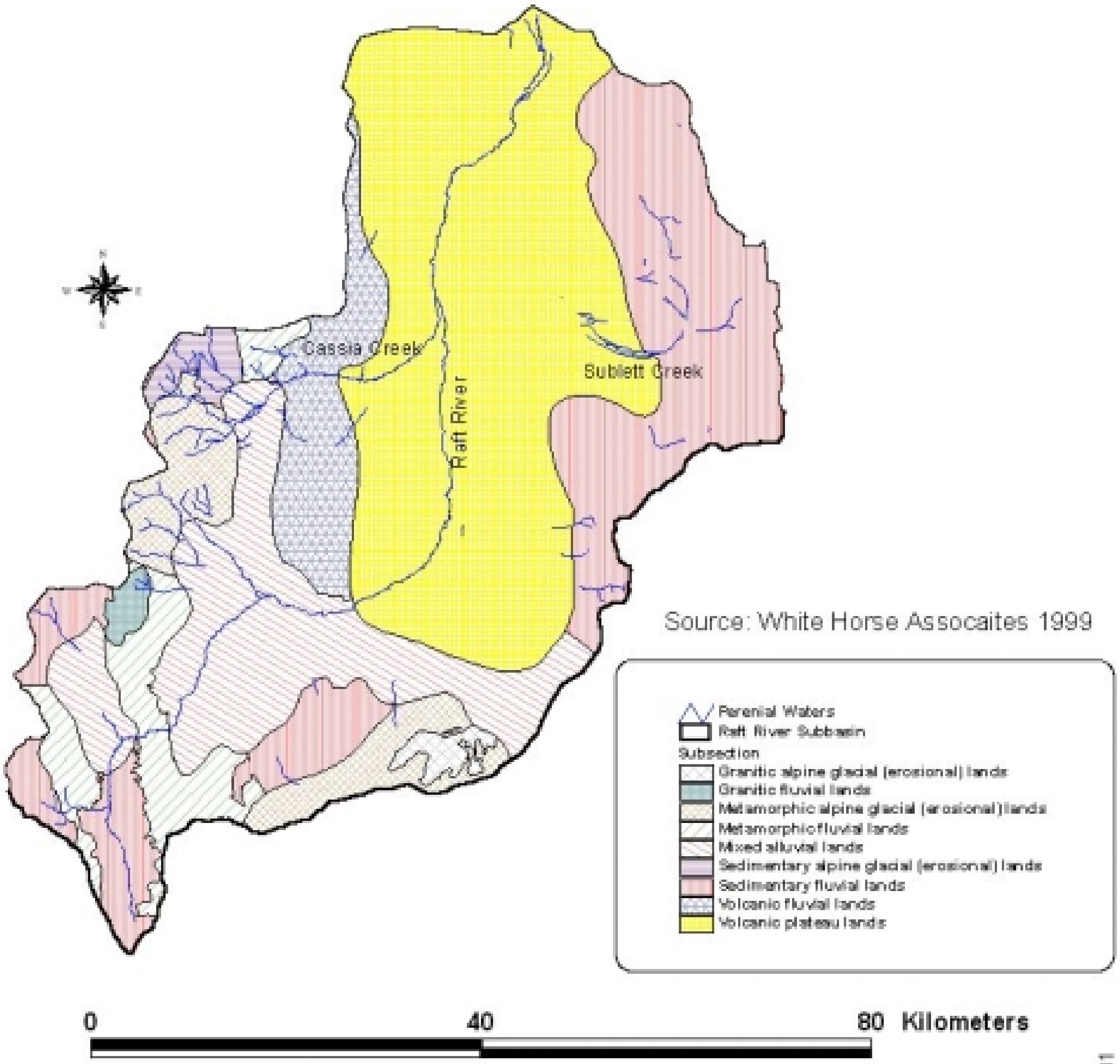
The Raft River Subbasin is cartographically covered by 1:24,000-scale and higher USGS topographic quadrangle maps. Lands surrounding the Raft River Subbasin (Idaho and Utah) has two dominant subsections, which are the Great Basin and the Jarbidge High Mountain Ranges. The dominant landforms are glaciated mountains, fluvial mountains, plateaus and escarpments, and depositional lands. Slope gradients average 40 to 70 percent on the glaciated mountains and the fluvial mountains, 0 to 30 percent on the plateaus and depositional lands, and are near vertical on the lands surrounding the Raft River (Figure.14).

Subbasin Plant and Animal Characteristics

This section describes the plant and animal characteristics of the Raft River Subbasin relative to vegetation; wetlands/riparian areas; fisheries; wildlife; macroinvertebrates; and threatened, endangered, and sensitive species.

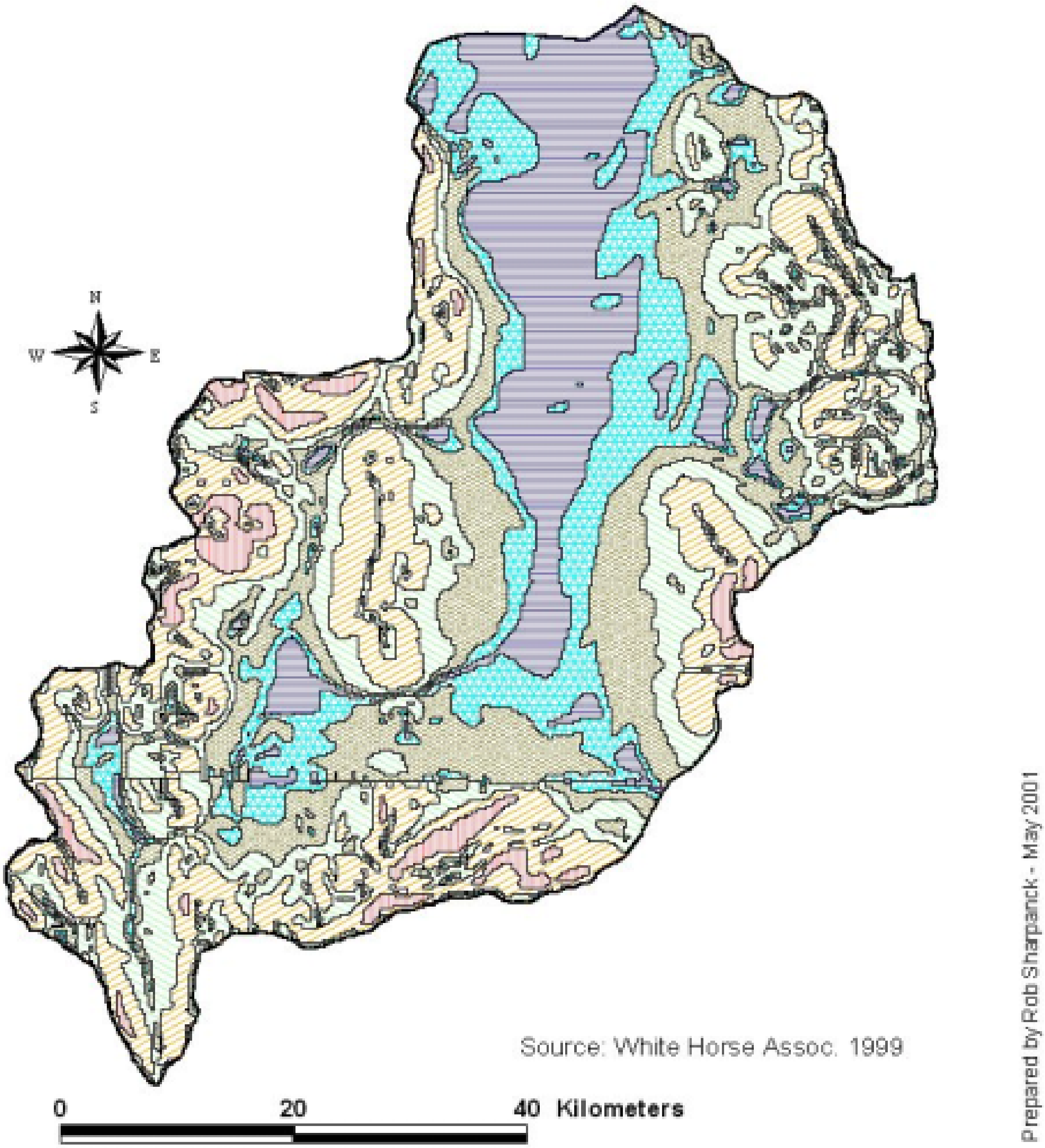
Subbasin vegetation

The vegetation on public USFS and BLM lands of the Raft River Subbasin can be categorized into two general categories: vegetation at the lower-to-middle elevation areas and vegetation at the middle-to-higher elevation areas. Generally these are broad categories that link to the area's ecoregions and to the natural and/or disturbed hydrology of the ecoregion.



Description	Hectares	Sq. Km.	% of Area
Granitic alpine glacial (erosional) lands	3,183.0	31.6	0.8
Granitic fluvial lands	2,443.8	24.4	0.6
Metamorphic alpine glacial (erosional) lands	25,995.4	260.0	6.6
Metamorphic fluvial lands	24,415.8	244.2	6.2
Mixed alluvial lands	62,432.7	624.3	15.9
Sedimentary alpine glacial (erosional) lands	5,114.9	51.1	1.3
Sedimentary fluvial lands	93,550.5	935.5	23.9
Volcanic fluvial lands	25,120.8	251.2	6.4
Volcanic plateau lands	149,565.7	1,495.7	38.2

Figure 13. Raft River Subbasin subsections.



Slopes	Hectares	Sq. Kilometer	% of Area
Less than 1 %	59,085.2	590.9	15.1
1 to 2 %	59,237.9	592.4	15.1
2 to 5 %	82,976.3	829.8	21.2
5 to 10 %	89,932.9	899.3	23.0
10 to 22 %	87,391.0	873.9	22.3
22 to 46 %	13,175.5	131.8	3.4

Figure 14. Raft River Subbasin gradient classes.

Vegetation communities in the lower/middle elevations include sagebrush, riparian, and grasslands.

1. The sagebrush and grassland vegetation community includes cheatgrass, meadow grass, wheatgrass, mixed shrubs, rabbitbrush, and several sagebrush species. In other areas of the lower valley bottoms, where low shrub wetlands exist, shrubby cinquefoil, chicken sage, silver, big, fuzzy, and alkali sagebrush occur along various streams, springs, and vernal wetlands (USFS 1997).

2. Vegetation communities associated with riparian habitat includes tall willow shrublands associated with high gradient channels at lower elevations. Various other willow species exist in several of the riparian areas including coyote willow, whiplash willow, mountain alder, and water birch (USFS 1997).

Vegetation communities in the middle/higher elevation areas include forested vegetation, scrub-shrub vegetation, and emergent (herbaceous) vegetation.

1. The natural forest vegetation of the Sublett Mountains, Black Pine Mountains, Raft River Mountains, and Albion Mountains at higher elevations includes aspen, black cottonwood, Douglas fir, subalpine fir, Engelmann spruce, willow, juniper, and occasionally aspen. Some plant species found in the forests of the area that require moist sites are huckleberries, buckbrush, alder, and some sagebrush species (USFS 1997).

2. In the higher elevation wetlands and riparian areas, emergent (herbaceous) vegetation is dominated by sedges and sedge-like species including beaked sedge, water sedge, Nebraska sedge, clustered field sedge, soft-leafed sedge, softstem sedge, and common spikegrass (USFS 1997).

Subbasin Wetlands/Riparian Areas

Riparian areas are water-dependent systems that occur on lands adjacent to streams and rivers. Their occurrence is related to the interaction between stream channels and valley bottoms. Water that infiltrates into the riparian floodplain during periods of high flow returns to the channel during periods of low flow, which contribute to a source of cool summer flow for many streams. The inundation of the floodplain of a riparian area during flood stages reduces water velocities downstream and aids in reducing the risk of channel erosion. The stored ground water recharge is then released slowly in the dry season. The vegetation associated with the wetlands shades and helps moderate water temperatures. These areas provide a critical refuge for a variety of aquatic species and rearing areas for juvenile fish. Vegetation along streams buffers against inputs of sediment from hillsides and adjacent lands.

In the Raft River Subbasin, as in many areas of the west, the frequency and extent of seasonal floodplain and wetland inundation have been altered by changes in flow regimes. These changes include diversions, ground water withdrawals, modification in channel geometry due to sedimentation and erosion, channelization, and road building. Riparian areas and wetlands are subject to increasingly concentrated and competing resource demands. These demands include mineral, sand, and gravel extraction; human settlement; water withdrawal; agricultural practices; livestock use; wildlife; and recreation. Riparian areas and wetlands in the Raft River Subbasin encompass approximately 1,617 hectares (4,000 acres) of the total of 356,164 hectares (880,100 acres) in the subbasin. This is less that 1 percent of the total land in the subbasin and therefore amounts to a minimal percent of the land use. All of the wetlands and riparian areas are dependent upon the waters of the Raft River and its tributaries for their existence.

Most of the remaining wetlands/riparian areas that exist along the Raft River have willow strips and wet meadows that primarily are used for grazing and hay production. Most of the riparian shrubs are severely impacted by man either through livestock grazing or clearing for pasture or native hay. The lack of water flow now in many sections of the Raft River has eliminated miles of wetlands and riparian areas. A few rare areas of only about 40 surface hectares (100 acres) exist in a total of two to three wetlands along the lower Raft River. At the mouth of the Raft River at the Snake River an area of 1,200 to 1,600 hectares (3,000 to 4,000 acres) is impacted by floodwaters and a shallow water table which limits the use of the wet meadows to hayland pasture. Small depressions within this wetland at the mouth of the Raft River are supporting primarily hydrophilic vegetation such as cattails, rushes, grasses, and sedges (SCS et al. 1991).

Healthier areas of wetlands/riparian areas exist along some of the Raft Rivers tributaries. Some areas also exist in the Sublett Mountains along Sublett Creek, Fall Creek, Lake Creek, and Van Camp Creek. Other major areas of wetlands and riparian areas are around Cassia Creek above Malta (approximately 567 hectares total). These wetlands include wet meadows used as pastures and for native hay production. Riparian-scrub-shrub (willow) wetlands are also found along the creek and associated ditches in some areas; examples of these can be found in the Elba area. In some parts of the highlands, riparian areas along the creeks have reverted to near native conditions. In the area north and west of Almo, approximately 730 hectares (1,800 acres) exist along Almo Creek, Edwards Creek, and Little Cove Creek. Some current riparian restoration and good management practices in this area are helping restore the natural stream flow and riparian areas along Edwards and Almo Creeks (SCS et al. 1991).

Subbasin fisheries (general description)

There are many species of cold water fish in the streams and reservoirs of the Raft River Subbasin (Table 16). The various fish species found within the subbasin include rainbow trout, brown trout, brook trout, cutthroat trout, cutthroat/rainbow hybrid, kokanee, sculpin species, redside shiners, long nose dace, speckled dace, and sucker species such as the Utah and mountain sucker.

Raft River

Historically, the lower portion of the Raft River from Malta to the Snake River has had salmonid spawning. The river acted as a migration corridor for Yellowstone cutthroat, mountain whitefish, sculpin, dace, and suckers (IDFG 2001). Currently, neither a salmonid fishery nor spawning exist in this stretch of the Raft River. Sediment, channelization, irrigation diversions, and low to nonexistent summer flows are limiting factors to any potential fish populations.

The Raft River from the Utah line to Malta has a small fishery with limited spawning in some areas above The Narrows area. In higher flow periods there may be limited spawning with a small resident population of Yellowstone cutthroat and rainbow trout along with some non-game species (IDFG 2001).

Salmonid spawning and fisheries exist in many of the tributaries to the river and that section of the Raft River located in the Utah section of the Raft River Subbasin.

Table 16. Fish species and pollution tolerance in the Raft River Subbasin.

Species	Scientific Name	Tolerance[a]
Yellowstone cutthroat trout	*Oncorhynchus clarki bouvieri*	II
Rainbow trout	*Oncorhynchus mykiss*	II
Brown trout	*Salmo trutta*	MI
Brook trout	*Salvelinus fontinalis*	MI
Cutthroat/rainbow hybrid	*Oncorhynchus clarki X O. mykiss*	II
Kokanee salmon	*Oncorhynchus nerka*	II
Sculpin	*Cottus sp.*	
Utah sucker	*Catostomus ardens*	TT
Mountain sucker	*Catostomus platyrhychus*	MT
Shiners	*Richardsonius sp.*	
Longnose dace	*Rhinichthys cataractae*	MI
Specked dace	*Rhinichthys osculus*	MI
Leatherside chub	*Gila copei*	MT
Arctic grayling	*Thynallus arcticus*	II

[a] From DEQ 1996. Tolerance Value: II = Highly intolerant, MI = Moderately intolerant, MT = Moderately tolerant, TT = High tolerant

Sublett Area

The streams in this area are suitable for trout. Salmonid spawning occurs in the perennial tributaries of Sublett Reservoir, Sublett Creek, and Lake Creek (Fall Creek and Van Horn Creek are tributaries to Lake Creek). In these streams, cutthroat, rainbow, and brown trout all spawn. Sublett Reservoir has a drainage basin of approximately 117 square kilometers (km^2). The Sublett Reservoir has a population of cutthroat, rainbow, and brown trout, along with kokanee salmon. There is hatchery supplementation of game fish to the reservoir and, since 1990, there have been stockings of cutthroat trout, Henry's Lake cutthroat trout, kamloops strain of rainbow trout, Hayspur rainbow trout, kokanee, and brown trout. Riparian habitat along these streams contributes to the fishery in this area. Sublett Creek from Sublett Reservoir to the lower boundaries has a small fishery but the control of flow for irrigation demands create problems for the fish population.

Some seeps and small springs possibly support some resident populations of cutthroat and rainbow trout in the creek (IDFG 2001). Sublett Creek above the Sublett Reservoir has suitable habitat for spawning and early rearing although much of the stream appears silt-laden. The riparian zone is heavily grazed in some areas with little overhead cover present. In addition, the spring fed streams contain a heavy cover of macrophyte vegetation dominated by watercress. This situation is very common in spring-fed systems with small contributing watersheds. Some stretches of the stream have willows in abundance with good habitat/riparian zones. Idaho Department of Fish and Game (IDFG) indicate with their survey results that brown trout successfully move upstream at least 3 km from Sublett Reservoir for spawning and early rearing (Warren 2000).

Cassia Creek Area

Cassia Creek originates high in the Albion Mountains above Malta approximately 19 km south of the town of Albion. Through much of its length Cassia Creek flows through a broad valley vegetated primarily with sagebrush and agricultural lands. Numerous grain fields, pastures, and hay crop fields border the creek along much of the lower reaches. Much of the stream is utilized for agricultural purposes and is mostly dewatered in the lower reaches during the irrigation season. Livestock use of the riparian corridor is substantial. The riparian vegetation is typically willows, birch, and various shrubs and grasses. The fish habitat is abundant throughout much of Cassia Creek but sedimentation is substantial due to poor landuse practices.

Fish sampled by IDFG in 1987 were identified as rainbow, cutthroat, and brook trout; leatherside chub; longnose dace; and one unidentified sucker.

Spawning habitat, although natural reproduction is occurring, has been significantly affected by the sediment load rendering most potential gravel areas unsuitable for recruitment. Sediment is probably a direct result of poor landuse practices in the watershed. Runoff from agricultural lands, and, to a lesser degree, livestock grazing, has resulted in a substantial sediment problem in Cassia Creek (Grunder et al. 1987).

Cassia Creek, from Conner Creek to Raft River, has some fisheries in the first couple of miles downstream. There are some naturalized cutthroat and rainbow trout in the creek and hatchery fish additions to the site. Further down Cassia Creek through Malta and to the confluence with Raft River, irrigation diversions dry up the creek most years. Cassia Creek, from the headwaters to Conner Creek, has rainbow, cutthroat, and hybrid trout naturalized and spawning. The riparian habitat on Cassia Creek in this area helps provide streambank stability and stream shade and acts as a sediment filter strip along much of the stretch. It is generally rated as excellent by the IDFG. Other than sediment loads, other habitat parameters are in excellent condition. New Canyon Creek and Flat Canyon Creek (tributaries to the headwaters of Cassia Creek) both have salmonid spawning of rainbow and cutthroat trout fisheries (IDFG 2001).

Almo and Edwards Creek Area

Almo Creek is a third-order tributary of Raft River, originating in the Albion Mountains of the Sawtooth National Forest approximately 10 km northwest of Almo. The stream flows through a steep V-shaped canyon vegetated with sagebrush and juniper. Almo Creek then crosses a broad, flat valley (Big Cove). The riparian vegetation is dense and diverse, consisting primarily of willows, quaking aspen, birch, and Douglas fir. Some excellent fish habitat exists throughout the length of Almo Creek (Grunder et al. 1987). Irrigation diversions often dewater the lower sections during the irrigation season. Fish collections both in 1987 and 1999 by IDFG indicate cutthroat trout in the stream. Spawning habitat consists primarily of cobble-and boulder-sized particles; however, sufficient gravel areas exist for reproductive purposes. Sedimentation appears to be minimal (Grunder et al. 1987; Warren 2000). Some habitat restoration has been accomplished on Almo Creek and Edwards Creek and improvements are occurring. Additional work is planned in the area to complete a project funded by §319 Nonpoint Source Program cost share funding on these two creeks. Almo Creek and nearby Edwards Creek are not currently listed on the §303(d) list.

Black Pine Area

Two tributaries from the Black Pine area to Raft River are Eight Mile Creek and Six Mile Creek. Neither of these streams are listed on the §303(d) list.

Eight Mile Creek is a tributary of the Raft River and originates on the west side of the Black Pine Mountains. The creek flows down a narrow canyon with junipers and through a sparsely vegetated riparian area, consisting of junipers, sagebrush, and some willows. Overall habitat conditions are rated poor by IDFG. The stream flows for approximately 5 km before it enters a small irrigation compound just below the forest boundary. Recent fish collections were completed in 1987, 1996, and 1999 by IDFG personnel. The Yellowstone cutthroat trout in the stream have been identified as a population of pure strain of *Oncorhynchus clarki bouveri* by Robert Behnkes in 1986 (Grunder et al. 1987). This strain was verified by the other two IDFG samplings on the creek. The spawning habitat substrate appears abundant but fines in the gravel are a concern. Spawning is occurring on the stream but rearing and holding areas for trout are limited and ongoing sedimentation from the erosion of streambanks and adjacent slopes appears to be a problem.

Six Mile Creek is a tributary of the Raft River which also originates on the west side of the Black Pine Mountains. Approximately 1.5km of the stream is free flowing from its source at Six Mile Spring and flows through a V-shaped canyon vegetated with sagebrush, juniper and various species of grass and then into a small irrigation impoundment at the base of Six Mile Canyon. The riparian vegetation is sparse, consisting mostly of grasses and sagebrush. Most of the watershed is used for livestock grazing. Yellowstone Cutthroat trout have been documented in the past by IDFG and in 1999 cutthroats were found along with rainbow trout hybrids (Grunder et al. 1987; Partridge and Warren 1995; Warren 2000).

Raft River Utah Area

Several tributaries in the Raft River Watershed located in Utah have fisheries. For example, George Creek is a tributary and originates in the Raft River Division of the Sawtooth National Forest. The creek is normally diverted for irrigation demands and seldom reaches the Raft River. The lower section of George Creek has poor spawning habitat with fine silt as the primary substrate. The upper section of the creek's headwaters possesses a population of cutthroat trout. Further discussions of the Utah fisheries will not be made in this document.

Independence Lakes

The Independence Lakes are located near Cache Peak at 3,170 m (10,399 ft). They are the only system of natural lakes on the entire southern division of the Sawtooth National Forest and are a popular recreation destination. Natural reproduction occurs in some of the lakes and they have had hatchery supplements in the past of rainbow trout, cutthroat trout, California Golden trout, and Arctic grayling.

Subbasin Wildlife

With the many varied and mingled areas of forest/woodlands, rangeland, cultivated fields, and water habitat, food and cover is provided for many mammals, birds, and fish. The populations are largely determined by the suitability of the habitat; that is, the supply of food, cover, and water.

Mule deer are the most abundant of the big game animals in the subbasin, but there are also small populations of pronghorns in the area. Recently elk and moose have had an increase in population in the Sublett area. Beaver, mink, muskrat, and other small furbearers live along the streams. Much of the mule deer, elk, and moose summer activity within the Raft River Subbasin occurs on the Sawtooth National Forest or other public lands. The major use of private land by these species occurs during the winter for food and cover. Crucial deer winter range in the basin amounts to approximately 73,000 acres on the state, private, and BLM lands within this area. These essential areas have supported up to approximately 6,100 deer during the winter months. Pronghorn are limited to a small area within the Raft River Subbasin. The pronghorn inhabit the area on a yearlong basis, shifting within the area as food and water conditions dictate (SCS et al. 1991).

The Raft River area has a variety of upland game species that inhabit the different habitat types. On private lands pheasant, morning doves, and quail are prevalent. Others such as the sage grouse, Hungarian partridge, chukkar partridge, and rabbits are dependent on the rangelands of the BLM and USFS. Various forest grouse species live on the forestlands of the Sawtooth National Forest.

Waterfowl in the Raft River Subbasin, as a group, are found throughout the area. The Raft River itself does not offer a great deal of waterfowl habitat due to limited amounts of open water and riparian habitat. Waterfowl use is predominantly in the upper part of the subbasin near the Snake River/Lake Walcott areas. A U.S. Fish and Wildlife Service (USFWS) wildlife refuge on Lake Walcott provides habitat for the area waterfowl. The watersheds to the south provide feeding areas for the waterfowl in the area. The northern area also provides winter habitat for migrating waterfowl along the Snake River flyway. Mallards, teal, shovelers, pintails, and mergansers are found in the northern sections and to a lesser extent in the Sublett area and along the various tributaries. Significant numbers of Canada geese are common and frequent the grain fields located in the subbasin. Snow geese pass through the basin in the spring and fall.

Many bird species can be found in a number of general terrestrial habitats (riparian, grassland, sagebrush) located on lower and middle elevation public land areas. Riparian habitat species include prairie falcon, merlin sage grouse, Lewis' woodpecker, yellow warbler, dusky flycatcher, willow flycatcher, Wilson's warbler, Swainson's thrush, and others. Grassland habitat species include the northern harrier, bobolink, and grasshopper sparrow. Sagebrush habitat species include prairie falcon, merlin, sage grouse, gray flycatcher, loggerhead shrike, brewer's sparrow, sage sparrow, and others. All of these species respond positively or negatively to changes in habitat conditions or habitat structural components by land uses such as grazing.

Subbasin Macroinvertebrates

DEQ has developed a multi-metric index of macroinvertebrate communities called the Stream Macroinvertebrate Index (SMI) to use as an indicator of stream health (Grafe et al. 2002). The SMI assesses the status of aquatic life beneficial uses in wadeable streams and large rivers in Idaho. Macroinvertebrate species vary dramatically in their tolerance to temperature, pollutants, and sediment in the water and in the substrate of streams. Water quality determinations can be made following the identification of the composition of macroinvertebrate populations in the sample area, determining relative abundance, and determining other population or life history traits.

The insect orders used for description of water quality include Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies), and Diptera (true files). Other insect orders utilized might include Coleoptera (Beetles), Lepidoptera (butterflies and moths), Neuroptera (lacewings), Hymenoptera (ants, bees, and wasps), and Hemiptera (true bugs).

Subbasin Threatened, Endangered, and Sensitive Species

Within the Raft River Subbasin, there are several state and federal agencies that list species of special concern; candidate species; or endangered, threatened, and sensitive species. The USFWS is the main (nonanadromous, nonmarine species) listing agency. The USFWS lists 21 animals and three plants as endangered, threatened, or as candidate species within the state of Idaho (Table 17) (*http://ecos.fws.gov/webpage/webpage_region_lists.html?lead_region= 1*). However, in Cassia County there are only seven listed species with three additional candidate species. Of these 10 species four are aquatic, plus one semiaquatic plant. Three of the animals are snails that are found only in the mainstream of the Snake River and as such are not influenced by activities within the Raft River Subbasin. Therefore, the only federally listed aquatic plants and animals that will be influenced by the SBA or TMDL would be the spotted frog (*Rana luteiventris*) and the Ute ladies' tresses (*Spiranthes diluvalis*).

Table 17. Threatened and endangered species in the Raft River Subbasin.

Species Common Name	Scientific Name	Comments
Spotted frog	*Rana luteiventris*	Considered the Great Basin sub-population of the Columbian spotted frog. Determined that listing was warranted in 1993. Currently a candidate species.
Ute Ladies-tresses	*Spiranthes diluvalis*	Recognized as a distinct species in 1984. Listed as threatened in 1992.
Canada lynx	*Lynx canadensis*	Proposed for listing as threatened.
Gray wolf	*Canis lupus*	Currently listed as endangered.
Bald eagle	*Haliaeetus leucocephalus*	First protected in 1966 by the Endangered Species Preservation Act. Listed in 1973 under the Edangered Species Act. Down listed from endangered to threatened in 1995.
Utah valvata snail	*Valvata utahensis*	Listed as endangered in 1992.
Snake River physa snail	*Physa natricina*	Listed as endangered in 1992.
Bliss Rapids snail	*Taylorconcha serpenticola*	Listed as threatened in 1992.
Christ's paintbrush	*Castilleja christii*	Candidate species
Yellow-billed cookoo	*Coccyzus americanus*	July 2001, U.S. Fish and Wildlife Service published findings that indicated the yellow-billed cookoo should be listed. Other priorities preclude this listing; therefore, it is considered a candidate species. (This information is not on current USFWS Web site listed above)

The Ute ladies' tresses has the potential to be found in wet meadows, along riparian zones and in other wetlands (USFS web page 2001). The spotted frog is an aquatic animal found in and near streams, lakes, marshes, and ponds. The spotted frog frequents these aquatic habitats in mixed coniferous forests, subalpine forests, grasslands, and sage and rabbitbrush shrublands (Stebbins 1985). Management decisions, as a result of the SBA-TMDL, will need to address these two species and may affect upland species as well. These too will need to be addressed in any implementation plans developed by state and federal land management agencies.

In addition to the listed and candidate species, the USFS through the USFWS maintains a list of interested, or watch, species. These plants and animals are those that are not listed but that the USFWS suggests that the federal agencies consider in their management and planning activities. The Sawtooth National Forest contains 37 species found on this list.

The IDFG also maintains a statewide list of species of special concern (Table 18). Many of the species on this list are duplicates of those listed by the USFWS and other federal agencies. However, the list does not contain plant species. A list of the IDFGs species of special concern can be found at *www2.state.id.us/fishgame/info/nongame/ngconcern.htm.*

Table 18. Raft River species of special concern.

Idaho Department of Fish and Game Species Of Special Concern			
Species Common Name	**Scientific Name**	**Species Common Name**	**Scientific Name**
California bighorn sheep	*Ovis canadensis californiana*	Ferruginous hawk	*Buteo regalis*
Pygmy rabbit	*Brachylagus idahoensis*	Black tern	*Chlidonias niger*
Townsend's big-eared bat	*Corynorhimus Townsendii*	Long-billed curlew	*Numenius americanus*
Long-eared myotus	*Myotis evotis*	Greater sage-grouse	*Centrocercus urophasianus*
Cliff chipmunk	*Tamias dorsalis*	Northern goshawk	*Accipiter gentilis*
Little pocket mouse	*Perognathus longimembris*	Trumpeter swan	*Cygnus buccinator*
Western small-footed myotis	*Myotis ciliolabrum*	Western toad	*Bufo boreas*
Leatherside Chub	*Gila copei*	Northern leopard frog	*Rana pipiens*
Yellowstone cutthroat trout	*Oncorhynchus clarki lewis*	Columbia spotted frog	*Rana luteiventris*
Davis wavewing	*Cymopterus davisii*	Common garter snake	*Thamnophis sirtalis*
Slender moonwort	*Botrychium lineare*	Short-horned lizard	*Phrynosoma douglassi*

The USFWS and the IDFG are interested in additional plants and animals as well as where there are concerns about the population status and threats to their long-term viability. These species have no legal status under the Endangered Species Act. However, in context with ecosystem-level management these species and their habitats should be considered in the TMDL implementation processes.

1.3 Cultural Characteristics

The population, land use and land ownership, agriculture, forestry, rangeland, mining, recreation, roads, rural development, and economic growth all characterize various management practices in the Raft River Subbasin that can affect water quality. The majority of the subbasin lies within Cassia County. Figure 15 shows the Raft River Subbasin county coverage.

Raft River Subbasin Ownership

Land ownership in the Raft River Subbasin is shown in Table 19 and Figure 16 for combined land ownership in both the Idaho and Utah sections of Raft River HUC 17040210.

Table 19. Raft River Subbasin land ownership.

Fourth Field HUC[a]	LAND USE	US FOREST SERVICE	RANGE (BLM)[b]	PRIVATE	STATE LAND[c]	US FISH AND WILDLIFE	WATER	TOTAL
Raft River	%	20	31.8	45.2	2.9	0.0	0.0	100
17040210	Sq. Miles	303	481	684	43.8	0.090	0.24	1512
USGS[d]	Acres[e]	194,033	308,025	437458	28058	61.4	154.1	967,789

[a] HUC = Hydrological unit code.
[b] Bureau of Land Management.
[c] Private = agriculture land and includes dryland, irrigated-gravity flow land, irrigated sprinkler land, and grazing lands. Urban areas are also included in private lands.
[d] U.S. Geological Survey.
[e] one square mile = 640 acres...

Raft River Subbasin Land Use

Land use in the Raft River Subbasin is additionally broken down into categories as listed on Figure 17 and Table 20 (White Horse Associates 1999; from USGS 1:250 K Land Use and Land maps).

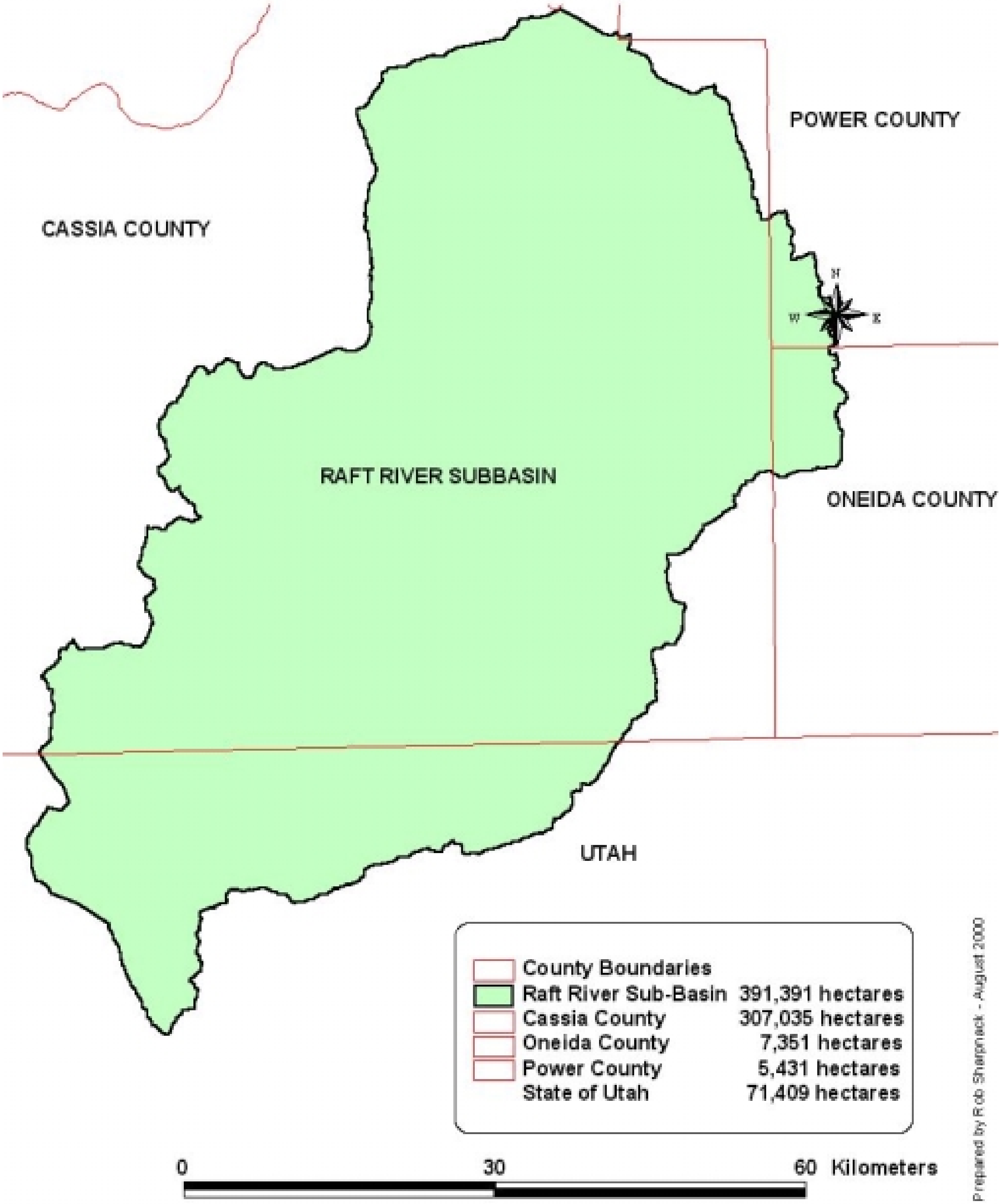
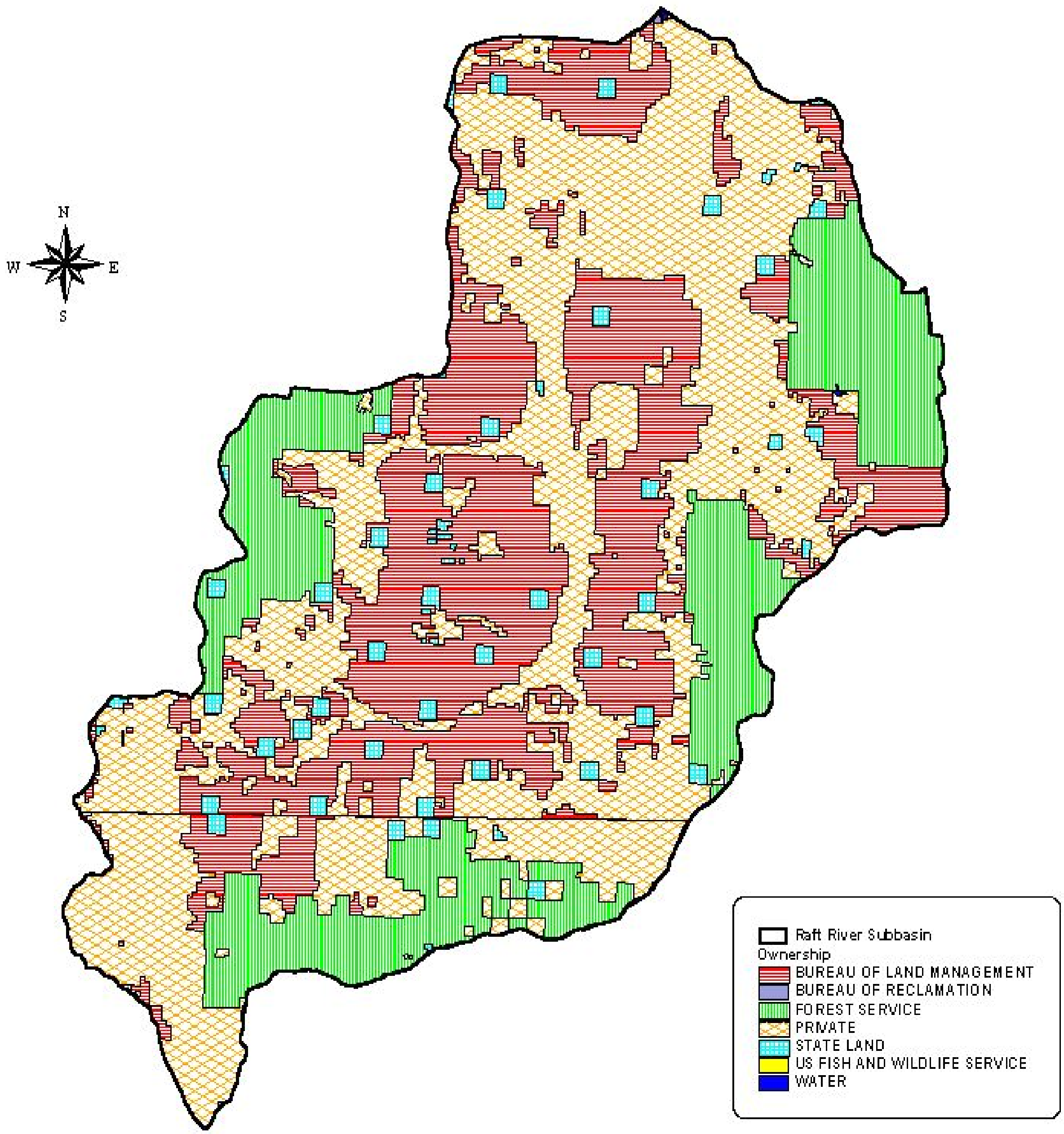


Figure 15. Raft River Subbasin county coverage.



Ownership in the Subbasin	Hectares	Sq. Km	% of Area
BUREAU OF LAND MANAGEMENT	124,653.4	1246.5	31.9
BUREAU OF RECLAMATION	53.4	0.5	0.0
FOREST SERVICE	78,522.2	785.2	20.0
PRIVATE	177,033	1,770.3	45.2
STATE LAND	11,354.5	113.5	2.9
US FISH AND WILDLIFE SERVICE	24.9	0.2	0.0
WATER	62.3	0.6	0.0

Prepared By Rob Sharpnack - August 2000

Source: White Horse Assoc. 1999
from Interior Columbia Ecosystem Management Website

0 6 12 18 24 Kilometers

Figure 16. Raft River Subbasin ownership.

Table 20. Land Use categories and percentage of land in the Raft River Subbasin.

Land Use	Percent Of Area
Commercial Services	0.03
Confined Feeding Operations	0.04
Cropland and Pastures	25.04
Deciduous Forest Land	0.17
Evergreen Forest Land	13.21
Forested Wetlands	0.07
Herbaceous Rangeland	2.66
Industrial	0.06
Lakes	0.00
Mixed Forest Land	11.69
Mixed Rangeland	43.27
Mixed Urban or Built-up Land	0.03
Nonforested Wetlands	0.37
Other Agricultural Land	0.06
Reservoirs	0.02
Residential	0.00
Shrub and Brush Rangeland	2.84
Streams and Canals	0.02
Strip Mines, Quarries, and Gravel Pits	0.05
Transportation, Communications	0.38

History

The Raft River Valley had its first permanent settlements around the present area of Malta. The natural lush green meadows along the Raft River attracted cattlemen during this period. The first cattle were brought into the area during the spring of 1868. Small-scale farming began in the Raft River Valley in the late 1870s. These small operations were usually located along the various streams because of the availability of water for irrigation. Small irrigation diversions were made to distribute the water over the fields. The first major crops were grain, alfalfa, and pastures for cattle. By the late 1880s, large tracts of acreage that could be served by diversion of surface flows from the Raft River and its principal tributaries were developed for agriculture use. By this time, nearly all available surface water was appropriated.

By legislative act in 1879, Cassia County was created and Albion was chosen as the county seat. Albion remained the county seat until 1908 when the town of Burley, on the Snake River and near the railroads, became the county seat.

The Reclamation Act of 1902 marked the beginning of rapid expansion of agriculture in Minidoka and Cassia countries. Development of large irrigation projects such as dams and canal systems along the Snake River brought about rapid expansion of agriculture around the communities of Burley and Rupert.

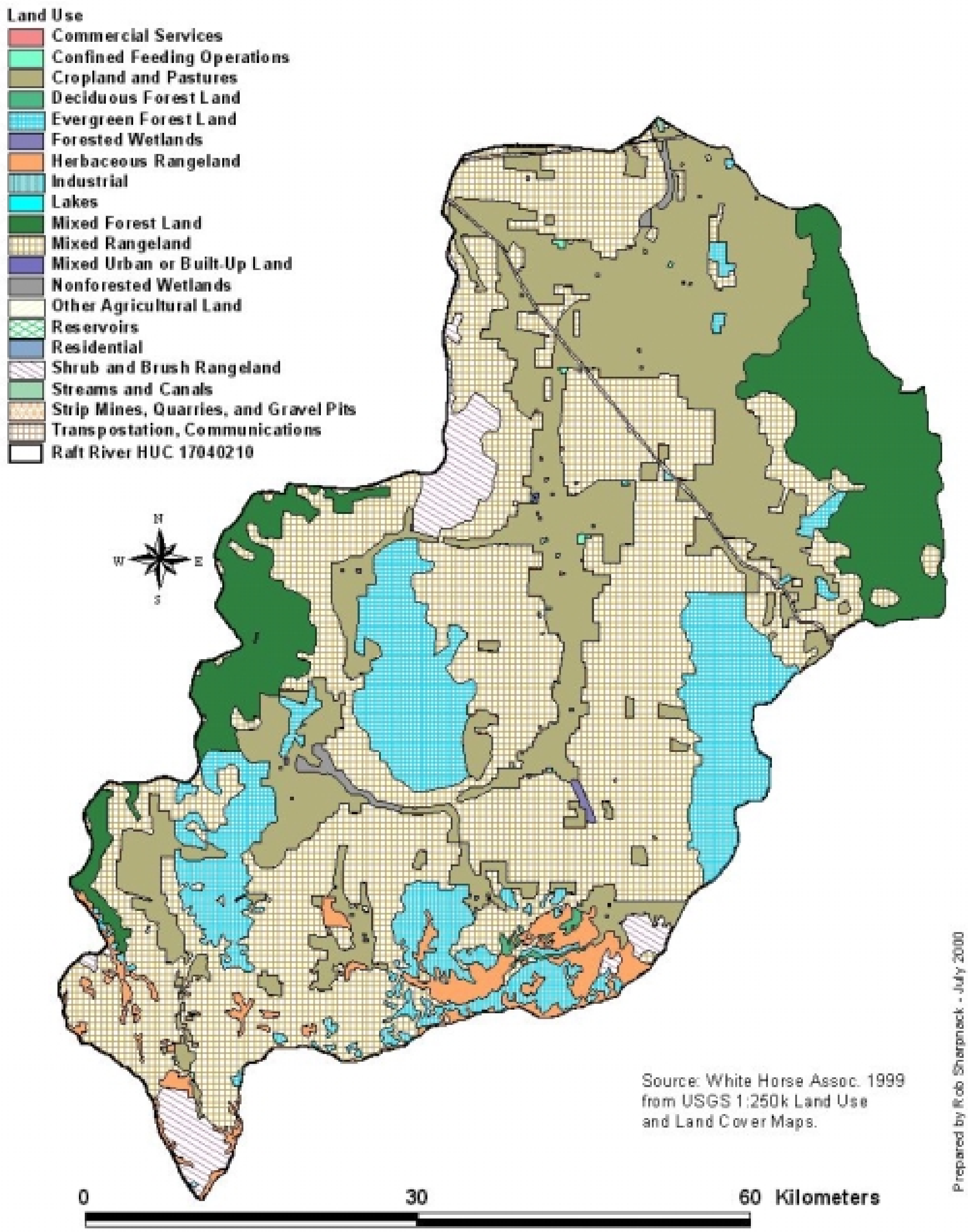


Figure 17. Raft River Subbasin land use.

It was during the 1910s that both cattlemen and homesteaders flocked into the valley. Non-irrigated (dryland) farming operations started around the turn of the century. In several isolated areas where rainfall was sufficient, dryland farming became economical. Dry land farming remains a large part of the agriculture economics in the Raft River Subbasin.

Pumping ground water for irrigation in the Raft River Valley started in the 1920s, but it was not until about 1950 that the large-scale pumping began for supplemental irrigation and the irrigation of large tracts remote from surface supplies. With electric power already in the valley, many wells were developed and agriculture expanded. Sprinkler irrigation equipment was introduced in the early 1960s and helped increase the rate of agricultural development since topography did not create problems for proper irrigation.

Continued new and increased use of the ground water resource continued in the early 1960s with attendant aquifer water-level declines. The potential effect of these declines on established water rights caused the Idaho State Reclamation Engineers to close the basin in July of 1963 to further application to appropriate ground water for irrigation (The Raft River Subbasin Idaho-Utah, as of 1966, USGS).

Population

The Overall population in Cassia County has increased approximately 20 percent from 1970 to 2000. Table 21 shows overall growth from 1970 through 2000 (IDC 2001 web page).

Table 21. Cassia County population estimate.

YEAR[a]	URBAN	RURAL	COUNTY TOTAL
1970	8,154	8,863	17,017
1980	8,528	10,899	19,427
1990	9,810	9,722	19,532
1998	10,566	10,793	21,359
2000	10,545	10,871	21,416

[a] 1970 and 2000 rural and urban estimates were based on the average value of 1980-1998 based on an average rural to county ratio of 1:1.92.

The populations of cities in Cassia County in 2000 were Burley, 9,316; Declo, 338; Albion, 144; and Oakley, 668 (IDC 2001). Most of the population of the Raft River Subbasin is rural except for small urban areas including Malta (population 177 [IDC 2001]) Elba, Almo, and Naf. Approximately 2,000+ people reside in the watershed (SCS et al. 1991).

Economics, Principal Activities

Agriculture is the major local industry in the Raft River Subbasin. It is comprised of farms that encompass crop production (both dryland and irrigated land) and animal production. Farming is the major economic base of the area where cereal crops, alfalfa, field corn, sugar beets, pasture, blue grass for landscaping, and potatoes are grown. Livestock operations include cattle and sheep ranches. Confined animal feeding operations (CAFO's) have become major industries in the area, with a major livestock feeding operation, several large dairies, mink farms, and hog farms. However, the number of farms in much of the area is decreasing. For example, the number of farms in Cassia County has changed from 870 in 1982 to 729 in 1997 (Idaho

Agricultural Statistics, Idaho Agricultural Statistics Survey, Idaho Department of Agriculture, Boise, Idaho and http://www.nass.usda.gov/id/).

Although the number of farms are decreasing throughout the county, there has been an increase in growth of livestock numbers over the last 12 years (Table 22) (Idaho Agriculture Statistics, Idaho Agricultural Statistics Survey, Idaho Department of Agriculture, Boise, Idaho and http://www.nass.usda,gov/id and http://www.nass.usda.gov/id/publications/county%20estimate/coesttoc.htm#livestock). The number of livestock in Cassia County includes all beef and dairy cows that have calved, along with calves, bulls, steers, and heifers. With the increase of dairies in the area a percent of dairy stock are dry at any one time and replacement heifers are always being raised.

Table 22. All cattle, calves, and sheep in Cassia County.

Year	All Cattle and Calves	Beef Cows Calved	Dairy Cows Calved	Other Cattle	Sheep and Lambs
1990	116,000	27,500	8,400	80,100	12,000
1996	144,000	27,000	12,000	105,000	10,000
2001	169,000	26,500	19,000	123,500	14,000
Growth index ratio[a]	1.46	0.96	2.26	1.54	1.17

[a] Growth Index Ratio = value for 2001 divided by value for 1990

Subbasin Forestry

The Sawtooth National Forest comprises more than 2.1 million acres of public land, most of it in southcentral Idaho, with one section located in the Raft River Subbasin in Utah. The headquarters are located in Twin Falls, Idaho. The forest is made up of four administrative units. These units include the Minidoka, Ketchum, and Fairfield Ranger Districts and the Sawtooth National Recreation Area.

Trees in the forest provide homes for wildlife and a pleasant visual backdrop for visitors and residents. In the Raft River area every year trees are harvested for firewood, posts, poles and Christmas trees. Some timber sales have occurred in the recent past on the east side of Black Pine Mountain. Forest Service plans have called for some selective harvesting of pines and replanting of aspen trees to improve the aspen forest in the area. In addition to providing for harvest, the timber country also provides habitat for game and non-game animals. Non-game animals include beaver, river otter, mountain bluebirds, blue jays, grey jays, red-tailed hawks, and golden and bald eagles. Furthermore, cattle and sheep graze on this National Forest in most areas.

Subbasin Rangeland

Generally, rangeland grazing in the Raft River Subbasin can be divided into by two groups. The first is grazing on public lands such as those managed by BLM, USFS, and Idaho Department of Lands (IDL) (state owned lands which encompass the equivalent of two sections in every township in Idaho). The second group is grazing on private lands, which may include individual pastures, or can be intermingled with or interdependent on the public grazing lands in the watershed. Rangeland grazing is a major agricultural industry in the Raft River Subbasin and is predominantly managed by the BLM and USFS. It is estimated that 51.8 percent of the land is owned and managed by one of these federal land management agencies. The remainder of the land is owned by the state or privately held with small amounts administered by other federal agencies (White Horse Associates 1999).

Subbasin Mining

Mining development has existed in the Raft River Subbasin since the early pioneers arrived in the area. Several of the mines were placer mines for gold or uranium. Most mining sites were mining claims with minimal development. Some rare earth mines have existed at one time for iron, titanium, zirconium, thorium, uranium, and beryllium in the Almo Basin and City of Rocks areas. Large mining developments such as the Pegasus Gold Mine (on the west side of the Black Pine Mountains) do not exist in the area. However, sand and gravel-mining sites are common in the watershed. In addition, some crushed rock pits are also located in the subbasin. Geothermal mining was once explored at a government-sponsored site in the area, but was later abandoned.

Subbasin Recreation

Generally, traditional recreation in the Raft River Subbasin has consisted of hunting for big game such as mule deer, elk, moose, mountain lion, and antelope. The area also offers wing shooting for ducks, geese, chukker, Hungarian partridge, pheasant, sage grouse, and forest grouse. The area offers fishing, camping, hiking, motorized trail use, and horseback riding, along with mountaineering in the City of Rocks area. The City of Rocks National Reserve is an area of unique granite formations and a landmark on the California Trail with historic trail remnants still visible. The various recreation opportunities available at the reserve have made the area popular as a tourist area. The last three years (1999-2001) have seen approximately 80,000 visitors per year. The Pomerelle Mountain Resort on the edge of the subbasin, located on Mount Harrison, offers snow skiing, snow boarding, and cross county skiing. Many groomed snowmobile and motorized trails exist within the subbasin. The area around Mount Harrison has become famous for hang-gliding and other aerial pursuits. The Skyline Trail that runs from the top of Mount Harrison to Independence Lakes and on to the City of Rocks National Reserve is popular with hikers, mountain bikers, and horseback riders. Recreational pursuits have become more important to the economy of the Raft River Subbasin.

Roads

Roads may be a source of sediment in the Raft River Subbasin and may effect the water quality of adjacent streams. Roads that parallel streams such as Lake Creek, Fall Creek, Van Camp Creek, and Sublett Creek in the Sublett area could introduce sediment to the streams. Roads that go into the mountains above Cassia Creek may also introduce sediment into Cassia Creek and its tributaries. Most road construction sediment is produced within the first three years of life on the road, but may continue at a significantly reduced rate for longer periods (USFS 1989). Figure 18 shows towns and major roads in the Raft River Subbasin.

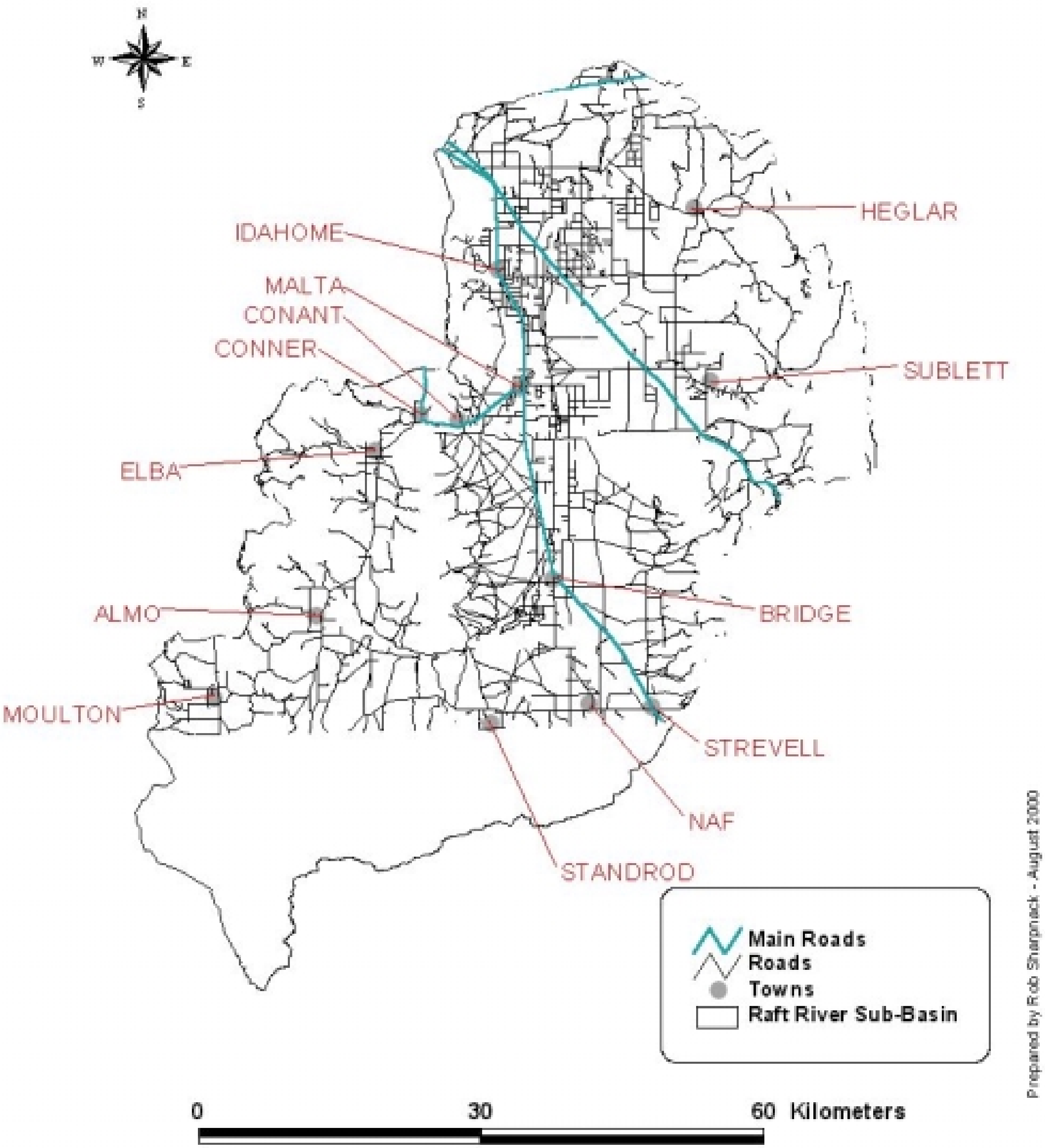


Figure 18. Raft River Subbasin roads and towns.

Existing Local Government and Civic Groups Working in Water Quality Issues

The watershed covers an area of approximately 880,100 acres in Idaho and Utah, of which about 44 percent is privately owned. Of this acreage, about 174,200 acres are farmed. The NRCS estimates all the acreage has an average soil loss of over 10 tons/acre/year with the worst case potential soil loss at 35 tons/acre/year. Sediment delivery rates are high for the cropland and most of it lies close to the Raft River. The delivered sediment causes flooding problems in the area. It also causes water quality problems for tributaries, the Raft River, and Lake Walcott.

Local government and civic groups include the local highway district, East Cassia and West Box Elder (Utah) Soil Conservation Districts, Raft River Flood Control Districts No. 15, City of Malta, Cassia County Commissioners, and the Raft River Rural Electric Cooperative. They have all be involved in addressing four basic resource problems. These groups have identified these problems as:

1. Flooding of the Raft River and the Cassia Creek area.
2. Severe soil erosion on cropland.
3. Inadequate irrigation water supply.
4. Degraded water quality of the lower Raft River and Lake Walcott.

The objectives of the groups listed above are to:

1. Identify alternative treatment measures that will reduce or eliminate flooding, severe erosion, and sedimentation problems.
2. Identify any feasible solutions that would improve the irrigation water supply.
3. Identify available programs that could assist in the implementation of selected evaluation alternative solutions (SCS et al. 1991).

These problems and objectives will be further defined in the Raft River Implementation Plan. The East Cassia Soil Conservation District, along with support by the NRCS, has worked with agriculture interests on many projects for sediment control and water quality.

The Walcott Watershed Advisory Group (WAG) along with a Raft River Committee affiliated with the WAG is becoming active in the subbasin by working with DEQ on the TMDL process.

2. Subbasin Assessment – Water Quality Concerns and Status

This section contains the characterization of the Raft River Subbasin water quality concerns and the status of the streams of the watershed. A description of the boundaries of the water quality limited segments (from the 1998 §303(d) list) will be provided along with an identification of the listed pollutants. This section follows the specifications defined in *State of Idaho Guidance for Development of Total Maximum Daily Loads* (cite XXXX). It also follows the appropriate specifications detailed in the CWA (Federal Water Pollution, Control Act, PL 92-500 1972, amended PL 25-217 in 1977, PL 97-117 in 1981, and PL 100-4 in 1987) as amended by the Code of Federal Regulations (CFR); Idaho's Water Quality Standards and Wastewater Treatment Requirements (IDAPA 58.01.02); and Idaho Code on Water Quality (IC §39-3601 *et seq.*[also called the WAG/BAG Law]). The objective in each of these laws and/or statutes is "declared in the 1972 CWA to restore and maintain the chemical, physical, and biological integrity of the nation's water " (Copeland 2000 [p 3]).

2.1 Water Quality Limited Segments Occurring in the Raft River Subbasin

Water quality limited segments are streams (or segments of streams) where it is known that water quality in that particular segment does not meet applicable water quality standards. Additionally water quality limited streams are defined as those streams that are not expected to meet applicable water quality standards, even after the application of the technology-based effluent limitations required by the CWA (40 CFR § 130.2(j) and 40 CFR § 131.3(h)). IDAPA 58.01.02.003.117 supports this definition.

The process to designate water quality limited segments is established by 40 CFR § 180.7(b)(1) by EPA. Under this process, such waters require a TMDL when certain specified pollution reduction requirements (identified in 40 CFR § 130.7(b)(1)(i), (1)(ii), and (1)(iii) are not stringent enough to implement water quality standards. Idaho Code section 39-3602 (27) requires the TMDL process for any water body not fully supporting designated or existing beneficial uses.

Pollutants may be toxic-based or nutrient-based. According to IDAPA 58.01.02.003.106 a toxic substance is "any substance, material or disease-causing agent, or combination thereof, which after discharge to water of the state and upon exposure, ingestion, inhalation or assimilation into any organism (including humans), either directly from the environment or indirectly by ingestion through food chains, will cause death, disease, behavioral abnormalities, malignancy, genetic mutation, physiological abnormalities (including malfunctions in reproduction or physical deformations in affected organisms or their offspring)." Toxic substances include, but are not limited to, the 126 priority pollutants identified by EPA after § 307(a) of the CWA. On the other hand, according to IDAPA 58.01.16.002.18, a nutrient is "any one of the natural elements including, but not limited to, carbon, hydrogen, oxygen, nitrogen, potassium, phosphorus, magnesium, sulfur, calcium, sodium, iron, manganese, copper, zinc, molybdenum, vanadium boron, chlorine, cobalt, and silicon, that are essential to plant and animal growth." IDAPA 58.01.02.003.67 defines nutrients as "the major substances necessary for the growth and reproduction of aquatic plant life, consisting of nitrogen, phosphorus, and carbon compounds (Buhidar 2001).

Table 23 lists the 1998 §303(d) listed stream segments and reservoir and their pollutants in the Raft River Subbasin. Also listed are streams on which data are being collected for background and headwater information prior to the next §303(d) listing cycle. The listing basis for all streams and Sublett Reservoir is the 1998 §303(d) list and the 1998 §305(b) report. See Figure 3 in Chapter 1 (under Subbasin Characteristics) for a map of stream segments.

Table 23. §303(d) listed segments and water bodies of the subbasin.

Water Body Name	Segment ID Number	1998 §303(d)[a] Boundaries	Pollutants[b]
Raft River	2430	Malta to Snake River	Ex Sed, Ex N, NH_3, DO, *E. coli*, Q, Sal,
Raft River	2331	Utah line to Malta	Ex Sed, DO, Tem, *E. coli*, Sal
Tributaries or Tributary Segments/Reservior			
Sublett Creek	2432	Sublett Reservoir to lower boundaries	Ex Sed, Ex N, DO. *E. coli*, Q
Sublett Reservoir	2434	Sublett Reservoir	Ex Sed, Ex N, DO, Q
Fall Creek	7612	Headwaters to Lake Fork	U
Cassia Creek	2438	Conner Creek to Raft River	Ex Sed, Q
Cassia Creek	Not §303(d) listed	Headwaters to Conner Creek	U
Lake Creek	Not §303(d) listed	Headwaters to Sublett Reservoir	U
Van Camp Creek	Not §303(d) listed	Headwaters to Lake Creek	U
New Canyon Creek	Not §303(d) listed	Headwaters to Cassia Creek	U
Flat Canyon Creek	Not §303(d) listed	Headwaters to Cassia Creek	U

[a] Refers to a list created in 1998 of water bodies in Idaho that did not fully support at least beneficial use. This list is required under section §303(d) of the Clean Water Act.
[b] Q = flow alternation or diversions. Ex Sed = Excess sediments. Ex N = Excess nutrients. NH_3 = Total ammonia. DO = Dissolved oxygen. *E.. coli* = *Escherichia coli*. Tem = temperature (thermal modification). U = Unknown pollutants. Sal = salinity.

2.2 Applicable Water Quality Standards

Idaho's state water quality standards divide the state into six separate hydrologic basins. In these basins, the major rivers, lakes/reservoirs, and creeks are identified (designated) for specific beneficial uses. According to IDAPA 58.01.02.101.01, surface waters not designated in the Raft River Subbasin "shall be designated according to section 39-3604, Idaho Code, taking into consideration the use of the surface water and such physical, geological, chemical, and biological measures as may affect the surface water. Any undesignated water shall be protected for beneficial uses, which includes all recreational use in and on the water and the protection and propagation of fish, shellfish, and wildlife, wherever attainable. Industrial water supplies, wildlife habitats, and aesthetics are minimum designated standards for all waters of the state.

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 (DEQ 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 58.01.02.003.35, .050.02, and 051.01 and .053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. Practical application of this concept would be when a water could support salmonid spawning, but salmonid spawning is not yet occurring.

Designated Uses

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

Presumed Uses

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

Other water quality standards, which apply to the Raft River SBA-TMDL, are in the state's Antidegradation Policy (IDAPA 58.01.02.051.01-02). These standards read as follows:

> Maintenance of Existing Uses for All Waters. The existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
>
> High Quality Waters. Where the quality of the waters exceeds levels necessary to support propagation of fish, shellfish and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the Department finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the Department's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the department shall assure water quality adequate to protect existing uses fully...

IDAPA 58.01.02.50.01 states:

> Apportionment of water. The adoption of water quality standards and the enforcement of such standards is not intended to conflict with the apportionment of water to the state through any of the interstate compacts or court decrees, or to interfere with the rights of Idaho appropriators, either now or in the future, in the utilization of the water appropriation which have been granted to them under the statutory procedure…

IDAPA 58.01.02.50.02.a states:

> Wherever attainable, surface waters of the state shall be protected for beneficial uses which for surface waters includes all recreational uses in and on the water surface and the preservation and propagation of desirable species of aquatic biota…

IDAPA 58.01.02.50.02.c states:

> In all cases, existing beneficial uses of the water of the state will be protected.

Table 24 summarizes Idaho's beneficial uses and criteria for its water bodies. Those uses designated for selected water bodies within the Raft River Subbasin, as defined in IDAPA 58.01.02.15, can be found in Table 25.

Table 24. State of Idaho's recognized benefical uses.

BENEFICIAL USES	APPLICABLE CRITERIA
Agricultural Water Supply	Water quality appropriate for the irrigation of crops or as drinking water for livestock. This use applies to all surface waters of the state (IDAPA 58.01.02.100.03.b). Numeric criteria as needed are derived from the EPAs *Water Quality Criteria 1972* (EPA 1975). (IDAPA 58.01.02.252.02).
Domestic Water Supply	Water quality appropriate for drinking water supplies (IDAPA 58.01.02.100.03.a). Numeric criteria for specific constituents and turbidity (IDAPA 58.01.02.252.01.a-b).
Industrial Water Supply	Water quality appropriate for industrial water supplies. This use applies to all waters of the state (IDAPA 58.01.02.100.03.c). Numeric criteria are categorized as general surface water quality criteria (IDAPA 58.01.02.252.03).
Cold Water Aquatic Life	Water quality appropriate for the protection and maintenance of a viable aquatic life community for cold water species (IDAPA 58.01.02.100.01.a). Numeric criteria are established for pH, dissolved oxygen, gas saturation, residual chlorine, water temperature, ammonia, turbidity, and toxics (IDAPA 58.01.02.250.02.a-g).
Seasonal Cold Water Aquatic Life	Water quality appropriate for the protection and maintenance of a viable aquatic life community of cool and cold water species (IDAPA 58.01.02.100.01.c). Numeric criteria are established for pH, dissolved oxygen, gas saturation, residual chlorine, water temperature, ammonia, turbidity, and toxics (IDAPA 58.01.02.250.03.a-c).
Warm Water Aquatic Life	Water quality appropriate for the protection and maintenance of a viable aquatic life community for warm water species (IDAPA 58.01.02.100.01.d). Numeric criteria are established for pH, dissolved oxygen, gas saturation, residual chlorine, water temperature, ammonia, and toxics (IDAPA 58.01.02.250.04.a-c).
Modified Aquatic Life	Water quality appropriate for an aquatic life community that is limited due to one (1) or more conditions set forth in 40 CFR 131.10(g) which preclude the attainment of reference streams or conditions (IDAPA 58.01.02.100.01.e). Numeric criteria for pH, dissolved oxygen, gas saturation, residual chlorine, water temperature, ammonia, and toxics will be considered on a case by case basis (IDAPA 58.01.02.250.05).
Salmonid Spawning	Waters which provide or could provide a habitat for active self-propagating populations of salmonid fishes (IDAPA 58.01.02.100.01.b). Numeric criteria are established for pH, gas saturation, residual chlorine, dissolved oxygen, intergravel dissolved oxygen, water temperature, ammonia, and toxics (IDAPA 58.01.02.250.02.e).
Primary Contact Recreation	Water quality appropriate for prolonged and intimate contact by humans or for recreational activities when the ingestion of small quantities of water is likely to occur. Such waters include, but are not restricted to, those used for swimming, water skiing, or skin diving. (IDAPA 58.01.02.100.02.a). Numeric criteria are established for *Escherichia coli* bacteria (IDAPA 58.01.02.251.01.a-b).
Secondary Contact Recreation	Water quality appropriate for recreational uses on or about the water which are not included in the primary contact category. These activities may include fishing, boating, wading, infrequent swimming, and other activities where ingestion of raw water is not likely to occur (IDAPA 58.01.02.100.02.b). Numeric criteria are established for *Escherichia coli* bacteria (IDAPA 58.01.02.251.02.a-b).
Wildlife Habitats	Water quality appropriate for wildlife habitats. This use applies to all surface

BENEFICIAL USES	APPLICABLE CRITERIA
	waters of the state (IDAPA 58.01.02.100.04). Numeric criteria are categorized as general surface water quality criteria (IDAPA 58.01.02.253.01).
Aesthetics	This use applies to all surface waters of the state (IDAPA 58.01.02.100.05). Numeric criteria are categorized as general surface water quality criteria (IDAPA 58.01.02.253.02).
Special Resource Water	Those specific segments or water bodies that are recognized as needing intensive protection to preserve outstanding or unique characteristics. Designation as a special resource water recognizes at least one of the following characteristics: (1) the water is of outstanding high quality, exceeding both criteria for primary contact recreation and cold water aquatic life; (2) the water is of unique ecological significance; (3) the water possesses outstanding recreational or aesthetic qualities; (4) intensive protection of the quality of the water is in paramount interest of the people of Idaho; (5) the water is part of the National Wild and Scenic River System, or is within a state or National Park or wildlife refuge and is of prime or major importance to that park or refuge; (6) intensive protection of the quality of the water is necessary to maintain an existing but jeopardized beneficial use (IDAPA 58.01.02.056). Special resource waters receive additional point source discharge restrictions (IDAPA 58.01.02.054.03 and 400.01.b).
NOTE: All waters are protected through general surface water quality criteria. Narrative criteria prohibit ambient concentrations of certain pollutants that impair designated uses. Narrative criteria are established in Idaho water quality standards for hazardous materials; toxic substances; deleterious materials; radioactive materials; floating, suspended, or submerged matter; excess nutrients; oxygen demanding materials; and sediment (See IDAPA 58.01.02.200.01-08).	

Table 25 Raft River Subbasin designated beneficial uses.

Water Body	Designated Uses[a]	1998 §303(d) List[b]
RAFT RIVER SEGMENTS – DESIGNATED BENEFICAL USE		
Raft River, Malta to SR 2430	CW, SS, PCR	Yes
Raft River, Utah line to Malta 2331	CW, SS, PCR	Yes
TRIBUTARY SEGMENTS-EXISTING BENEFICAL USES		
Sublett Creek, Sublett Reservoir to lower boundaries 2432	AWS	yes
Sublett Reservoir 2434	CW, SS, PCR, SCR, AWS	Yes
Fall Creek, Headwaters to Lake Fork 7612	CW, SS, PCR, SCR, AWS	yes
Cassia Creek, Conner Creek to Raft River, 2438	CW, SS, PCR, SCR, AWS	yes

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

[b] Refers to a list created in 1998 of water bodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection "d" of the Clean Water Act.

2.3 Summary and Analysis of Existing Water Quality Data

Water quality data within the Raft River Subbasin are very sparse. Five USGS gauges exist(ed) within the subbasin. These gauges will be used to develop hydrographs for the remaining ungauged watersheds. Other entities collecting data include the IDFG, USFS, BLM, and EPA. The fish collections (IDFG) were usually done in conjunction with the BLM or USFS for their management needs. However, these collections are very limited. Some information exists within the EPA's STORET database. Again, this information is very limited or applicable to non-water quality limited streams. In all cases STORET was queried for each water quality limited water body within the subbasin. For the most part, DEQ TMDL monitoring data and Beneficial Use Reconnaissance Program information make up the largest, or only, portion of the available data.

Stream Characteristics

The subbasin is cartographically covered by 1:24,000-scale and higher USGS topographic quadrangle maps. The total vertical relief in the area is 1,861 m, ranging from a low elevation of approximately 1,290 m near Snake River to a high elevation of 3,151 m at Cache Peak in the Albion Mountains. Locally, slopes on the alluvial fans are usually quite gentle (although overall relief to the canyons and valley bottoms is considerable), with considerably steeper slopes in the mountains.

The topography is chiefly an expression of the geologic structure and historical glacial and sedimentary processes. The faulted, linear mountain chains of the Basin and Range ecoregion border the Snake River Basin Plain to the south. In general, the subbasin slopes from the southeast and southwest towards the Snake River in the north.

As stated previously, the Raft River Subbasin covers approximately 3,919 km^2 in total area. Nearly 3,196 km^2, or 81.55 percent of the subbasin, are within the state of Idaho. The Idaho portion of the subbasin contains both the highest and lowest elevation points. The average elevation of the entire subbasin is approximately 1,571 m. The entire subbasin slope range is from less than 1 percent to 46 percent. The average subbasin slope is approximately 1.97 percent (Change in elevation divided by overall subbasin length). Generally, the alluvial valleys have slopes of less than 1 percent, while the remainder of the subbasin is mountainous and has slopes greater than 10 percent. Overall, the subbasin has a northeastern aspect. The stream channels and mainstem rivers follow a dendritic drainage pattern throughout the subbasin. In the subbasin, there are 503.0 km of perennial streams; 3,3317.6 km of ephemeral and intermittent streams; and 15.4 km of canals and ditches. Roughly 40 percent of the perennial streams are located between 1,524 and 1,829 m elevations, which corresponds with the alluvial low slope area of the subbasin. Approximately 75 percent of the ditches are located in the 1,219 to 1,524 m elevation classification. This area corresponds with the lowland agricultural area from near Malta to the Snake River. In this same area 148.2 km of perennial streams exist.

Additionally, the subbasin has been further subdivided into 21 watersheds (See Figure 9). These units will be used extensively in allocating nonpoint source loads.

Raft River

Raft River begins in the north central mountains of Utah (Grouse Creek and Raft River Mountains) and the south central mountains (Albion Mountains and Middle Mountain) of Idaho and flows to the confluence of the Snake River. Raft River flows from Utah into Idaho.

Approximately 122.5 km are in Idaho. Along this course, several perennial tributaries (e.g., Cassia Creek, Edwards Creek, and North and South Junction Creeks) enter the system, as do numerous intermittent and ephemeral systems. Three USGS gauge locations are used or have been in use historically in Idaho. The uppermost location of the current gauge is near Onemile Creek at the Raft River Narrows. A historical gauge location is downstream from The Narrows gauge below Onemile Creek. The lowermost gauge was located at the mouth near the Snake River. The lowermost gauge was in operation from April 1985 until July 1989, with a contributing watershed area of 1,510 mi^2. Given this size watershed, channel characteristics can be extrapolated from regional curves. These regional curves can be found in *Applied River Morphology* (Rosgen 1996). Extrapolating from the regional curve, the Raft River at this sampling location should have a mean depth of 2.00 m, a bankfull width of 92.37 m and a cross-sectional area of approximately 129.29 m^2. From the historical gauge data, the period of record average discharge at this location was 0.31 cubic meters per second (m^3/s). Low discharge occurred during the fall quarter with only 0.02 m^3/s. Spring discharge was 0.77 m^3/s, while winter base discharge was 0.22 m^3/s. Summer discharge was 0.19 m^3/s (see Figure 19).

At the upper location, the current USGS gauge, discharge averaged 0.57 m^3/s for the period of record (October 1946 to September 2001). Low discharge occurred during the fall quarter with only 0.24 m^3/s. Spring discharge was 1.08 m^3/s, while winter base discharge was 0.50 m^3/s. Summer discharge was 0.46 m^3/s (Figure 20).

Physical Characteristics

The upper segment of the two §303(d)-listed segments of the Raft River begins at the Utah-Idaho border. This segment is 67.90 km long. The valley through which this segment flows is approximately 53 km in length. Over the entire listed segment, the creek has a very low slope of 0.409 percent. This slope corresponds to a 4-m fall per kilometer. Slopes of this magnitude are usually seen in highly sinuous streams that are by nature depositional. Sinuosity is classified as moderate (1.3) for the listed segment. Floodplain materials are composed of fine textured sands and silts derived from alluvium and glacial till. Consequently, it would be expected that the percent fines of Raft River should be elevated in comparison to a channel with much higher slopes, lower sinuosity, and coarser floodplain materials. In this case, percent fines would be comparable to the lower section of Trapper Creek in the Goose Creek Subbasin.

Hydrology

As stated in the pervious section, a USGS gauge has been in operation since 1946. The average annual hydrograph for the Raft River period of record discharge is shown in the following figures (Figures 19 and 20).

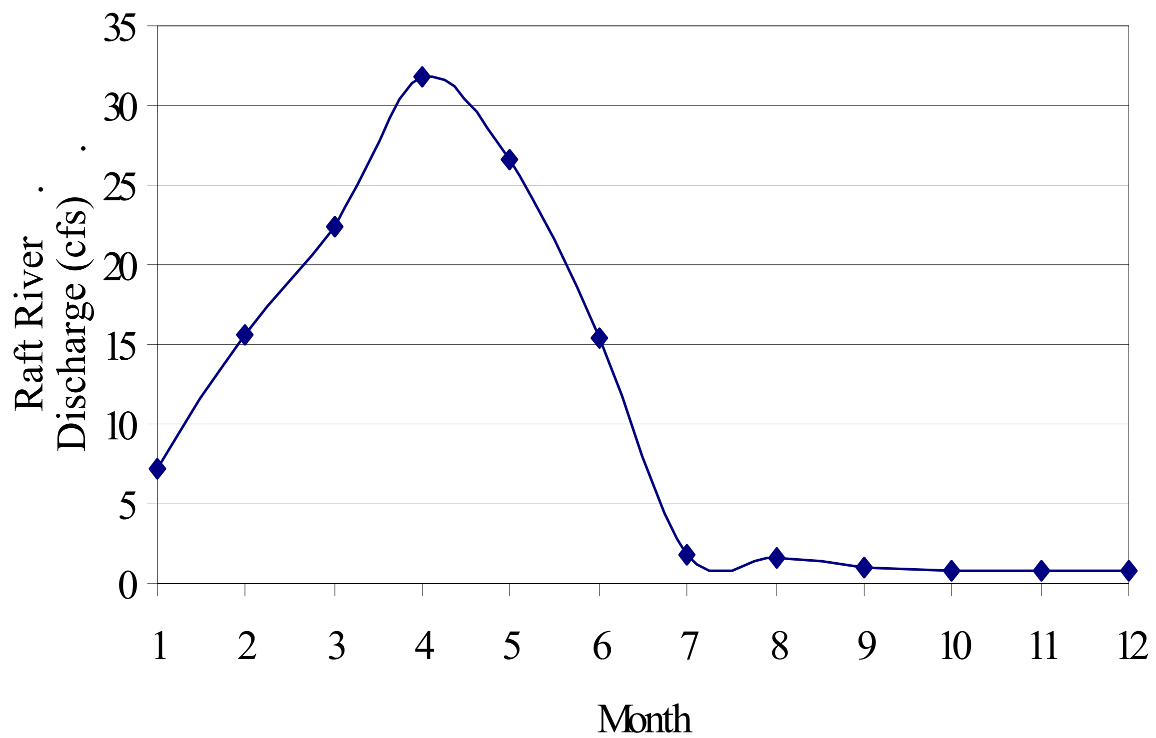


Figure 19. Discharge as measured at the mouth of Raft River near the Snake River.

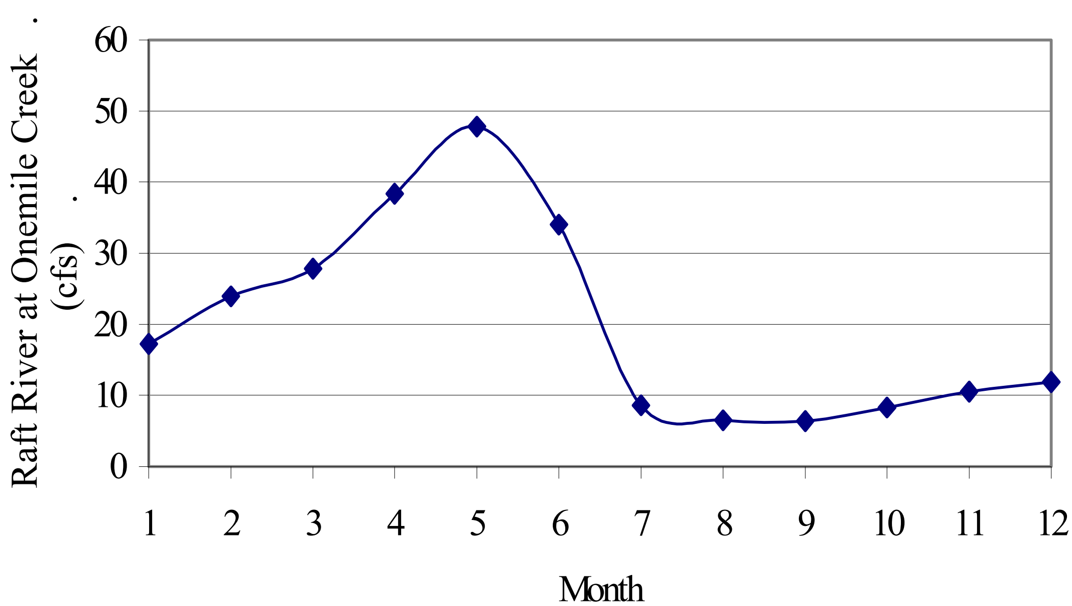


Figure 20. Discharge as measured at The Narrows of Raft River near Onemile Creek.

Raft River Existing Water Quality Data

Water quality samples containing a full suite of constituents collected within the lower listed segment of the Raft River are rare. Upon a review of the STORET database, two locations were sampled in the lower section and one in the upper section. Approximately 23 site visits were made in the lower section and seven in the upper location. These visits were spread out from 1961 to 1977. For each of the listed constituents in the lower section the overall average of the historical data is presented in Table 26.

Table 26. Lower Raft River historical water quality data (1961-1977).

Parameter[a]	Average[b]	Standard Deviation
Bacteria	1,236 colonies/100 ml (fecal *coli*)	2,131
Dissolved Oxygen	8.75 mg/L	3.51
Total NH_3	0.31 mg/L	0.50
Nutrients (TP)	0.16 mg/L	0.16
Nutrients (NO_x)	1.03 mg/L	0.97
Sediment	53 mg/L	87
Flow Alteration	3 cfs (22-24 Aug 1971)	0.00

[a] NH_3 = ammonia, TP = total phosphorus, NO_x = nitrogenoxides.
B ml = milliliters, fecal *coli* = fecal *coliforms,* mg/L = milligrams per liter.

From this data and the older fisheries information, a sense of the historical water quality can be gathered. In the decades following these collections many nonpoint source changes have occurred. The USFS and BLM have tightened grazing regulations, land ownership has changed, our knowledge of water quality and BMPs has increased, and most importantly our use of water has changed dramatically in the lower section. These changes are evident in the most recent data collection attempts in the lower segment of Raft River. In this section, Raft River rarely has water flowing in it. Discharge near the end of August is unheard of.

Historical data collected in the upper segment are much sparser than in the lower section. Table 27 presents the averages of the seven data collections made in the Raft River Narrows.

Table 27. Upper Raft River historical water quality data.

Parameter[a]	Average[b]	Standard Deviation
Bacteria	Not Collected	Not Collected
Dissolved Oxygen	8.90 mg/L	2.97
Total NH_3	0.42 mg/L	0.44
Nutrients (TP)	Not Collected	Not Collected
Nutrients (NO_x)	1.49 mg/L	0.64
Sediment	4 mg/L	1 sample
Flow Alteration	Not Collected	NC

[a] NH_3 = ammonia, TP = total phosphorus, NO_x = nitrogenoxides.
[b] ml = milliliters, mg/L = milligrams per liter.

DEQ sampled in the creek over the course of 1999-2002. Additional samples were collected by the Soil Conservation District (SCD) throughout the summer of 1999. However, due to the limited number of sampling periods in the data set, DEQ's confidence in monthly average concentrations is low. The lack of a robust data set was due to limited budgets and, in part, to a limited time frame for collecting data. In most cases one sample was the most collected in any given month. Infrequently, multiple samples were collected in some months. This sampling design was intended to determine annual pollutant loads . The annual load estimated by this type of design would overestimate the annual load by 25 to 50 percent (Robertson and Richards 2000). To assist in the determination of seasonal components and appropriate critical conditions, the data will be presented as monthly averages in the following tables while period of record averages are presented in the text and in the tables and used for any future load calculations. For those cases when a parameter was below detection limits, half the detection limit was used to calculate the monthly average and used as part of the period of record average.

For the upper segment of Raft River four sample locations were intermittently sampled beginning in March of 1999 (Figure 21). No samples were collected by either DEQ or the SCD in the lower segment. This was because water was not available to sample in the lower segment on any of the sampling dates. Therefore, the lower section will remain on the §303(d) list for flow alteration. At such time that flows in the lower section return, water quality samples will be taken and the water quality will be assessed.

Water quality information was collected from multiple locations in the upstream segment to determine background concentrations and loads from the upstream segments of the river and from out of state.

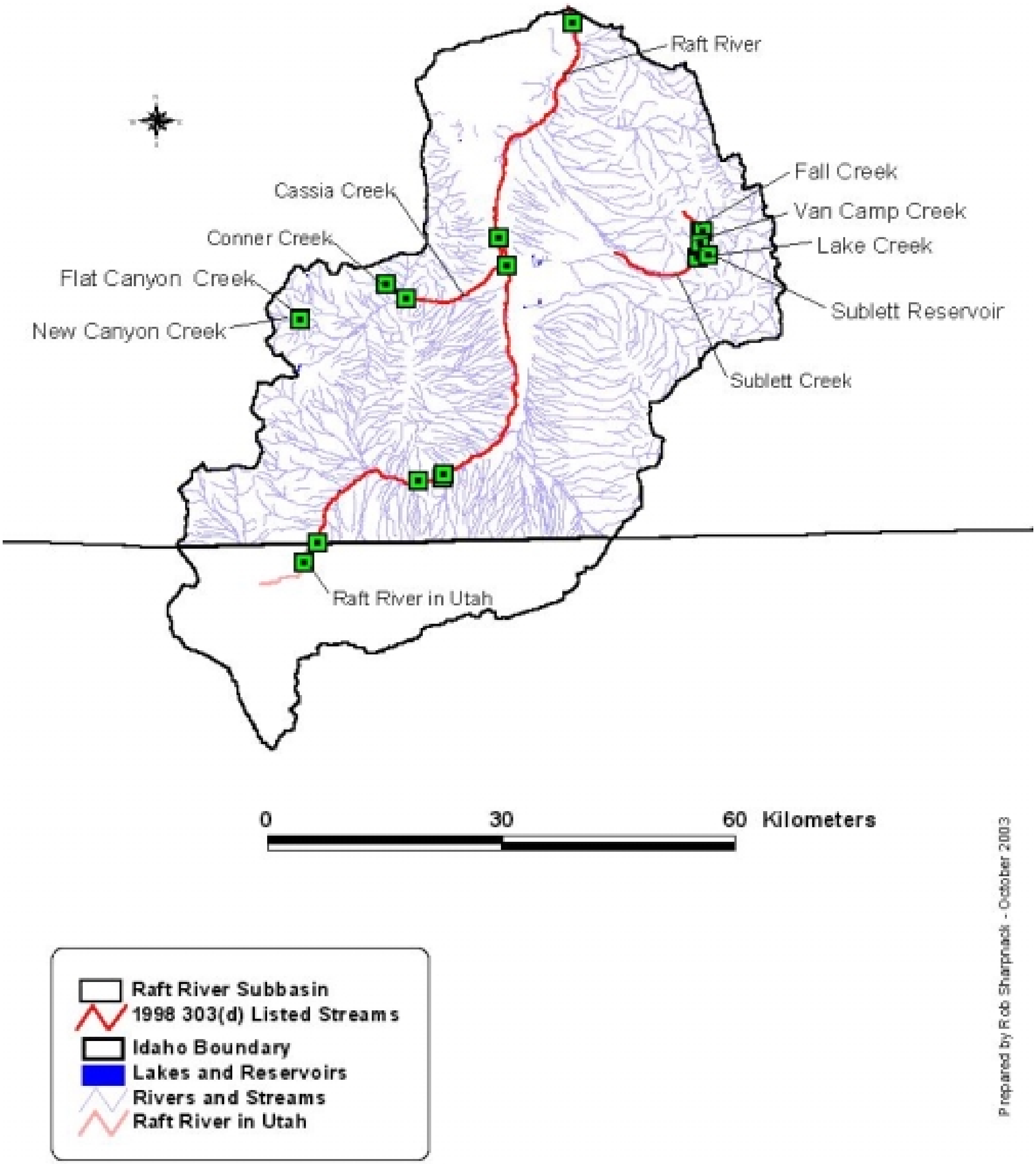


Figure 21. Monitoring locations throughout the Raft River Subbasin.

The chemical constituents at all sites seemed to be very similar throughout the sampling period. In order to determine if this was the case, an analysis of variance (ANOVA) test was conducted to test the null hypothesis (H_o).

H_o: Raft River Utah Mean = Raft River UT/ID Border Mean = Raft River Edwards Mean = Raft River Narrows Mean.

H_a: Raft River Utah Mean ≠ Raft River UT/ID Border Mean ≠ Raft River Edwards Mean ≠ Raft River Narrows Mean.

Each constituent sampled at the four locations was tested using Systat 7.0. For most constituents the null hypothesis was not rejected ($p > 0.05$). However, pH, total dissolved solids, and specific conductivity (SC) were significantly different from station to station (Table 28). Therefore, for these constituents, the null hypothesis was rejected. A Bonferroni post hoc test was conducted to determine which stations were significantly different from one another. The Raft River site located at The Narrows was the only site different from the other three. This was similar for all three constituents. The change in all three constituents is likely a natural phenomenon in that the Raft River often dries up in the upper reaches and a large spring source is located at The Narrows location. This spring would be much higher in dissolved salts than the surface runoff waters from the upper reaches. While the change could be associated with anthropogenic disturbances, other constituents (total phosphorus [TP], nitrate plus nitrite [NO_x], ammonia [NH_3], and total suspended solids [TSS]) associated with such disturbances do not reflect the same change.

For the most part the statistical tests allow DEQ to pool the water quality data together to allow a more robust understanding of the chemical nature of the upper segment of Raft River. Those pooled results are presented in Table 29.

Table 28. Analysis of variance p values for four sample locations.

Constituent	Significance Value (p)
Temperature	0.127
Dissolved Oxygen	0.981
Specific Conductivity	0.000
pH	0.000
Total Dissolved Solids	0.000
Total Suspended Sediment	0.427
Total Ammonia	0.192
Nitrate + Nitrite	0.578
Total Phosphorus	0.088
E. coli	0.629

Table 29. Monthly average water quality constituents in Raft River ID.

Month	No of Samples	TSS (mg/L)[a]	Total NH_3 as N (mg/L)[b]	Total NO_2 + NO_3 as N (mg/L)[c]	Total P (mg/L)[d]	Temp (°C)[e]	Dissolved Oxygen (mg/L)[f]	Bacteria *E. coli* (Col/100 ml)[g]
January	2	96				3.2	10.97	125
February	2	34				4.9	10.59	5
March	2	44				7.2	10.05	55
April	9	86	0.024	0.113	0.160	9.4	9.47	111
May	14	33	0.050	0.012	0.105	12.9	8.94	363
June	11	28	0.133	0.011	0.076	16.5	8.97	267
July	8	12	0.019	0.014	0.085	19.3	8.53	311
August	14	14	0.015	0.010	0.094	18.1	8.59	515
September	10	10	0.014	0.009	0.056	12.6	9.72	61
October	9	22	0.015	0.008	0.075	9.3	9.99	430
November	4	23	0.015	0.013	0.054	3.3	13.33	100
December	2	34				0.8	11.87	5
Average	87	30	0.04	0.02	0.090	12.7	9.48	276
Standard Deviation		35	0.11	0.04	0.050	5.5	1.48	776

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.
b Total ammonia as nitrogen in milligrams per liter.
c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO_2+NO_3 detection limit = 0.005mg/L.
d Total phosphorus in milligrams per liter.
e Temperature in degrees Celsius.
f milligrams per liter.
g colonies per 100 milliliters.

Total dissolved solids and SC information is provided, in Table 30, from each location due to the statistical tests indicating a significant difference among locations (most likely due to different water sources).

The pooled data collected on Raft River from the Utah State line to Malta indicate that when and where there is water in Raft River it is of moderate water quality. Although not a listed parameter, nutrients are low to moderate and nutrients do not appear to impact water quality. Total phosphorus averages 0.09 milligrams per liter (mg/L) on an annual basis with a few spikes in the early season runoff period. However, during the critical period for water quality, summer low flow, TP values are below target values set in other rivers in the Twin Falls Region (0.1 mg/L). Additionally, the other components of nutrients are not elevated and nitrate plus nitrite and total NH_3 values are very low. The data support the original non-listing of nutrients in this section of the river.

Table 30. Total dissolved solids and specific conductivity from four Raft River locations.

Month	Narrows TDS[a]	Narrows SC[b]	Utah Location TDS	Utah Location SC	Below Edwards Creek TDS	Below Edwards Creek SC
Mean	651	1,148	346	538	354	747
Standard Deviation	187	246	39	63	83	170
Minimum	335	523	300	469	247	520
Maximum	913	1,426	433	677	504	1,058
Number of Samples	44	44	18	18	16	16

[a] TDS = total dissolved solids.
[b] SC = specific conductivity.

Instantaneous dissolved oxygen (DO) concentrations never fall below state water quality standards. At the four locations 7.12 mg/L DO was the lowest value recorded. This, coupled with the lack of a nutrient problem, leads DEQ to concludes that oxygen demanding materials are likely minimal in the segment. However, a data gap concerning diel DO fluctuations exists. In the future, a diel oxygen concentration study should be undertaken to answer the question more fully. However, at this time DEQ concludes that oxygen demanding materials that would lead to low DO as a pollutant do not exist within the listed segment of Raft River.

Sediment is listed in the upper segment as a pollutant. As the data indicates, suspended sediment also is a low to moderate concern in the segment. Occasional elevated samples are seen during peak runoff events. These are more frequent in the early spring and winter months following storm events. These storm events likely redistribute the sediments from within the channel and from the banks. On an annual basis, however, the data does not support the need for a suspended sediment TMDL in this segment of Raft River. During the spring critical period for salmonid spawning suspended sediments are elevated for very brief periods of time (storm events), but on average do not exceed recommended targets (50-80 mg/L). Bank erosion inventories collected within the segment indicate that bank stability ranges from 87 percent to 50 percent. The reaches with highly stable banks are general associated with perennial water near The Narrows, while those reaches with high percentages of unstable banks are typically found in the more flow altered portions of the Upper Raft River segment near the Utah border and above Malta. A bed load sediment TMDL will likely address the elevated spring and winter TSS events better than an annual suspended sediment TMDL would.

Bacteria samples were also collected with the water chemistry samples at all of the locations. Bacteria exceeded the instantaneous state water quality standards for secondary contact recreation seven times. In most cases, the bacteria concentrations were lower in the downstream sampling locations than in the upper. Three of the exceedances of Idaho's instantaneous water quality standards were observed at the Utah testing location. However, it should be noted that this upper location is not within the jurisdiction of the Idaho water quality standards. It appears from the data that some improvement in water quality occurs, with regards to bacteria, from the upstream to downstream locations. However, the sample sets were not significantly different ($p = 0.511$); therefore, the amount of improvement should be considered insignificant as well. Of the remaining four instantaneous exceedances, three occurred at The Narrows location. The remaining sample was from the below Edwards Creek location. This location was sampled by the SCD and follow-up monitoring to calculate a geometric mean was not undertaken. However, a geometric mean calculated from the five closest samples, including the exceedance, yields a geometric mean of 135. These samples were collected from September 7 to December 20. It is likely that had follow-up monitoring taken place within 30 days as required, the geometric mean would have been much higher. Due to the lateness in the year and changes in land use that occur with the changing seasons, the bacteria counts were changing dramatically. Even with the dramatic decreases a geometric mean standard violation occurred. Thus, it is highly probably that bacteria exceeded state water quality standards in the upper Raft River segment near Edwards Creek.

The final three instantaneous violations occurred at the Raft River Narrows sampling location on July 29, 1999, May 20, 2002, and June 3, 2002. Follow-up monitoring for the 1999 exceedance did not occur. However, the May 20 exceedance was followed up and included the June 3 sample. Five samples were collected within the 30 day period of May 5, 2002 and June 3, 2002. The geometric mean of these five samples was 349, a clear exceedance of state water quality standards.

Temperature studies were also undertaken at two locations along Raft River. HOBO temp loggers were placed at the Raft River Narrows location and at the Utah location. Previous ANOVA results indicated that the instantaneous temperatures were not significantly different between these two locations. Instantaneous temperature measurements from the upstream (Utah) location and the lower location were statistically similar ($p = 0.379$). This may indicate that water quality impacts are similar through the upper segment of Raft River from Utah through Idaho. HOBO loggers were placed at these locations for four years (1999-2002). The upper-most was located just south of the Idaho border near Yost, Utah. Another was placed at The Narrows where the instantaneous samples were collected. The HOBOs were running concurrent with each other in 2000, and 2001, but not in 1999 and 2002 when the Utah logger was not placed. Box plots of the daily means show that the temperature is slightly lower at the Utah location (Figure 22). Water quality standards violations were common at both locations, although the Utah location rarely had exceedances in 2000. At The Narrows location exceedances were quite common in 2001, but fewer violations occurred in the other years. Daily maximum temperature violations also occur at The Narrows site commonly (Figure 23). Consequently, a temperature TMDL for the entire creek will be required. The TMDL may have to include Utah. Consequently, EPA may be required to take the lead of this multi-state, multi-regional TMDL if the implementation of the Idaho temperature TMDL proves ineffective.

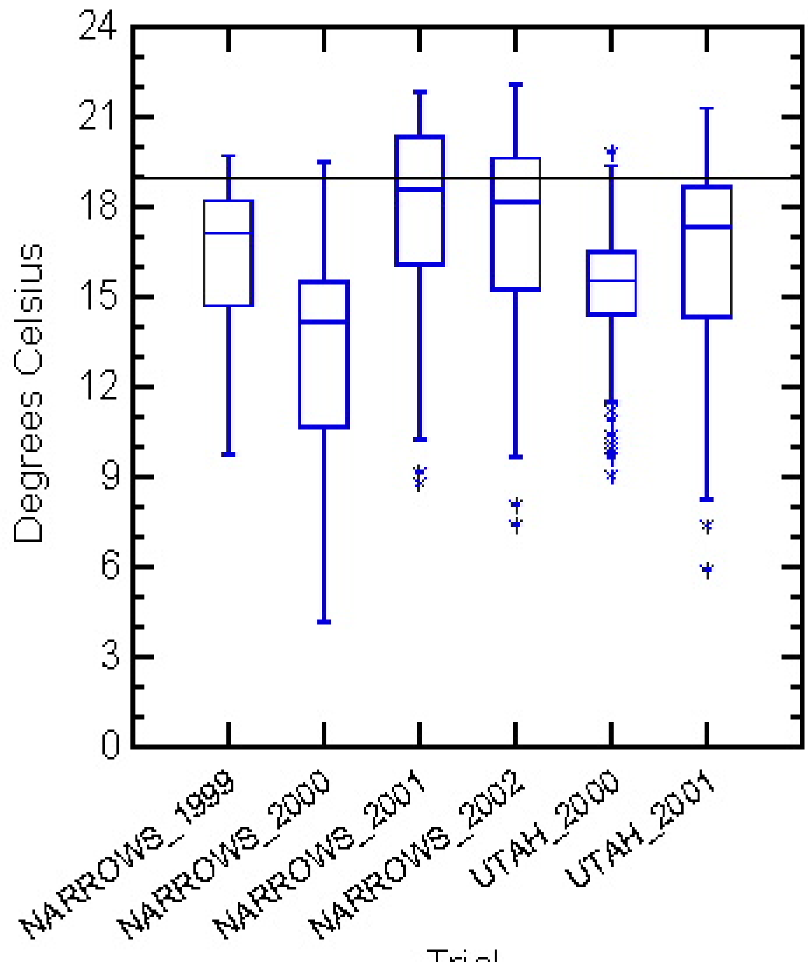


Figure 22. Daily mean temperatures at two Raft River locations over four years.

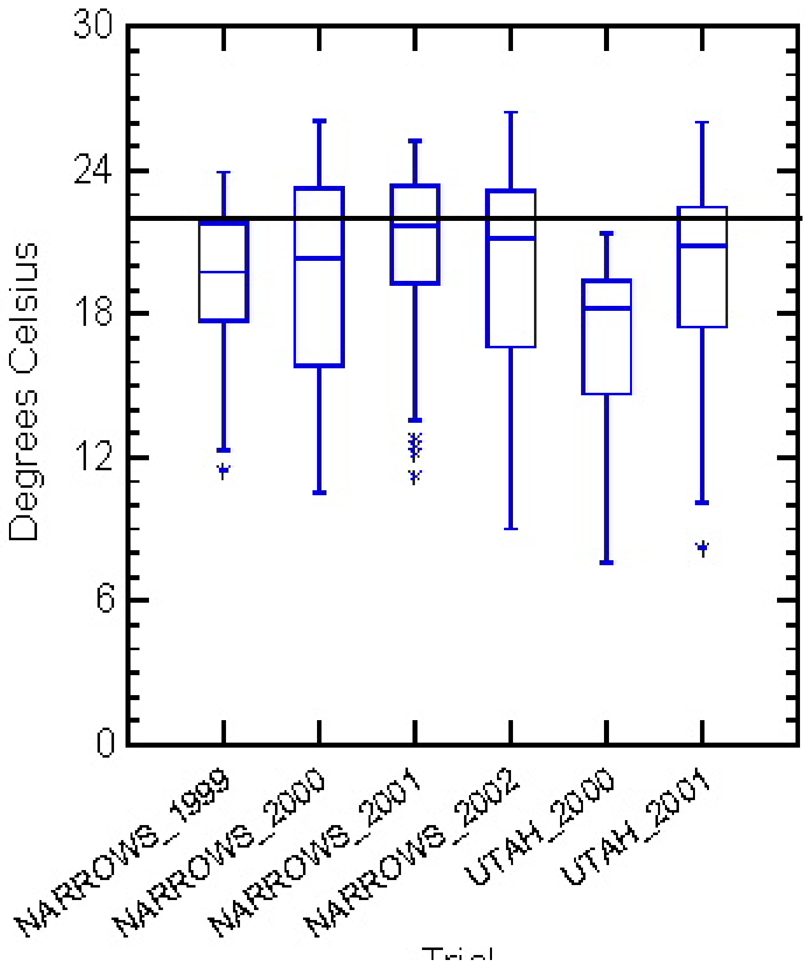


Figure 23. Maximum temperature measurements at two Raft River locations for four years.

The upper segment of Raft River is also listed for salinity, the only water body in the state so listed. Consequently, much of the information pertaining to the assessment of salinity will be based on other states' salinity TMDLs. The primary TMDL used to guide much of the analysis was the Big Sandy Creek Salinity TMDL prepared by the Montana Department of Environmental Quality (MDEQ) (Bauermeister 2001). The MDEQ uses SC and total dissolved solids (TDS) as the parameters to determine if salinity is a problem within their streams. Additional measures of sulfates and chlorides are also made. However, DEQ has only collected TDS and SC measures. These should suffice in making the determination of impairment based on the Montana criteria.

Montana suggests TDS and SC as measures because they measure the total mineral content of a water body. Additionally, SC and TDS are related and the SC/TDS relationship is unique to each stream based upon geology and ground water influence. The SC/TDS relationship for pooled Raft River sites visually appears to suggest two different sources of water or SC/TDS relationships (Figure 24).

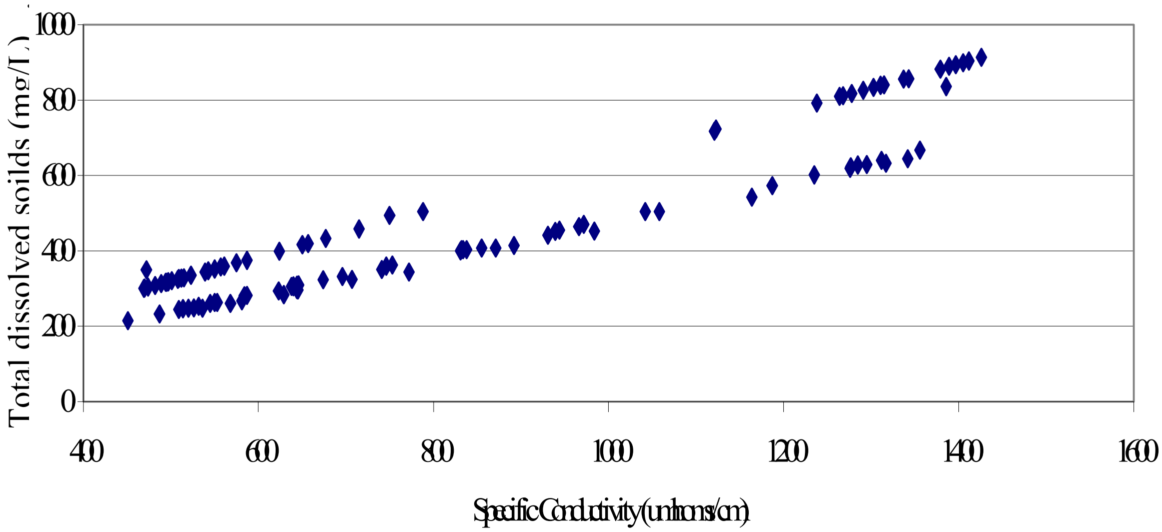


Figure 24. Total dissolved solids /specific conductivity relationship for the pooled Raft River data.

The overall statistical relationship; however, is significant ($p < 0.05$) and the fit is very high ($r^2 = 0.879$) for the pooled data. However, previous ANOVA indicated that the sample locations were significantly different ($p = 0.000$). The Bonferroni post hoc test indicated that the Raft River Narrows location was significantly different than the other three locations. In addition, this location also had the highest measured SC and TDS. Therefore, it is likely that this area has the highest probability of a salinity problem. However, ground water plays a bigger role in the hydrology of this location than that of the other three.

The TDS/SC relationship for The Narrows location seems to break down much more than the overall relationship, likely because of more year-to-year variation in the percent of ground water contribution. For example, in the drier years of 2001 and 2002, a higher percentage of the water at The Narrows was likely ground water.

An ANOVA was conducted on the year-to-year data collected at The Narrows location and it was determined that there were significant differences year-to-year in both TDS and SC ($p = 0.027$ and 0.048 respectively). Again, Bonferroni post hoc tests were used to determine which years were different. For TDS it appears that 1999 and 2001 were significantly different ($p = 0.045$) from other years, while the remaining years were not significantly different from each other ($p > 0.05$). Therefore, the TDS relationship should be best if 1999 and 2001 were excluded. However, this was not the case. The best fit to the relationship came if each year was plotted separately. In this case, the r^2's ranged from 0.89 to 1.0. Pooling them together resulted in an r^2 of 0.792 (Figures 25 and 26).

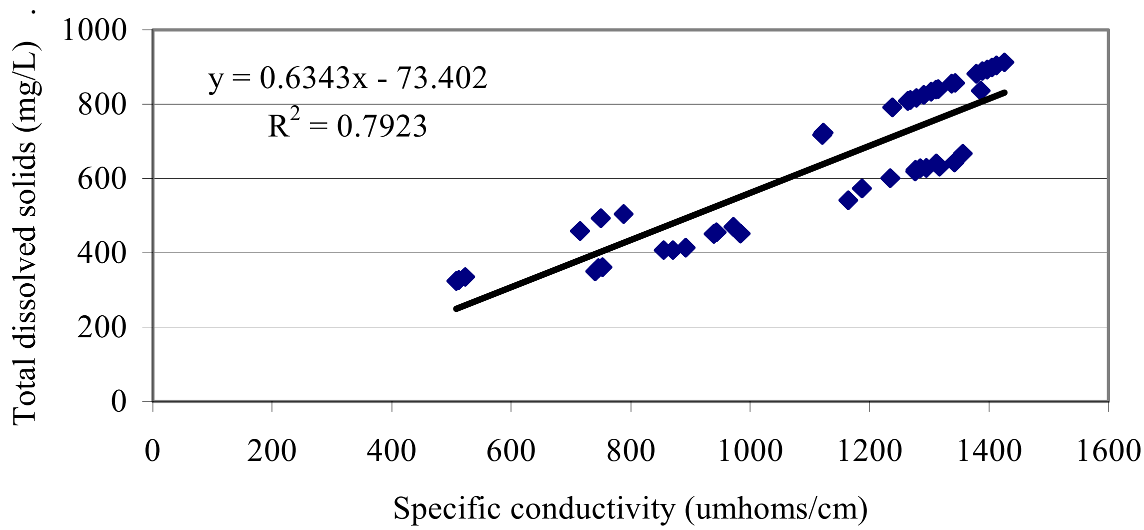


Figure 25. Total dissolved solids /specific conductivity relationship at the Raft River Narrows for four years.

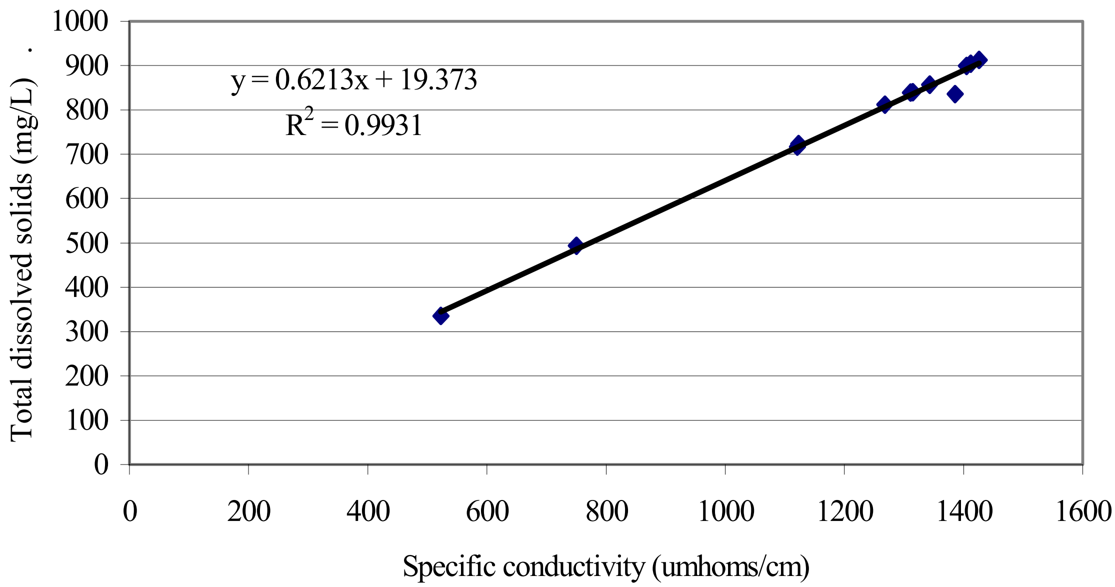


Figure 26. Total dissolved solids /specific conductivity relationship at the Raft River Narrows in 2001.

The TDS/SC relationship is important in the Big Sandy TMDL because the target selected was SC, yet the unit measured for compliance was TDS. In order to predict TDS year-to-year regardless of water conditions, the pooled relationship should be used because it covers a wider range of background conditions. Care should be noted, however; that the fit of the relationship and therefore the predictive ability of the relationship is somewhat less than using a single year.

The next step in the MDEQ TMDL was to identify a reference watershed against which to compare the SC values of Big Sandy Creek. In our case, an appropriate reference system for Raft River likely does not exist. However, the values generated in the Big Sandy Creek TMDL may suffice as they are conservative especially in comparison to other standards and guidelines as cited in the Big Sandy TMDL. For example, stock water guidelines for SC are below 5,000 microhms per centimeter (µmhoms/cm), SC greater than 2,200 µmhoms/cm can reduce the yield of alfalfa, and *Daphnia magna* suffers 6 percent mortality at 1,600 µmhoms/cm (Bauermeister 2001). The reference location for the Big Sandy TMDL was often below 1,600 µmhoms/cm. Based on these values, MDEQ chose 1,600 µmhoms/cm as the value to determine the creek-specific TDS target for any subsequent TMDLs.

As this relates to the Raft River, the target or assessment guideline to determine if TDS/salinity is impairing beneficial uses would be derived from the TDS/SC relationship in Figure 25, or 942 mg/L TDS. A review of all the data collected from Raft River reveals that no TDS values over the guideline were measured.

It appears from the data that suspended sediment, nutrients, DO, and TDS/salinity are within the bounds of water quality determined to be supportive of the designated beneficial uses. Consequently, DEQ will not complete a TMDL for these parameters on the creek. However, DEQ will complete TMDLs for bed load sediment, bacteria, and temperature. Flow alteration will remain on the §303(d) list as pollution and no TMDL will be completed for this parameter at this time. At such time that pollution TMDLs are generated, DEQ will undertake the necessary data collection and analysis to complete a flow alteration TMDL.

Point and Nonpoint Sources

The upper listed segment of the Raft River bisects two fifth field HUCs, 1704021107 and 1704021106. Geographic information systems (GIS) coverages indicate that 1.7 percent of the watershed is urban, 28.2 percent is irrigated croplands, and 70.1 percent is forest or rangelands. These are the major sources of nonpoint source pollution in the watershed. Of the irrigated lands, the majority is sprinkler irrigated. Additional sediment sources include unstable banks and reentrainment from the riverbed itself. However, quantification of these sources has not been completed. As of yet, no CAFOs or other point sources are known to exist within the watershed.

Sublett Creek

Sublett Creek begins in the south central mountains of Idaho in the Heglar area. The listed section of Sublett Creek is 13.26 km from the Sublett Reservoir to the “lower bounds” of the creek. Sublett Creek has been impounded for many years. An old earthen dam exists upstream from the current dam. This structure appears to have been constructed by the original homesteaders. The listed segment may have flowed to Raft River prior to the settlement of the west. However, the geology of the area makes it as likely that the creek would have subbed out in the alluvial flats of Raft River as is the current condition. Present day Sublett Creek discharges to a canal and drain system and is entirely used during the irrigation season. During the nonirrigation season Sublett Creek drains to this same system and is used for stock water, pasture water, and ground water recharge. In practice, Sublett Creek no longer exists 4 km from the reservoir. At this point all of the water is diverted into the water delivery system. DEQ’s assessment of Sublett Creek will be based upon data collected in the upper segment of the creek near the reservoir. No data were collected in the lower segments after the majority of water is contained within the delivery canals and ditches. Along this 4 kilometer course, no perennial tributaries enter the system, although approximately 10 ephemeral systems may contribute during runoff events. The USGS has not gauged Sublett Creek. The Sublett Creek Watershed is an area of approximately 135 km^2. Given this size watershed, channel characteristics were extrapolated from regional curves. These regional curves are in *Applied River Morphology* (Rosgen 1996). Extrapolating from the regional curve, Sublett Creek near the first headgate should have a mean bankfull depth of 0.67 m, a bankfull width of 10.77 m and a bankfull cross-sectional area of approximately 8.75 m^2. Due to the lack of gauged flow at the time of this writing, a statistical interpretation of hydrological events will be provided based upon the other gauge data located within the subbasin.

Physical Characteristics

The §303(d)-listed segment of Sublett Creek begins at the reservoir at an elevation of 1,613 m (headgate elevation). This assessed segment is 3.78 km long. The valley through which this segment flows is approximately 3.22 km in length. The segment has a very low slope of 0.86 percent. This slope corresponds to an 8.62 m fall per kilometer. Slopes of this magnitude are usually seen in moderate to highly sinuous streams that are depositional streams. However, sinuosity is classified as low (1.2) for the listed segment. This is likely the direct result of the stream being confined in the rather small valley bottom. Floodplain materials are composed of fine textured sands and small gravel derived from volcanic plateau lands in the lower bounds and sedimentary fluvial lands in the upper watershed. Consequently, it would be expected that the percent fines of Sublett Creek should be similar in comparison to a channel with low slopes, moderate sinuosity, and finer floodplain materials such as Goose Creek or Raft River. The annual hydrograph is strictly controlled by the water users and consequently bankfull measurements would not be representative of a watershed of similar size.

Hydrology

Due to the lack of data, the natural hydrology of Sublett Creek cannot be described with USGS gauge data. Additionally, the gauge data available at other locations do not correspond with data collected concurrently in Sublett Creek. The reservoir withdrawals change the shape of a normal runoff curve. Discharge corresponds more with crop requirements than with runoff events. Additionally, the whole of the Sublett drainage is highly influenced by ground water. Most of the precipitation in the area infiltrates into the karst geology of the surrounding mountains. The creeks feeding the reservoir often peak in discharge later in the summer rather than early spring (Lay 2002).

The average annual hydrograph for Sublett Creek based upon DEQ monitoring is shown in the following figure (Figure 27). It should be noted that measurements were not taken in November through March.

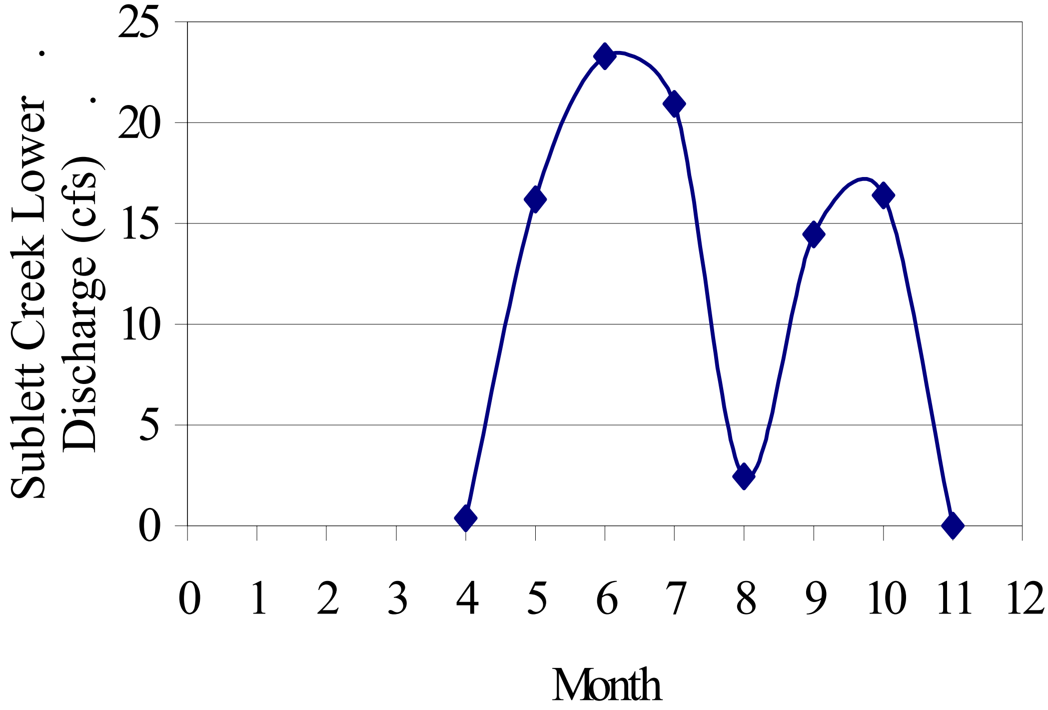


Figure 27. Sublett Creek monthly average discharge 2000-2002.

Existing Water Quality Data

Water quality samples containing a full suite of constituents collected within the listed segment of the Sublett Creek are rare. Upon a review of the STORET database no samples could be found.

DEQ sampled in the creek over the course of 2000-2001, with a few additional samples collected in 2002. Additional samples will be collected throughout the various phases of TMDL implementation as budgets and sampling time frames allow. However, due to the limited number of sampling periods in the data set, DEQ's confidence in monthly average concentrations is low. The lack of a robust data set was due to limited budgets and, in part, to a limited time frame for collecting data. In most cases one sample was the most collected in any given month. Infrequently, multiple samples were collected in some months. This sampling design was intended to determine annual pollutant loads . The annual load estimated by this type of design would overestimate the annual load by 25 to 50 percent (Robertson and Richards 2000). To assist in the determination of seasonal components and appropriate critical conditions, the data will be presented as monthly averages in the following tables while period of record averages are presented in the text and in the tables and used for any future load calculations. For those cases when a parameter was below detection limits, half the detection limit was used to calculate the monthly average and used as part of the period of record average.

One sample location was set up on the listed segment of Sublett Creek. The location was approximately 1.6 km below the reservoir (see Figure 21). Sampling began in July of 2000. The site was used to determine concentrations and loads for the stream.

Water quality data collected from the sample location reflect the high quality expected from the tailrace of a reservoir and from a primarily ground water fed system. Land use activities are not likely to influence the water quality of Sublett Creek to a great deal in the limited distance before the creek is removed from the natural channel. For example, TSS in Sublett Creek averages 7 mg/L (standard deviation 11 mg/L), which is lower than the samples collected above the reservoir at Raft River sites (15 mg/L). These samples were taken in the same day as the upper samples and include the critical periods of springtime low flows and summertime high flows. The TP is lower in Sublett Creek than Raft River as well, although the difference is less dramatic than suspended sediments. At Sublett Creek the average TP concentration was 0.055 mg/L (standard deviation 0.034 mg/L), while at the upper site the average TP concentration was 0.061 mg/L. The minimum measured TP concentration at Sublett Creek was a non detect (< 0.005 mg/L) in October and the maximum was 0.143 mg/L during the end of August following near complete draw-down of the reservoir.

Monthly concentrations of TP were never indicative of excess nutrients that may cause impairment (nuisance aquatic vegetation). Guidelines that DEQ has used in the past are not to exceed 0.160 mg/L TP in any single sample and 0.100 mg/L TP in any average monthly sample. The guidelines were never exceeded (Table 31). In addition, a lack of nuisance aquatic vegetation is seen within the system. Further chlorophyll *a* samples are required to determine a subbasin wide model for nutrient concentration and sestonic chlorophyll *a* concentrations. In addition, nitrogen compounds were also very low within the system. Nitrate plus nitrite samples averaged 0.041 mg/L (standard deviation 0.113 mg/L).

Dissolved oxygen was also monitored throughout 2000-2002. The DO never fell below state standards even following the complete diversion of Sublett Creek from up above the site. At that time, any discharge into the reach below the diversion was from seepage, a very small spring, or water leaking through the diversion structure. A fall of DO levels was expected to correspond with the decreased flow and a rise in stream temperature. However, this was not the case. Stream temperatures at that time remained near ground water temperatures, and DO levels remained relatively high (8 plus mg/L). Dissolved oxygen is often used in conjunction with pH to determine if excess nutrients have caused nuisance aquatic growths. In prior discussions, DEQ had determined that excess aquatic growths associated with excess nutrients had not occurred in Sublett Creek during the sampling period. The DO and pH data support this contention. Therefore, DEQ finds that the lower segment of Sublett Creek is not polluted with oxygen demanding materials.

Bacteria counts were very low for the most part. One sample exceeded the instantaneous criteria on September 4, 2000 (1,700 colonies/100 ml). However, follow-up monitoring was not completed to determine if water quality violation had occurred due to zero discharge from the reservoir. The proceeding day a sample was taken which was very low (6 colonies/100 ml). The following month (October 4, 2000) bacteria counts were 2 colonies/100 ml. The magnitude of the change in bacteria counts in September and October may be related to the proximity of a stock corral near the sample location. The corrals were used intermittently as a gathering point for redistribution to other areas of pasture or allotments. Due to the intermittent use it is unlikely that a month-long bacteria exceedance could occur based upon the frequent very low levels. Additionally, water to the creek had been turned off shortly after September 4, 2000. Periodic visits to the site indicated that the creek remained dry until nearly October 4. If the unusually high data point is excluded, the average bacteria count for Sublett Creek was 19 colonies/100 ml; if the unusually high data point is included, the average is 99 colonies/100 ml with a standard deviation of 368.

From the 2001 data set, TSS also appears to be a non-factor effecting beneficial uses. The upper segment of the creek contains a medium-sized reservoir that would act as a sediment sink. Consequently, much of the sediment stored in the system is never transported out of the reach as a suspended load. In extremely low water years, the suspended fraction may increase as the reservoir is completely emptied. With these events, the stored sediments would mobilize into the lower channel as the creek cuts through the sediments stored in the old channels. However, either the stored fraction in the reservoir is low enough or the complete draw-down of the reservoir occurs on such a regular basis that increased sediment loadings never occurred following draw-down. As stated previously, TSS below the dam averaged 7 mg/L while above the dam the average was near 15 mg/L. Month-to-month variation below the dam was very low as expected below storage structures. August and September samples were nearly identical to samples collected during the spring.

Instantaneous temperature measures were also collected in Sublett Creek. In the warmer months of July and August one temperature exceedance occurred. The exceedance occurred at a time when discharge from the reservoir was zero. At other times, while the creek was diverted, what little water remained in the creek did not exceed instantaneous temperature standards. Again, this was likely due to the influence of ground water in the lower reach. Temperature is likely not an issue in Sublett Creek due to the cold water springs that feed the system. These springs would act as a temperature buffer for the system.

The overarching water quality problem in Sublett Creek is not any of the previously mentioned water quality parameters. It is simply flow alteration. Typically, any water quality guideline or standard, if it is violated, is violated when the water is shut off to the creek. Temperature, low DO, and TSS are usually the parameters associated with flow alteration problems. In Sublett Creek's case, these parameters are buffered by the upstream watersheds water source and quality. However, the beneficial uses of the creek remain impaired due to long periods of zero flow during the spring filling period and during the summer when water is not required for the crops.

It appears from the data that nutrients, suspended sediment, DO, temperature, and bacteria are within the bounds of water quality determined to be supportive of the designated beneficial uses. If the beneficial uses sustain any impact in the lower segment it is due solely to flow alteration. Consequently, DEQ will not complete a nutrient, suspended sediment, DO, temperature, or bacteria TMDL on the creek. However, DEQ will retain Sublett Creek on the §303(d) list for flow alteration in the lower segment from the reservoir to the lower bounds of the creek.

Point and Nonpoint Sources

Sublett Creek flows through the sixth field HUCs 170402100401 and 170402100402. The GIS coverages indicate that 40.29 percent of the land use is dry land farming, 44.59 percent is rangelands, 14.89 percent is irrigated, and 0.23 percent of the watershed is forested. The major sources of nonpoint source pollution in the watershed are activities associated with these land uses. The listed segment falls mainly within the rangeland land use area. Additional sediment sources include unstable banks and reentrainment from the riverbed itself. However, quantification of these sources has not been completed. As of yet, no CAFOs or other point sources are known to exist within the watershed.

Table 31. Measured water quality constituents in Sublett Creek.

Month	No of Samples	TSS (mg/L)[a]	Total NH_3 as N (mg/L)[b]	Total NO_2 + NO_3 as N (mg/L)[c]	Total P (mg/L)[d]	Temp (°C)[e]	Dissolved Oxygen (mg/L)[f]	Bacteria *E. coli* (Col/100 ml)[g]
January	0							
February	0							
March	0							
April	2	5	0.012	0.046	0.050	9.16	12.43	3
May	5	16	0.015	0.018	**0.080**	12.36	9.35	1
June	2	1	0.010	0.008	**0.046**	13.70	8.73	0
July	3	2	0.024	0.010	**0.039**	19.75	8.36	50
August	3	8	0.024	0.180	0.090	19.90	9.79	58
September	3	3	0.018	0.020	0.036	13.76	9.88	570
October	3	5	0.009	0.010	0.025	8.10	10.21	13
November	0							
December	0							
Annual Average		7	0.016	0.041	0.055	13.91	9.70	99
Standard Deviation		11	0.011	0.113	0.034	4.81	1.73	368

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.
b Total ammonia as nitrogen in milligrams per liter.
c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO_2+NO_3 detection limit = 0.005mg/L.
d Total phosphorus in milligrams per liter.
e Temperature in degrees Celsius.
f milligrams per liter.
g colonies per 100 milliliters.

Cassia Creek

Cassia Creek begins in the south central mountains of Idaho in the Albion mountain range. The listed section of Cassia Creek is 20.50 km from the confluence of Conner Creek to the confluence of Raft River. In 1998, the upper segment of Cassia Creek was removed from the §303(d) list. The upper segment is 18.54 km long and begins at the confluence of Flat Canyon Creek and New Canyon Creek. Present-day Cassia Creek rarely reaches the Raft River during the irrigation season. During the nonirrigation season Cassia Creek will contribute some water to the Raft River system. DEQ's assessment of the lower segment of Cassia Creek will be based upon a few data points collected from one location when there was water in the creek. This sample location was near Malta on the Hudsepth cutoff road. Data collected mainly in the upper segment of the creek near Conner Creek will be used to reassess the delisted segment. However, this data may be used to add robustness and understanding of the water quality in the lower segment as well.

Along Cassia Creek, eight perennial tributaries enter the system (Conner, Cross, Stinson, New Canyon, Flat Canyon, Clyde, and Cold Spring Creeks as well as Rice Spring), although all of these enter above the listed segment (except Rice Spring which enters within the listed segment). Additionally, many ephemeral systems may contribute during runoff events. The USGS has gauged Cassia Creek near the confluence of Stinson Creek in the upper segment. The Cassia Creek Watershed is an area of approximately 458 km^2. Given this size watershed, channel characteristics were extrapolated from regional curves. These regional curves are in *Applied River Morphology* (Rosgen 1996). Extrapolating from the regional curve, Cassia Creek near Raft River should have a mean bankfull depth of 0.78 m, a bankfull width of 17.77 m and a bankfull cross-sectional area of approximately 19.08 m^2.

Physical Characteristics

The §303(d)-listed segment of Cassia Creek begins at Conner Creek at an elevation of 1,487 m. The listed segment is 20.50 km long. The valley through which this segment flows is approximately 18.76 km in length. The segment has a very low slope of 0.64 percent. This slope corresponds to a 6.45 m fall per kilometer. Slopes of this magnitude are usually seen in moderate to highly sinuous streams that are depositional streams. However, sinuosity is classified as low (1.1) for the listed segment. This is likely the direct result of the stream being channelized and diverted for irrigation uses for many years. Floodplain materials are composed of very fine textured sands and silts from volcanic plateau lands and volcanic fluvial lands in the lower watershed. Consequently, it would be expected that the percent fines of Cassia Creek would be similar in comparison to a channel with low slopes, moderate sinuosity, and fine floodplain materials such as Goose Creek or Raft River. The annual hydrograph is strictly controlled by the water users and consequently bankfull measurements would not be representative of a watershed of similar size.

Hydrology

Due to the lack of current data, the hydrology of Cassia Creek cannot be described with USGS gauge data. The only data available were collected in the late 1960s and 70s. Furthermore, changes in irrigation withdrawals since that time would change the shape of a normal runoff curve making a statistical relationship with other gauged watershed difficult to obtain, with weak predictive abilities. The weak relationship between the historical Cassia Creek data and similar data collect at Raft River can be seen in Figure 28. It appears that flow in Cassia Creek near the gauge varied much more while Raft River did not experienced as wide of swings in flow during the same period. As a result, the ability to predict Cassia Creek discharge using Raft River discharge is undermined. Consequently, the average annual hydrograph for Cassia Creek will be based upon the historical USGS monitoring collected (Figure 29).

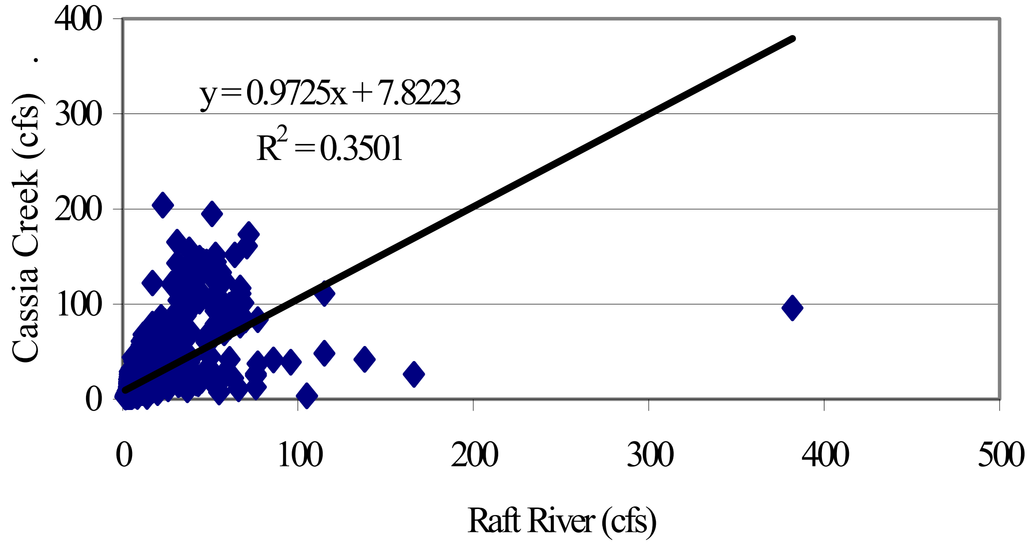


Figure 28. Linear regression model of Cassia Creek and Raft River discharge.

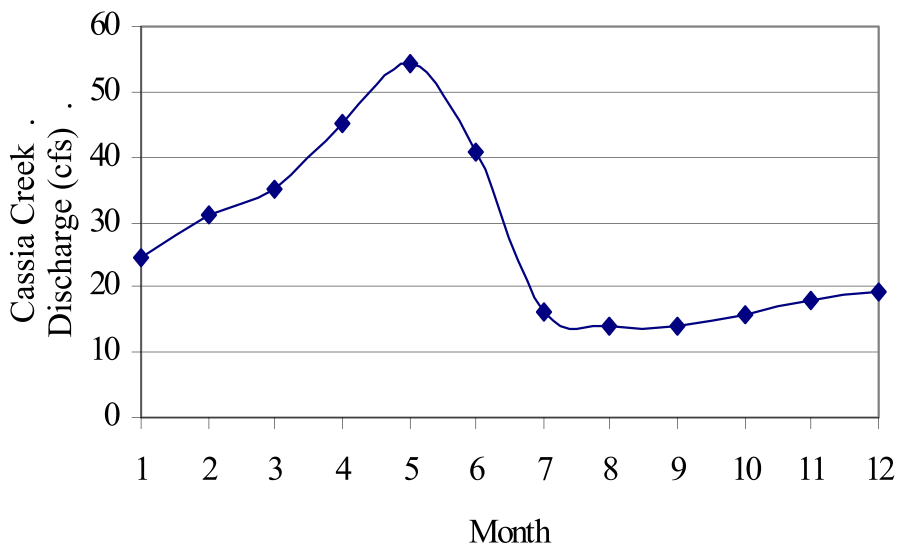


Figure 29. Annual average hydrograph for Cassia Creek based upon U.S. Geological Survey gauge data.

Existing Water Quality Data

Water quality samples containing a full suite of constituents collected within the listed segment of the Cassia Creek are rare. Upon a review of the STORET database no samples could be found.

DEQ sampled low in the listed segment creek nine times over the course of 2001-2002, and 26 times in the upper portion of the listed segment over 2000-2002. Additional samples will be collected throughout the various phases of TMDL implementation as budgets and sampling time frames allow. However, due to the limited number of sampling periods in the original 2001 data set, DEQ's confidence in monthly average concentrations is low. The lack of a robust data set was due to limited budgets and, in part, to a limited time frame for collecting data. In most cases one sample was the most collected in any given month. Infrequently, multiple samples were collected in one month. This sampling design was intended to determine annual load. However, the annual load estimated by this type of design would overestimate annual load by 25 to 50 percent (Robertson and Richards 2000). To assist in the determination of seasonal components and appropriate critical conditions, the data will be presented as monthly averages in the following tables while period of record averages are presented in the text and other tables and will be used for any future load calculations. For those cases when a parameter was below detection limits, half the detection limit was used to calculate the monthly average and used as part of the period of record average. Water quality information was collected from the upstream portion of the listed segment to determine background concentrations and loads from the unlisted segments of the river.

The chemical constituents at both sites seemed to be very similar throughout the sampling period. In order to determine if this was the case an ANOVA was conducted to test the null hypothesis.

H_o: Cassia Creek upper mean = Cassia Creek lower mean.

H_a: Cassia Creek upper mean ≠ Cassia Creek lower mean.

Each constituent sampled at the two locations were tested using Systat 7.0. For most constituents the null hypothesis was rejected ($p < 0.05$). However, temperature, DO, pH, TDS, bacteria, and SC were not significantly different from station to station (Table 32). Therefore, for these constituents the null hypothesis was not rejected.

For the remaining constituents, the means from the lower site, located near the Hudspeth cutoff, were much higher than the upper site means near Conner Creek. The change in the remaining constituents is likely the result of increased degradation in the lower segment. The constituents most likely affected by anthropogenic disturbances are the ones that are significantly elevated. The ones not as likely to be influenced by anthropogenic disturbances, (e.g. pH and SC) are not statistically different between locations.

For the most part, the statistical tests allow DEQ to reaffirm the removal of the upper segment from the §303(d) list in 1998 as well as the action taken to retain the lower segment on the list. However, the sparse data set from the lower segment will likely lead to greater uncertainty concerning pollutant loads for that segment. In addition, the data must be presented as separate data sets. These results are presented in Tables 33 and 34.

Table 32. Analysis of variance probability values for two sample locations.

Constituent	Significance Value (p)
Temperature	0.723
Dissolved Oxygen	0.954
Specific Conductivity	0.295
pH	0.235
Total Dissolved Solids	0.315
Total Suspended Sediment	0.007
Total Ammonia	0.040
Nitrate + Nitrite	0.048
Total Phosphorus	0.037
E. coli	0.287

Water quality data collected from the upper sample location reflect the water quality expected from a system in which aquatic life beneficial uses are fully supported. However, at this upper location, nutrients are on the verge of concentrations seen in systems in which the beneficial uses are impaired. Land use activities are beginning to change from rangeland uses to uses of irrigated agriculture and riparian pasture. Some constituents increase dramatically from segment to segment. For example, TSS in upper Cassia Creek averages 21 mg/L (standard deviation 29 mg/L), which is much lower than the samples collected in the lower segment (104 mg/L, standard deviation 135 mg/L). These samples were taken on the same day. There is a dramatic difference in TP concentrations as well, almost as dramatic as the difference in suspended sediments. At upper Cassia Creek the average TP concentration was 0.110 mg/L (standard deviation 0.061 mg/L), while at the lower site the average TP concentration was 0.215 mg/L average.

Monthly concentrations of TP at both sites were indicative of excess nutrients that may cause impairment (nuisance aquatic vegetation). Guidelines that DEQ has used in the past are not to exceed 0.160 mg/L TP in any single sample and 0.100 mg/L TP in any average monthly sample. The guidelines were almost always exceeded (see Tables 33 and 34). However, an assessment of nuisance aquatic vegetation was never made within the system. Further chlorophyll *a* samples are required to determine a subbasin wide model for nutrient concentration and sestonic chlorophyll *a* concentrations. Nitrogen compounds were elevated at both locations within the system. Nitrate plus nitrite samples at the upper location averaged 0.189 mg/L (standard deviation 0.068 mg/L).

Dissolved oxygen was also monitored at both locations. Dissolved oxygen never fell below state standards even following the complete diversion of Cassia Creek. A fall of DO levels was expected to correspond with the decreased flow and a rise in stream temperature. However, this was not the case. Stream temperatures at that time remained near ground water temperature and DO levels remained relatively high (8 mg/L plus). The relatively stable temperatures and DO levels indicate a strong influence of ground water in the hydrology of Cassia Creek.

Table 33. Monthly average water quality constituents in lower Cassia Creek.

Month	No of Samples	TSS (mg/L)[a]	Total NH_3 as N (mg/L)[b]	Total NO_2 + NO_3 as N (mg/L)[c]	Total P (mg/L)[d]	Temp (°C)[e]	Dissolved Oxygen (mg/L)[f]	Bacteria *E. coli* (Col/100 ml)[g]
January								
February								
March								
April	1	60	0.034	0.297	0.131	7.61	10.29	130
May	4	147	0.055	0.104	0.282	12.24	9.44	1469
June	1	76	0.029	0.139	0.187	11.42	8.58	980
July	dry							
August	dry							
September	dry							
October	dry							
November	1	2	0.010	0.005	0.058	5.63	13.5	25
December								
Average		104	0.042	0.123	0.215	10.63	9.84	999
Standard Deviation		135	0.049	0.096	0.214	2.85	1.64	1766

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.
b Total ammonia as nitrogen in milligrams per liter.
c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO_2+NO_3 detection limit = 0.005mg/L.
d Total phosphorus in milligrams per liter.
e Temperature in degrees Celsius.
f milligrams per liter.
g colonies per 100 milliliters.

Table 34. Monthly average water quality constituents in upper Cassia Creek.

Month	No of Samples	TSS (mg/L)[a]	Total NH_3 as N (mg/L)[b]	Total NO_2 + NO_3 as N (mg/L)[c]	Total P (mg/L)[d]	Temp (°C)[e]	Dissolved Oxygen (mg/L)[f]	Bacteria *E. coli* (Col/100 ml)[g]
January								
February								
March								
April	2	41	0.029	0.272	0.112	6.05	11.61	265
May	5	49	0.025	0.179	0.154	7.71	10.04	934
June	3	22	0.014	0.097	0.108	8.95	10.05	473
July	2	6	0.023	0.145	0.091	14.09	8.565	500
August	5	16	0.021	0.222	0.109	15.09	8.99	396
September	3	5	0.021	0.248	0.100	10.39	9.69	673
October	3	4	0.011	0.187	0.080	8.44	10.08	178
November	1	8	0.016	0.091	0.061	4.65	12.10	39
December								
Average		21	0.020	0.189	0.110	10.10	9.87	541
Standard Deviation		29	0.008	0.068	0.061	3.88	1.53	724

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.
b Total ammonia as nitrogen in milligrams per liter.
c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO_2+NO_3 detection limit = 0.005mg/L.
d Total phosphorus in milligrams per liter.
e Temperature in degrees Celsius.
f milligrams per liter.
g colonies per 100 milliliters.

Bacteria counts were very high at both locations. The instantaneous criterion (576 colonies/100 ml) was violated multiple times in both segments. However, follow-up monitoring was not completed after each violation. After the one of the first exceedances, follow-up monitoring did take place. The geometric mean of the five samples collected within the 30-day period equaled 173. The criterion for exceedance is 125. Budget constraints did not allow for further follow-up monitoring after subsequent bacteria violations in the upper location.

At the lower location, following an instantaneous bacteria criteria violation, DEQ attempted to determine if water quality violations had occurred. Subsequent samples could not be collected as the creek was dewatered during the 30-day period. However, the geometric mean of the five closest samples (all of the 2001 data) resulted in a geometric mean of 158, suggestive that bacteria are a continual problem within the lower segment.

From the upper data set, TSS appears to be a non-factor effecting beneficial uses, while the opposite is true for the lower segment. The upper segment of the creek contains a well-developed riparian zone that would act as a sediment buffer from land use activities in the uplands. Consequently, much of the sediment stored in the uplands is never transported to the reach. In the upper reach, TSS has an annual average of 21 mg/L. Additionally, the suspended sediment criteria established in other TMDLs (50 mg/L monthly average, 80 mg/L daily maximum) were never exceeded in the upper location.

In the lower reach, the riparian zone is less developed and land use activities occur closer to the stream system. In extremely low water years, the suspended fraction may decrease as the as less hydraulic bank interaction occur. With increased events the stored sediments would mobilize into the lower channel as the creek cuts through the sediments stored in the old channels. As see in Table 33, TSS in the lower section averaged 104 mg/L, while in the upper reach the average was near 21 mg/L.

Instantaneous temperature measurements were also collected in Cassia Creek. In the lower reach water is completely diverted before the warmer months of the summer. No exceedances were noted. Temperature is likely not an issue in Cassia Creek due to the complete diversion of water in most months of the year.

The overarching water quality problem in Cassia Creek is not any of the previously mentioned water quality parameters. It is simply flow alteration. Typically, any water quality guideline or standard, if it is violated, is violated when the water is shut off to the creek. Temperature, low DO, and TSS are usually the parameters associated with flow alteration problems. In Cassia Creek's case, these parameters are buffered by the upstream watersheds water source and quality. However, the beneficial uses of the creek remain impaired due to long periods of zero flow during the spring filling period and during the summer when water is not required for the crops.

It appears from the data that DO and temperature are within the bounds of water quality determined to be supportive of the designated beneficial uses. The beneficial uses sustain impact in the lower segment from flow alteration, habitat alteration, nutrients, bacteria and sediment. Consequently, DEQ will complete nutrient, bacteria, and suspended sediment TMDLs on the creek. Furthermore, DEQ will include the upper segments of Cassia Creek in the bacteria and nutrient TMDLs. Additionally Cassia Creek will remain on the §303(d) list for flow alteration and habitat alteration in the lower segment from Conner Creek to Raft River.

Point and Nonpoint Sources

Cassia Creek flows through the fifth field HUCs 1704021010, 1704021020, and 1704021021. The GIS coverages indicate that 86.1 percent is rangeland, 11.3 percent is forested, and 2.6 percent is irrigated. The major sources of nonpoint source pollution in the watershed are activities associated with these land uses. The listed segment contains most of the irrigated land uses within the watersheds. Additional sediment sources include unstable banks and reentrainment from the streambed itself. However, quantification of these sources has not been completed. As of yet, no CAFOs or other point sources are known to exist within the watershed.

Fall Creek

Fall Creek begins in the south central mountains of Idaho in the Heglar area. The listed section of Fall Creek is 4.75 km in length, encompassing an area from the headwaters to Lake Fork

Creek. The karst geology of the area greatly influences the hydrology of Fall Creek. Rapid infiltration of precipitation occurs throughout the watershed. This water is stored in the local aquifers and arises in a few large springs scattered throughout the watershed. Fall Creek originates at Upper Fall Creek Spring nearly 1 km from the headwater area. The creek channel above this spring is dry during most of the year.

The creek was originally listed in 1998 following BURP protocols and guidance in the Water Body Assessment (WBAG) version I (DEQ 1996). The creek is listed with unknown pollutants. The original listing criteria for Fall Creek are in question. The macroinvertebrate index used for the 1998 listing cycle had cutoff criteria for not full support at 2.5 and full support at 3.5 (an index score of less than 2.5 indicates the beneficial uses are not being supported; a score of over 3.5 indicates the uses are being supported). The Fall Creek scored a 3.48. An index score such as this would fall into the needing verification area. The habitat index score for Fall Creek was also relatively high for the Snake River Basin. The score was approximately 81 percent of the reference score. Given two moderately high index scores Fall Creek should not have been listed as not supporting its beneficial uses. Rather it should have been placed in the category of needing verification and the listing criteria would have been based upon other parameters. In addition, salmonid spawning appears to be fully supported (two plus size classes of salmonids plus young-of-year salmonids) under the WBAG version I guidelines. The only water temperature collected at that time on Fall Creek was at 12.5 °C. This would also have not precipitated a listing.

Under the WBAG version II guidelines (Grafe et al. 2002), Fall Creek would receive full support status. The fish index score equaled three (range 0-3), the habitat index equaled three (range 0-3) and the macroinvertebrate index score was 1 (range 0-3). The average of the three indices was 2.33. Any average score above two is considered fully supporting the aquatic life beneficial uses (DEQ 2002). Thus, it appears that Fall Creek was listed erroneously. However, DEQ will proceed with the assessment of the water chemistry collected to date on Fall Creek to determine if any water quality standards or guides are indicative of impaired beneficial uses.

DEQ's assessment of Fall Creek will be based upon data collected in the lower segment of the creek approximately 1.6 km from the confluence of Lake Fork Creek. No data were collected in the lower segment closer to the confluence. The watershed above the sample location is isolated from much of the normal human activity in the watershed due to a road closure at the sampling location. Along the stream course, no perennial tributaries enter the system although many ephemeral systems may contribute during runoff events. The USGS has not gauged Fall Creek. The Fall Creek Watershed is an area of approximately 8.29 km^2. Given this size watershed, channel characteristics were extrapolated from regional curves. These regional curves are in *Applied River Morphology* (Rosgen 1996). Extrapolating from the regional curve, Fall Creek near the confluence with Lake Fork Creek should have a mean bankfull depth of 0.62 m, a bankfull width of 8.04 m and a bankfull cross-sectional area of approximately 8.75 m^2.

Physical Characteristics

The §303(d)-listed segment of Fall Creek begins above Fall Creek Spring at an elevation of 1,926 m (1,829 m spring elevation). The valley through which this segment flows is approximately 4.57 km in length. The segment has a very moderate slope of 1.72 percent. This slope corresponds to a 17.21 m fall per kilometer. Slopes of this magnitude are usually seen in moderate to low sinuous streams that are mixed erosional and depositional streams. However, sinuosity is classified as very low (1.0) for the listed segment. This is likely the direct result of the stream being confined in the rather small valley bottom. Floodplain materials are composed of fine textured sands and small gravel derived from sedimentary fluvial lands. It would be expected that the percent fines of Fall Creek would be similar in comparison to a channel with moderate slopes, moderate sinuosity, and finer floodplain materials such as Sublett Creek. The annual hydrograph is highly influenced by the karst geology of the limestone mountains of the Heglar area. As a result, annual peaks in the hydrograph are not associated with normal runoff timing. Local residents and DEQ personnel observations indicate that peak flows occur in mid to late summer.

Hydrology

Due to the lack of data, the natural hydrology of Fall Creek cannot be described with USGS gauge data. Additionally, the gauge data available in other watersheds do not have a statistical relationship with data collected concurrently in Fall Creek. The geology and infiltration rates of the surrounding watershed change the shape of a normal runoff curve. The discharge does not correspond well with normal snowmelt runoff or precipitation events. Additionally, the whole of the Fall Creek drainage is highly influenced by ground water (see Sublett Creek hydrology discussion). The average annual hydrograph for Fall Creek based upon DEQ monitoring is shown in the following figure (Figure 30). It should be noted that measurements were not taken in all months (December through March). Additionally, it appears that Fall Creek consistently averages near 1 cubic feet per second (cfs) year-round with minimum fluctuations around this average.

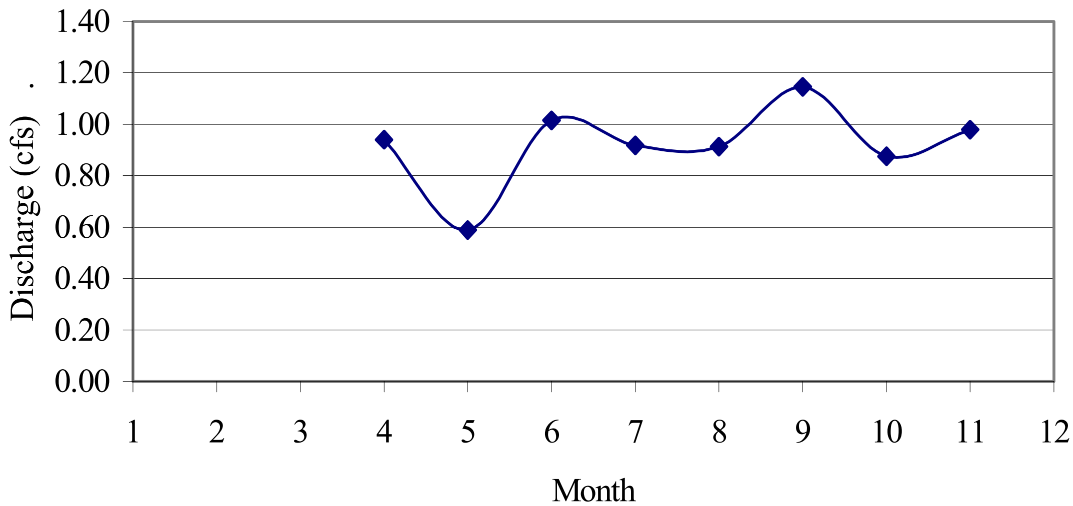


Figure 30. Fall Creek monthly average (April-November) discharge 2000-2002.

Existing Water Quality Data

Water quality samples containing a full suite of constituents collected within the listed segment of Fall Creek are rare. Upon a review of the STORET database no samples could be found.

DEQ sampled in the creek over the course of 2000-2001, with a few additional samples collected in 2002. Additional samples will be collected throughout the various phases of TMDL implementation as budgets and sampling time frames allow. However, due to the limited number of sampling periods in the original 2001 data set, DEQ's confidence in monthly average concentrations is low. The lack of a robust data set was due to limited budgets and, in part, to a limited time frame for collecting data. In most cases one sample was the most collected in any given month. Infrequently, multiple samples were collected in one month. This sampling design was intended to determine annual load. However, the annual load estimated by this type of design would overestimate annual load by 25 to 50 percent (Robertson and Richards 2000). To assist in the determination of seasonal components and appropriate critical conditions, the data will be presented as monthly averages in the following tables while period of record averages are presented in the text and other tables and will be used for any future load calculations. For those cases when a parameter was below detection limits, half the detection limit was used to calculate the monthly average and used as part of the period of record average.

One sample location was set up on the listed segment of Fall Creek. The location was approximately 1.6 km above the confluence with Lake Fork Creek. Sampling began in July of 2000 (see Figure 21). The site was used to determine concentrations and loads for the stream.

Water quality data collected from the sample location reflect the high quality expected from primarily a ground water driven system. Land use activities are not likely to influence the water quality of Fall Creek to a great deal in the limited distance before the creek reaches Lake Fork Creek. Therefore, the sample location should be indicative of the overall water quality of the stream. The water chemistry collected from the stream appears to corroborate the biotic assessments in the early months of the year. However, following changes in land use, the water chemistry of Fall Creek changes dramatically. Nearly all constituents are extremely elevated and exceed water quality standards and guidelines. For example, TSS in Fall Creek averages less than 10 mg/L in the spring and early summer and nearly 30 mg/L in the late summer and fall. As mentioned earlier, flows are not much different between these two periods. Total phosphorus concentrations also follow this pattern, though to a much greater extent. In the spring and early summer TP concentrations are near 0.060 mg/L while in the late summer and fall they are near 0.200 mg/L which is highly elevated in comparison with EPA guidelines and other creeks within the subbasin.

Monthly concentrations of TP are indicative of excess nutrients that may cause impairment (nuisance aquatic vegetation). Guidelines that DEQ has used in the past are not to exceed 0.160 mg/L TP in any single sample and 0.100 mg/L TP in any average monthly sample. The guidelines were exceeded August-November (Table 35). Furthermore, nuisance aquatic vegetation (water crest mats covering the creek channel) is seen within the system. Further chlorophyll *a* samples are required to determine a subbasin-wide model for nutrient concentration and sestonic chlorophyll *a* concentrations. In addition, nitrogen compounds were also elevated within the system. Nitrate plus nitrite samples were near 0.550 plus mg/L in the late summer to fall.

Dissolved oxygen was also monitored throughout 2000-2002. Dissolved oxygen never fell below state standards even during the late summer and fall period when the other constituents underwent rapid increases. Stream temperatures at that time remained near ground water temperatures and DO levels remained relatively high (8 plus mg/L). Dissolved oxygen is often used in conjunction with pH to determine if excess nutrients have caused nuisance aquatic growths. In prior discussions, DEQ had determined that excess aquatic growths associated with excess nutrients had occurred in Fall Creek during the sampling period. However, the type of aquatic vegetation is more similar to that found in springs than creeks, so changes in DO levels may not respond as they would in a more typical stream with more filamentous algae.

Table 35. Measured water quality constituents in Fall Creek.

Month	No of Samples	TSS (mg/L)[a]	Total NH_3 as N (mg/L)[b]	Total NO_2 + NO_3 as N (mg/L)[c]	Total P (mg/L)[d]	Temp (°C)[e]	Dissolved Oxygen (mg/L)[f]	Bacteria *E. coli* (Col/100 ml)[g]
January	0							
February	0							
March	0							
April	2	6	0.011	0.411	0.052	11.64	11.20	21
May	5	5	0.009	0.257	0.058	12.57	9.69	12
June	2	2	0.005	0.250	0.063	10.90	8.27	44
July	3	1	0.020	0.440	0.060	12.79	8.20	673
August	5	24	0.063	0.572	0.217	13.61	8.13	1964
September	3	30	0.030	0.571	0.216	14.45	7.96	956
October	3	26	0.011	0.529	0.191	9.20	9.58	221
November	1	30	0.018	0.552	0.185	11.30	9.81	130
December	0							
Annual Average		15	0.025	0.443	0.133	12.36	8.96	653
Standard Deviation		17	0.027	0.154	0.099	1.90	1.68	1442

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.
b Total ammonia as nitrogen in milligrams per liter.
c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO_2+NO_3 detection limit = 0.005mg/L.
d Total phosphorus in milligrams per liter.
e Temperature in degrees Celsius.
f milligrams per liter.
g colonies per 100 milliliters.

Bacteria counts were very low throughout the early part of the year. However, samples collected after July were typically very high. Instantaneous criteria were exceeded in July, August, and September. However, follow-up monitoring was not completed to determine if a water quality violation had occurred. Given the magnitude of the early instantaneous violations and the duration (three months) of the instantaneous violations, DEQ feels it is safe to assume that bacteria counts are sufficient to warrant a TMDL.

From the data set, TSS appears to be a non-factor effecting beneficial uses. However, the data do indicate that the changes in land use in the late summer have the potential to degrade beneficial uses. As with the other measured constituents, TSS begin to elevate in August and remains elevated through at least November. Although the levels during the elevated period are not considered harmful to the beneficial uses (i.e., they are below 50 mg/L), they do warrant some level of concern. Continued changes could lead to a rapid unraveling of the system in high water years. At this time, DEQ feels that a TMDL for nutrients may alleviate the need for concern. Additional monitoring throughout the TMDL development stage and implementation phase will address the needs concerning TSS in Fall Creek.

Instantaneous temperature measures were also collected in Fall Creek. No temperature exceedances occurred. Rarely did the creek approach 15 °C even in the warmer months of July and August. Temperature is likely not an issue in Fall Creek due to the cold water springs that feed the system. These springs act as a temperature buffer for the system.

It appears from the data that suspended sediment, DO, and temperature are within the bounds of water quality determined to be supportive of the designated beneficial uses. If the beneficial uses sustain any impact in the segment it is due to bacteria and nutrients. Consequently, DEQ will complete bacteria and nutrient TMDLs on the creek.

Point and Nonpoint Sources

Fall Creek flows through sixth field HUC 170402100403, which is the Lake Fork Creek Watershed. The GIS coverages indicate that 100 percent of the land use is rangelands. The major source of nonpoint source pollution in the watershed are activities associated with this land use. The listed segment may also be influenced by recreation activities along the roaded portion of the watershed. Additional sediment sources include unstable banks and reentrainment from the riverbed itself. However, quantification of these sources has not been completed. As of yet, no CAFOs or other point sources are known to exist within the watershed.

Lake Fork Creek

Lake Fork Creek begins in the south central mountains of Idaho in the Heglar area. Lake Fork Creek is not currently §303(d) listed. However, since Lake Fork Creek empties into Sublett Reservoir and Sublett Reservoir is §303(d) listed, an assessment of the water quality of Lake Fork Creek will be completed. Lake Fork Creek is 9.45 km long from the headwaters to Sublett Reservoir. The karst geology of the area greatly influences the hydrology of Lake Fork Creek. Rapid infiltration of precipitation occurs throughout the watershed. This water is stored in the local aquifers and arises in a few large springs scattered throughout the watershed. Lake Fork Creek actually originates at Upper Lake Fork Creek Spring, Moonshine Spring, and Lake Fork Springs nearly two kilometers from the watershed headwater area. The creek channel above these springs is dry during most of the year.

Following BURP protocols and guidance in WBAG version I (DEQ 1996), the creek was not listed. The macroinvertebrate index used for the 1998 listing cycle had cutoff criteria for not full support at 2.5 and full support at 3.5. Lake Fork Creek scored a 3.65. An index score such as this would put Lake Fork into the full support area. The habitat index score was also relatively high for the Snake River Basin. Given two moderately high index scores Lake Fork Creek was not listed. Under the new water body assessment guidelines Lake Fork Creek would also have received full support status. The fish index score equaled three (possible score range 0-3), the habitat index equaled three (possible score range 0-3) and the macroinvertebrate index score was 3 (possible score range 0-3). The average of the three indices was three. Any average score above two is considered fully supporting the aquatic life beneficial uses (Grafe et al 2002).

DEQ's assessment of Lake Fork Creek will be based upon data collected in the lower segment of the creek near the confluence with the reservoir. The watershed above the sample location is well traveled, has many unimproved camping locations, and has normal rangeland activities. Along the stream course, two perennial tributaries enter the system (Van Camp Creek and Fall Creek), along with many ephemeral systems that may contribute during runoff events. The USGS has not gauged Lake Fork Creek. The Lake Fork Creek Watershed is an area of approximately 35.20 km^2. Given this size watershed, channel characteristics were extrapolated from regional curves. These regional curves are in *Applied River Morphology* (Rosgen 1996). Extrapolating from the regional curve, Lake Fork Creek near the confluence with Sublett Resevoir should have a mean bankfull depth of 0.63 m, a bankfull width of 8.63 m and a bankfull cross-sectional area of approximately 5.57 m^2.

Physical Characteristics

Lake Fork Creek begins above Lake Fork Creek Spring at an elevation of 1,987 m (1,829 m spring elevation). The valley through which this segment flows is approximately 8.82 km in length. The segment has a relatively steep slope of 3.81 percent. This slope corresponds to a 38.14 m fall per kilometer. Slopes of this magnitude are usually seen in A-type channels with low sinuosity that are erosional in nature. Sinuosity is also classified as low (1.1) for the stream. This is likely the direct result of the stream being confined in the rather small valley bottom. Floodplain materials are composed of fine textured sands and small gravel derived from sedimentary fluvial lands. It would be expected that the percent fines of Lake Fork Creek would be similar in comparison to a channel with moderate slopes, moderate sinuosity, and finer floodplain materials such as Sublett Creek. The annual hydrograph is highly influenced by the karst geology of the limestone mountains of the Heglar area. Precipitation events and snowmelt are more likely to infiltrate into the groundwater system than be expressed in the surface water system. As a result, annual peaks in the hydrograph are not associated with normal runoff timing. Local residents and DEQ personnel observations indicate that peak flows occur in mid to late summer. These peak flows are derived from the groundwater sources and may be the result of the annual snowmelt recharge reaching the surface system during the late summer.

Hydrology

Due to the lack of data, the natural hydrology of Lake Fork Creek cannot be described with USGS gauge data. Additionally, the gauge data available from other watersheds does not correlate with data collected concurrently in Lake Fork Creek. Consequently, a statistical approach to developing an annual hydrograph cannot be used. The geology and infiltration rates of the surrounding watershed change the shape of a normal runoff curve. Discharge does not correspond well with normal snowmelt runoff or precipitation events. Additionally, the whole of the Lake Fork Creek drainage is highly influenced by ground water (see Sublett Creek hydrology discussion). The average annual hydrograph for Lake Fork Creek based upon DEQ monitoring is shown in the following figure (Figure 31). It should be noted that measurements were not taken in December through March. It appears that Lake Fork Creek varies consistently between 1 and 1.50 cfs year round with minimum fluctuations around this average (average 1.26 cfs with a standard deviation of 0.52).

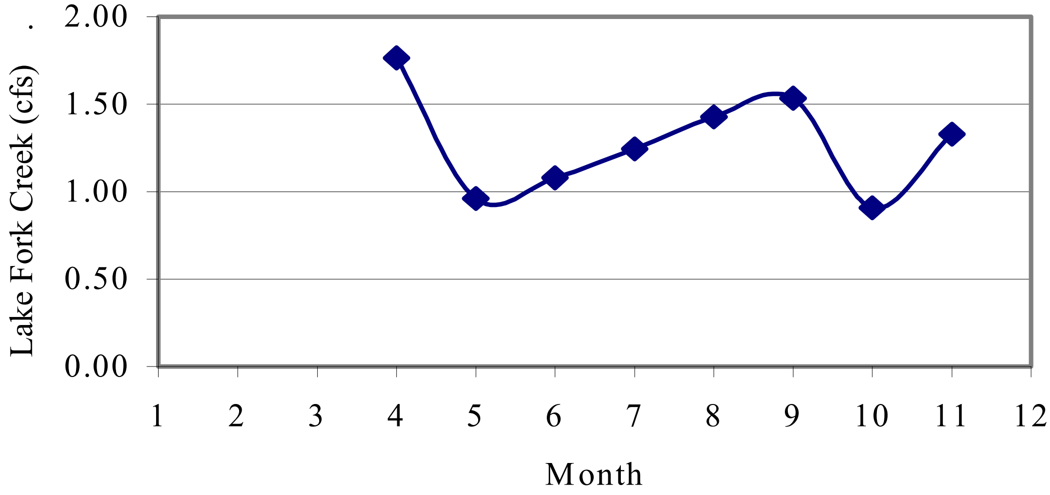


Figure 31. Lake Fork Creek monthly average discharge April through November 2000-2002.

Existing Water Quality Data

Water quality samples containing a full suite of constituents collected in Lake Fork Creek are rare. Upon a review of the STORET database no samples could be found.

DEQ sampled in the creek over the course of 2000-2001, with a few additional samples collected in 2002. The creek was sampled to address the needs of the §303(d0 listed reservoir downstream. Additional samples will be collected throughout the various phases of TMDL implementation as budgets and sampling time frames allow. However, due to the limited number of sampling periods in the original 2001 data set, DEQ's confidence in monthly average concentrations is low. The lack of a robust data set was due to limited budgets and, in part, to a limited time frame for collecting data. In most cases one sample was the most collected in any given month. Infrequently, multiple samples were collected in one month. This sampling design was intended to determine annual load. However, the annual load estimated by this type of design would overestimate annual load by 25 to 50 percent (Robertson and Richards 2000). To assist in the determination of seasonal components and appropriate critical conditions, the data will be presented as monthly averages in the following tables while period of record averages are presented in the text and other tables and will be used for any future load calculations. For those cases when a parameter was below detection limits, half the detection limit was used to calculate the monthly average and used as part of the period of record average.

One sample location was set up on Lake Fork Creek. The location was near the confluence with Sublett Reservoir. Sampling began in July of 2000 (see Figure 21). The site was used to determine concentrations and loads for the stream.

Water quality data collected from the sample location reflect the high quality expected from primarily a ground water driven system. Land use activities are similar to the upper segment of Sublett Creek. A well-traveled road exists along much of the creek. Dispersed campsites are also located along the creek corridor. Rangeland activities also occur throughout the watershed. As the sample location is near the bottom of the watershed, the water quality should capture all of the land use activities located within the watershed. The water chemistry collected from the stream appears to corroborate the biotic assessments.

Nearly all constituents were at normal to low levels and rarely exceeded water quality standards and guidelines. For example, TSS in Lake Fork Creek averaged less than 13 mg/L (16 mg/L standard deviation) for the period of record. A single sample was collected above 50 mg/L throughout the entire study. However, this single sample did not exceed the recommended daily maximum of 80 mg/L set in other approved TMDLs within the Twin Falls Region. As mentioned earlier, flows are not much different between months and seasons in Lake Fork Creek.

Monthly concentrations of TP are indicative of excess nutrients that may cause impairment (nuisance aquatic vegetation) in the downstream reservoir. The TP concentrations are variable and high enough that impairment to Lake Fork Creek could be possible if other parameters were elevated as well. Guidelines that DEQ has used in the past for protection of the downstream water body are not to exceed 0.080 mg/L TP in any single sample and 0.050 mg/L TP in any average monthly sample. The guidelines for Lake Fork Creek itself would be similar to other streams in the subbasin that do not flow to a lake or reservoir (e.g. Fall Creek). The guidelines for protection of the reservoir were exceeded seven of the eight months in which samples were collected (Table 36). The guidelines for the water quality of Lake Fork Creek are exceeded half of the time. However, nuisance aquatic vegetation isn't typically seen within the system. Although, some water crest mats do exist within the creek channel typical of a spring system with low annual flushing flows. Further chlorophyll *a* samples are required to determine a subbasin-wide model for nutrient concentration and sestonic chlorophyll *a* concentrations. In addition, nitrogen compounds were only slightly elevated in comparison with other systems within the subbasin. Nitrate plus nitrite samples were near 0.200 mg/L in the late summer to fall.

Dissolved oxygen was also monitored throughout 2000-2002. Dissolved oxygen never fell below state standards even during the late summer and fall period. Stream temperatures at that time remained near ground water temperatures and DO levels remained relatively high (8 plus mg/L). Dissolved oxygen is often used in conjunction with pH to determine if excess nutrients have caused nuisance aquatic growths. In prior discussions, DEQ had determined that excess aquatic growths associated with excess nutrients had not occurred in Lake Fork Creek during the sampling period. The type of aquatic vegetation present is more similar to springs than creeks, and changes in DO levels may not respond as they would in a more typical stream with more filamentous algae.

Bacteria counts were very low throughout the early part of the year. However, samples collected after July were typically higher. Instantaneous criteria were exceeded once in August. However, follow-up monitoring was not completed to determine if a water quality violation had occurred. The instantaneous violation appears to have been an isolated event. Samples collected within the same month were low and the following month samples were even lower (the proceeding month's data are not available). However, due to the potential for bacteria contamination, as seen in other systems within the subbasin, DEQ will continue to monitor bacteria concentrations throughout the TMDL development phase. At this time, DEQ feels that a TMDL for nutrients may alleviate the need for concern, as the implementation strategies would be similar for both nutrients and bacteria given that rangeland activities are the most prevalent land use. Additional monitoring throughout the TMDL development stage and implementation phase will address the needs concerning bacteria in Lake Fork Creek.

Table 36. Measured water quality constituents in Lake Fork Creek.

Month	No of Samples	TSS (mg/L)[a]	Total NH_3 as N (mg/L)[b]	Total NO_2 + NO_3 as N (mg/L)[c]	Total P (mg/L)[d]	Temp (°C)[e]	Dissolved Oxygen (mg/L)[f]	Bacteria *E. coli* (Col/100 ml)[g]
January	0							
February	0							
March	0							
April	2	32	0.025	0.168	0.153	11.51	10.01	8
May	5	23	0.014	0.147	0.102	15.32	8.51	8
June	2	3	0.010	0.078	0.046	10.52	9.32	12
July	2	6	0.007	0.005	0.065	16.49	8.38	141
August	5	8	0.012	0.050	0.120	16.82	8.90	260*
September	3	10	0.014	0.142	0.084	14.92	8.92	69
October	3	8	0.012	0.257	0.092	9.46	9.68	90
November	1	8	0.016	0.311	0.094	10.60	11.37	44
December	0							
Annual Average		13	0.013	0.131	0.098	13.98	9.11	95
Standard Deviation		16	0.007	0.136	0.051	3.39	1.26	138

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.
b Total ammonia as nitrogen in milligrams per liter.
c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO_2+NO_3 detection limit = 0.005mg/L.
d Total phosphorus in milligrams per liter.
e Temperature in degrees Celsius.
f milligrams per liter.
g colonies per 100 milliliters.

From the data set, TSS appears to be a non-factor effecting beneficial uses. However, it does indicate that Lake Fork Creek may experience a more typical annual hydrograph. Total suspended sediment is slightly elevated in the spring during what little runoff is generated in the watershed. Following this period, TSS drops dramatically for the remainder of the year. The levels during the elevated period are not considered harmful to the beneficial uses (i.e., below 35 mg/L).

Instantaneous temperature measures were also collected in Lake Fork Creek. No temperature exceedances occurred. Rarely did the creek approach 15 °C even in the warmer months of July and August. Temperature is likely not an issue in Lake Fork Creek due to the cold water springs that feed the system. These springs would act as a temperature buffer for the system.

It appears from the data that suspended sediment, DO, and temperature are within the bounds of water quality determined to be supportive of the designated beneficial uses. If the beneficial uses sustain any impact it is due to nutrients and possible bacteria. Consequently, DEQ will complete a nutrient TMDL on the creek and continue to monitor bacteria concentrations.

Point and Nonpoint Sources

Lake Fork Creek flows through sixth field HUC 170402100403, which is the Lake Fork Creek Watershed. The GIS coverages indicate that 100 percent of the land use is rangelands. The major sources of nonpoint source pollution in the watershed comes are these land uses. The listed segment may also be influenced by recreation activities along the roaded portion of the watershed. Additional sediment sources include unstable banks and reentrainment from the riverbed itself. However, quantification of these sources has not been completed. As of yet, no CAFOs or other point sources are known to exist within the watershed.

Sublett Reservoir

Sublett Reservoir lies within the Heglar mountains of Idaho in an area east of the towns of Sublett and Malta. The major sources of water for the reservoir are Lake Fork Creek and Sublett Creek. At full pool, the reservoir covers approximately 39 hectares. The Sublett Canal Company operates a nonrecording weir below the reservoir. The Sublett Reservoir watershed is an area of approximately 114 km^2. Almost all of the nearly 1,039 acre-feet is in the usable storage pool. The crest of the spillway is at 5,335 ft. The reservoir has an earthen spillway that would be damaged if water were allowed to spill. Through water management, the reservoir fills each year but does not require spilling water through any water conveyance system other than the current canal system. Based on crop demands, the water level in Sublett Reservoir may fluctuate up and down several times throughout the irrigation season year (Lay 2003).

Physical Characteristics

The reservoir has an overall length of 1.32 km and an effective length of 1.08 km through the Lake Fork Creek arm. The maximum width is 0.40 km while the average width is 0.21 km. Shoreline development is low at 1.97 (a perfectly round lake would have a shoreline development of 1.0, while a highly dendritic lake would have much higher shoreline development). For comparison, Lake Mead has a shoreline development of 9.72, Salmon Falls Reservoir 5.32, and the third lake of the Independence Lakes has a shoreline development of 1.03. The maximum depth measured by DEQ in the year 2001 was 10 m with a mean depth of 3.29 m (mean depth = volume [m^3]/ surface area [m^2]).

Hydrology

The hydrology of Sublett Reservoir can best be described by a summation of Lake Fork Creek and Sublett Creek data. To estimate how much water enters the reservoir, DEQ averaged each month's data for Lake Fork and Sublett Creeks. In any month in which zero data were collected, the annual average was used for that month. This process will likely overestimate the amount of water entering the reservoir. The annual average input ranged from nearly 4 cfs in Sublett Creek to 1.25 cfs in Lake Fork Creek (Figure 32).

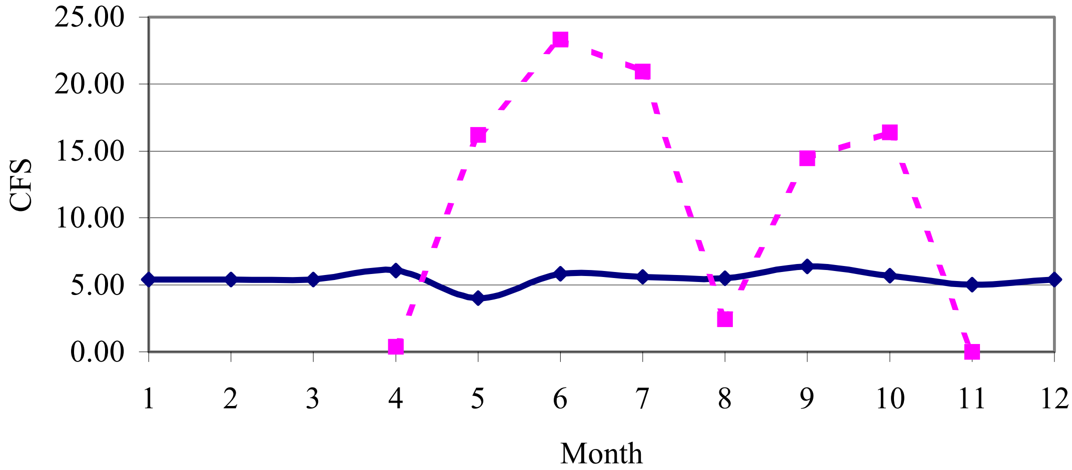


Figure 32. Annual average hydrograph for the reservoir input (solid line) and output (dashed line).

Fisheries

Idaho Department of Fish and Game stocking records indicate that numerous species of fish have been stocked into Sublett Reservoir since 1967. Predominantly rainbow and cutthroat trout are placed into the water body. Fish and Game records indicate that "other" salmon and "other" trout were stocked from the early 1970s until the early 90s. Kokanee and brown trout are captured by sportsmen from the reservoir regularly. Typically, one strain or another of rainbow or cutthroat trout are stocked each year up to several times per year and range from fry to catchable sizes. Therefore, DEQ assumes that any salmonids captured in Sublett Reservoir are from stocked populations (brown trout are likely naturalized populations that spawn in Sublett or Lake Fork Creeks). Idaho Department of Fish and Game have, over the past 10 years, managed the reservoir under their general category.

Macroinvertebrates

DEQ collected macroinvertebrates in Sublett Reservoir one time in 1997. Macroinvertebrates were collected in three general locations and pooled for analysis. The first location was near the boat launching area near the Sublett Creek inlet, the second was in the Lake Fork Creek inlet, and the third was near the dam. Few macroinvertebrates were collected in the pooled samples. Overall, the community consisted of chironomids and oligochaete worms. An assessment of the water quality based on the macroinvertebrate community is unlikely due to poor sample collection of macroinvertebrates statewide and a lack of a reference community to compare to. However, the macroinvertebrate community in Sublett Reservoir appears similar to oligotrophic lakes and reservoirs.

Aquatic Vegetation

Emergent aquatic vegetation such as milfoil (*Myriophyllum* sp.) and pondweed (*Potomogeton amplifolius)* is common in the very clear waters of Sublett Reservoir. However, some of the primary production comes from algal cells within the reservoir. DEQ collected phytoplankton in 1997 to determine the composition of the algae in the reservoir. At that time, the phytoplankton community consisted of five groups, green algae, diatoms, yellow-green algae, blue-green algae, and a group of "uncertain classification." Typically, blue-green algae dominate highly eutrophic systems. In Sublett Reservoir, the blue-greens made up only 18.15 percent of the biovolume, while diatoms and green algae made up 58.10 percent of the biovolume. As another indicator of trophic state, chlorophyll *a* samples were collected throughout the year to determine if nuisance conditions existed. For lakes, Carlson's trophic state index (TSI) can be used to determine if a lake is undergoing cultural eutrophication (Carlson 1977). Utah DEQ has used a TSI score of 50 as a threshold value to indicate impaired water quality in many of the TMDLs completed for excess nutrients in lakes. In order to reach a TSI of 50 for chlorophyll *a* the concentration of chlorophyll *a* has to be higher that 7.22 micrograms per liter (µg/L). The samples were collected from Sublett Reservoir three times during the summer of 2001 before low levels made boat access to the reservoir impossible. The samples collected were 2.99, 2.70, and 1.9 µg/L, which were well below the value suggested to indicate nuisance aquatic vegetation growths. A single sample was collected in 1997; the concentration was 3.4 µg/L chlorophyll *a* in that sample. Based on the available data, it is unlikely that excessive nutrients are the factor effecting the phytoplankton of Sublett Reservoir. However, the emergent aquatic vegetation visually appears to be in excess. In addition, during low water events the emergent vegetation made it difficult to launch a boat to obtain water quality samples (Lay 2003). Quantification of the area or volume of the emergent vegetation needs to be conducted. However, the extent of the vegetation appears to be sufficient that beneficial uses are impaired and a nutrient TMDL should be done.

Sublett Reservoir Existing Water Quality Data

The quantity of water quality samples collected by entities other than DEQ within Sublett Reservoir is unknown. The STORET database contains no samples collected from the reservoir. Data queries from other agencies have yielded no water chemistry data. Therefore, DEQ data is the only readily available data for Sublett Reservoir.

DEQ sampled in the reservoir over the course of 2001, and additional samples will be collected throughout the various phases of TMDL implementation as budgets and sampling time frames allow. However, due to the limited number of sampling periods in the original 2001 data set, DEQ's confidence in monthly average concentrations is low. The lack of a robust data set was due to limited budgets and, in part, to a limited time frame for collecting data. In most cases one sample was the most collected in any given month. Infrequently, multiple samples were collected in one month. This sampling design was intended to determine annual load. However, the annual load estimated by this type of design would overestimate annual load by 25 to 50 percent (Robertson and Richards 2000). To assist in the determination of seasonal components and appropriate critical conditions, the data will be presented as monthly averages in the following tables, while period of record averages are presented in the text and other tables and will be used for any future load calculations. For those cases when a parameter was below detection limits, half the detection limit was used to calculate the monthly average and used as part of the period of record average.

Three sample locations were set up on Sublett Reservoir with sampling beginning in April of 2001. The first sampling site was set up near the dam in the area of the deepest part of the reservoir or "Zmax". The Zmax site was used to determine average concentrations for the water body. At this location, the reservoir waters have had a chance to equilibrate and begin to function as a lake rather than as a stream. Two additional sampling locations were established in each arm of the reservoir. These locations were used to understand the relative contribution from the two major inputs. The chemical constituents within each site seemed to be very similar throughout the sampling period. However, there seemed to be some differences amoung sites.

In order to determine if this was the case, analysis of variance was conducted to test the null hypothesis.

H_o: Sublett Creek Arm = Lake Fork Creek Arm = Zmax .
H_a: Sublett Creek Arm ≠ Lake Fork Creek Arm ≠ Zmax

Each constituent sampled at the three locations was tested using Systat 7.0. For all constituents (secchi depth, nitrogen, SC, TP, NH_3, temperature, DO, and TSS) the null hypothesis was not rejected ($p > 0.05$). These constituents can be pooled for discussion. The relationship between sites is as expected for such a small water body with such similar water sources in both small tributaries.

The levels of the measured constituents (Table 37) in Sublett Reservoir are very low. These levels in most all cases indicate a high assimilative capacity of the reservoir, low use, and low degradation. For example, TSS at Zmax averages 1.16 mg/L, at the Sublett Arm 2.00 mg/L, and at the Lake Fork Arm 1.00 mg/L. Average TP was 0.028 mg/L at Zmax. Total phosphorus in both arms (0.034 and 0.036 mg/L) was only slightly elevated due to the proximity to the sources.

Carlson's TSI can also be used to determine if nutrients are in excess. Again, the TSI for TP score above 50 has been used in other states as a threshold for excess nutrients. A TSI of 50 corresponds with 0.025 mg/L of TP, 2 m secchi, and 7.25µg/L chlorophyll *a*. Based upon these numbers Sublett Reservoir exceeded the threshold value for TP at all locations a total of 12 of the 16 times the reservoir was sampled as the summer progressed. The secchi depth threshold was exceeded several times throughout the summer. However, this was likely due to actual depth to bottom, rather than a lack of water clarity. In those samples secchi depth equaled lake bottom depth. Chlorophyll *a* was sampled only at Zmax. At that location, a TSI of 50 was never exceeded. Overall, the average TSI scores for all three locations were well below the 50 threshold as seen in Figure 33.

The TSI scores in a reservoir can be very complicated under severe draw-down events such as the summer of 2001. Phosphorus can be mobilized from the sediments in the deeper portions of the lake due to natural processes. When a lake is drawn down, this layer of water becomes mixed with the epilimnetic (and low TP) waters, enriching a system later in the year when it is typically poor in nutrients. In addition, sediments rich in adsorbed TP can be remobilized as the waters recede. Both of these situations likely occurred in Sublett Reservoir through the summer of 2001. Further investigations are required to determine if there is a significant trend in TSI scores. However it appears from TSI scores for total nitrogen (TN) and TP , that the reservoir is nutrient limited as the TSI scores were typically in the mid 30's, while secchi scores were near 50. Thus, it is not likely that nutrients are impairing the phytoplankton component of the aquatic vegetation.

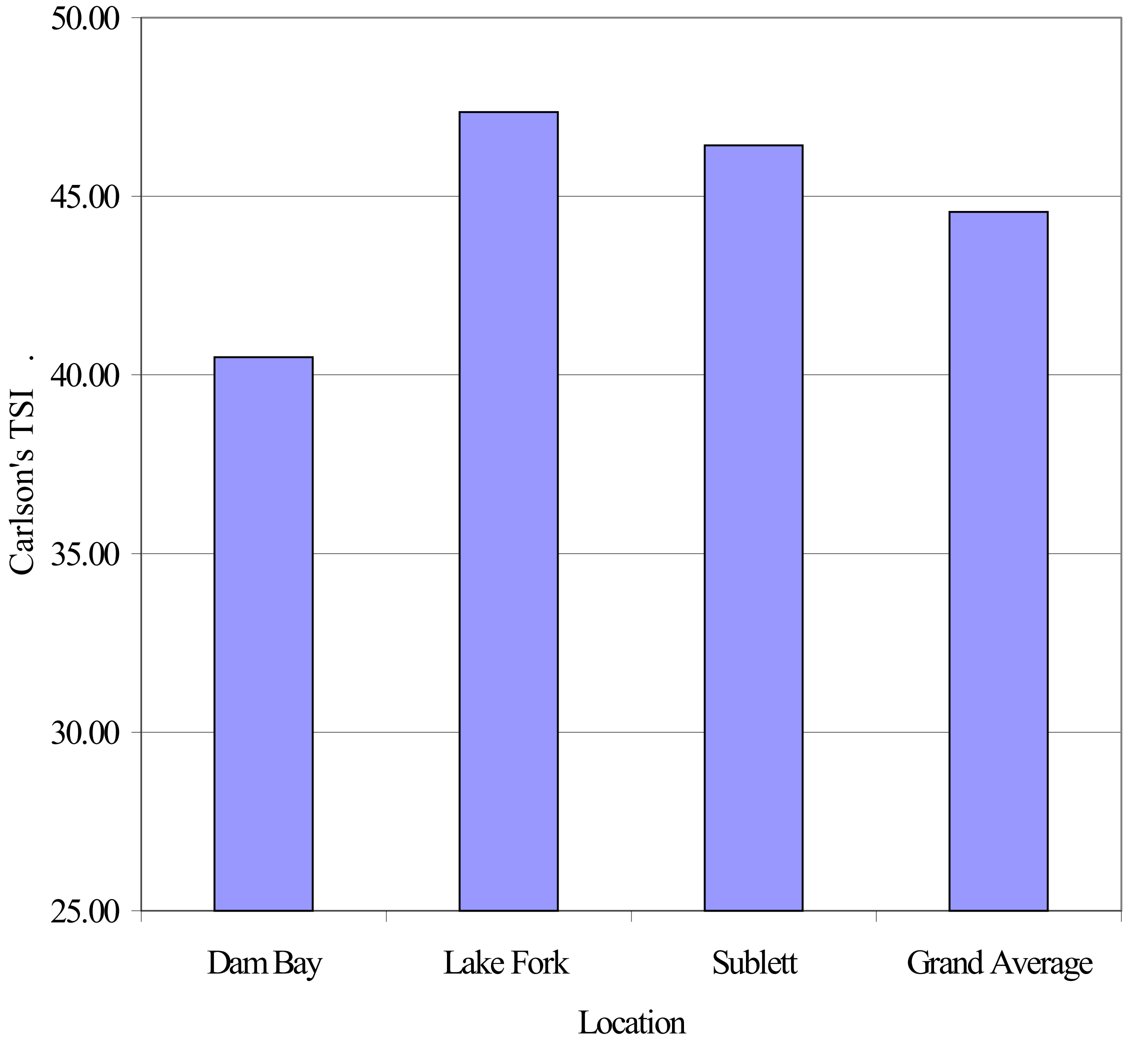


Figure 33. Sublett Reservoir Trophic State Index scores.

Individually, TSI scores can give additional information when interpreting single constituents. However, the determination of trophic state should not be based upon a single component of the index. Individually the components of the overall TSI score make it appear that Sublett Creek is a slightly eutrophic reservoir (see Figure 34). Much of the weight is placed on the secchi and TP values. However, the average chlorophyll *a* TSI score (38.87) does not reflect this trophic state. Likewise, the TSI based upon secchi should be much lower as some of the values where secchi depth equaled bottom depth were included. Furthermore, TN also appears to be well below the eutrophic threshold of 50 (TN TSI averages 35.64). However, TP was elevated (52.38) and may influence the production of aquatic vegetation in Sublett Reservoir to a greater extent than nitrogen. The average TSI score for all components for the sampling period of 2001 fluctuated along the same trend as TSI-TP. Thus can be seen the weight TSI-TP has in the overall average. However, the overall TSI score indicates that Sublett Reservoir is a mesotrophic reservoir. Reservoirs of this type are well balanced in terms of fish production and water quality. In more oligotrophic lakes, fish production is less while water quality is higher. The same trade-off exists for eutrophic waters: higher fish production, lower water quality. Therefore, mesotrophic lakes are viewed by many as the ideal target; hence, the many states and entities that use a TSI target of 50 as their management goal.

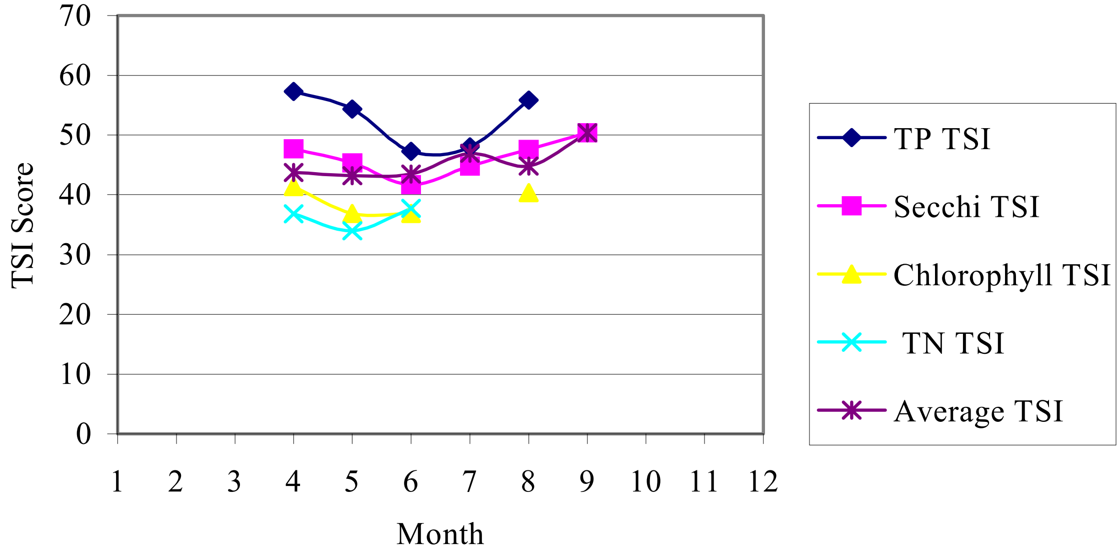


Figure 34. Average lake wide Trophic State Index scores throughout the 2001-sampling season.

Bacteria samples were collected near the Sublett Creek Arm. This area is in close proximity to a boat launch area. *E. coli* were seldom present in the samples, and when they were, it was in very low numbers (2 colonies/100 ml). These data are presented in Table 37.

Temperature and dissolved oxygen profiles were also collected throughout 2001 (Figure 35 and 36) at Zmax. At the end of April, the reservoir appeared to have a weak stratification although the maximum measured depth was only 10 m. The weak stratification may have set up at the beginning of the month with the bottom of the thermocline was near 7 m in depth and epilimnion was near 2 m. As the epilimnion warmed throughout May, the stratification became less pronounced with only two layers. By the end of May the epilimnion was down to 6 m and the thermocline was down to 10 m, irrigation withdrawals began to steadily remove water from the system. The bottom withdrawal system employed by the reservoir removes the colder hypolimnetic waters leading to a more isothermal state as the year progresses. This condition is further aggravated by the size of the water body, windy conditions, and the influx of spring water in the tributaries. Small systems, such as Sublett Reservoir, will mix readily, thus becoming polymictic (many small stratifications occurring between wind events). Additionally, through the irrigation season approximately 70 percent of the depth is removed from the lake. This water is taken from the bottom portion of the reservoir. With the addition of 15-16 °C water from the streams almost year round, the lake has a limited time frame to stratify. The stratification began to break down in late June and the lake was isothermal from late June throughout the remainder of the summer. This was likely due to strong wind events that drove the epilimnion deeper and the bottom withdrawals that removed the colder hypolimnetic water from the reservoir.

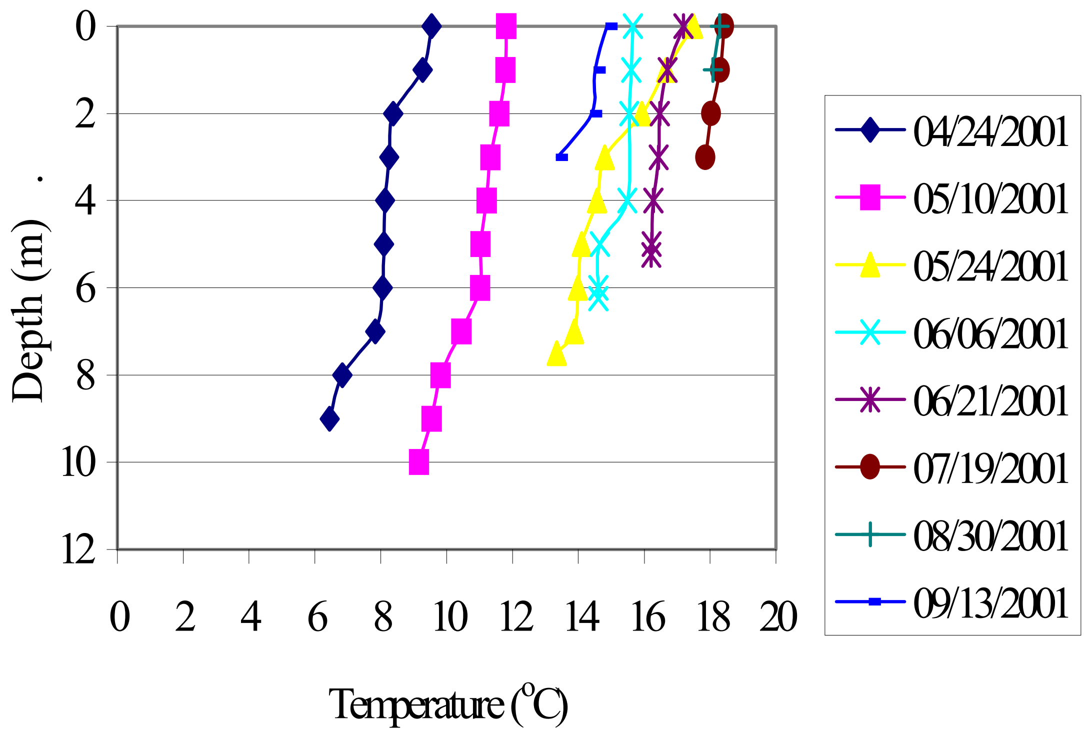


Figure 35. Temperature/Depth profiles.

Dissolved oxygen profiles were collected along with the temperature profiles. Similar situations were observed. During the early spring stratification, DO levels were relatively high throughout the water column, although some oxygen depletion was noted near the bottom meter of the reservoir. The oxygen depletion became less evident as the year progressed, likely due to isothermal mixing of the water body with well-oxygenated stream water and water from or near the reservoir surface. In prior discussions, DEQ had determined that excess aquatic growths had not occurred in Sublett Reservoir during the 2001 sampling period. The DO and pH data support this contention. In addition, in lakes and reservoirs with significant primary production (or nuisance aquatic growths) the hypolimnetic waters will often become anoxic. In lakes that are isothermal, this situation rarely happens. However, oxygen can become depleted in the lower bounds of some lakes and a chemocline can be established. A chemocline was not established in Sublett Reservoir and oxygen depletion did not occur. Therefore, DEQ finds that Sublett Reservoir is likely not polluted with oxygen demanding materials.

It appears from the TSI data and water column chemistry data that suspended sediment and DO are within the bounds of water quality determined to be supportive of the designated beneficial uses. Consequently, DEQ will not complete a suspended sediment or DO TMDLs on the reservoir. However, based upon the TSI scores for TP, the quantities of emergent vegetation at many locations throughout the reservoir, and the nutrient concentrations found in the two tributary waters, a nutrient TMDL is required for Sublett Reservoir.

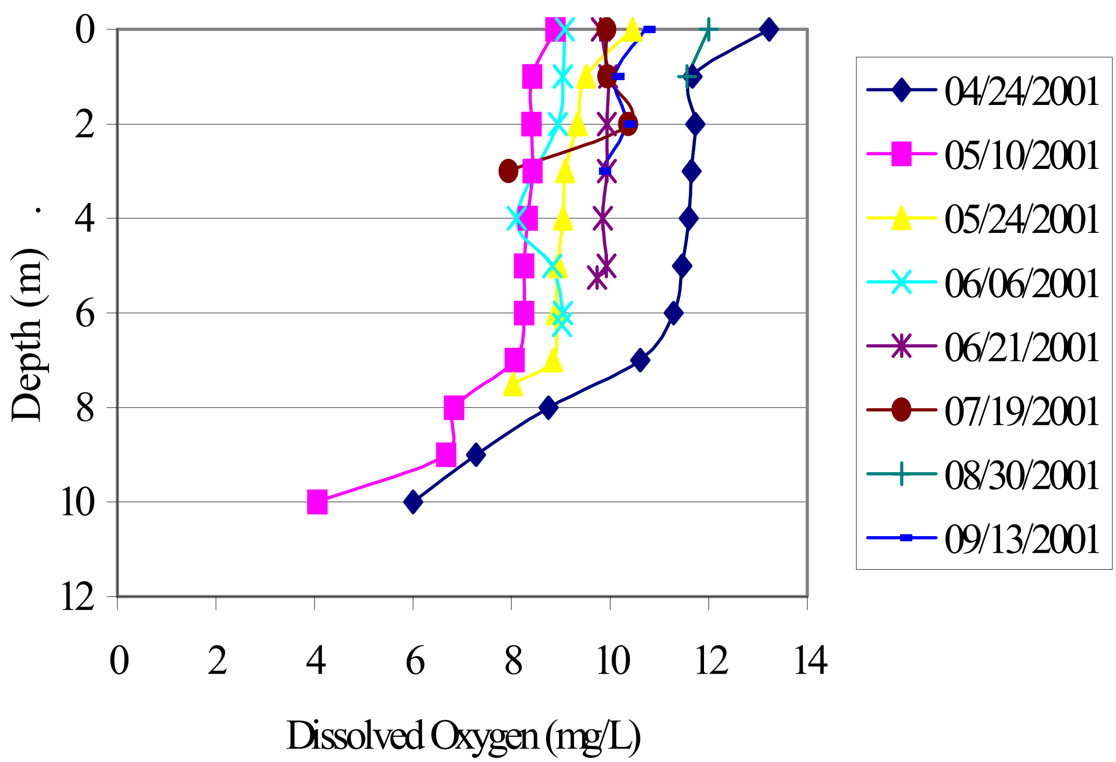


Figure 36. Dissolved oxygen (mg/L)/depth profiles.

The overarching water quality problem in Sublett Reservoir is the same as in the creek below the reservoir and it is not any of the previously mentioned water quality parameters. It is simply flow alteration. Typically, any water quality guideline or standard, if it is violated, is violated when the water is removed from the reservoir. Temperature, low DO, and TSS are usually the parameters associated with flow alteration problems. In the reservoir's case, these parameters are buffered by the upstream watersheds' water source and quality. However, the beneficial uses of the reservoir remain in jeopardy due to long periods of minimum pool volume during the late summer irrigation period. Flow issues are by far the most complex of the listed parameters. It appears that the beneficial uses are fully supported in spite of elevated nutrients and severe draw-down events. Again, this status is likely due to the high quality of the upstream waters and minimal impacts in the watersheds. Flow issues are further compounded in that the reservoir was built solely for irrigation use and the recreation and aquatic life beneficial uses are ancillary to that use. DEQ will continue to list Sublett Reservoir for flow alteration until such time that flow alteration issues are better understood politically and scientifically.

Table 37. Measured water quality constituents in Sublett Reservoir.

Month	No of Samples	TSS (mg/L)[a]	Total NH_3 as N (mg/L)[b]	Total NO_2 + NO_3 as N (mg/L)[c]	Total P (mg/L)[d]	Temp (°C)[e]	Dissolved Oxygen (mg/L)[f]	Bacteria *E. coli* (Col/100 ml)[g]
January								
February								
March								
April	3	1	0.006	0.005	0.035	11.45	9.09	
May	6	1	0.010	0.005	**0.035**	14.53	9.01	2
June	6	2	0.009	0.006	**0.027**	16.22	9.62	1
July	2	1	0.007	0.003	**0.032**	17.89	10.26	**1**
August						18.29	11.63	1
September						14.63	10.46	2
October								
November								
December								
Annual Average		1	0.009	0.006	0.032	15.06	10.12	1
Standard Deviation		1	0.003	0.001	0.012	3.06	1.08	

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.
b Total ammonia as nitrogen in milligrams per liter.
c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO_2+NO_3 detection limit = 0.005mg/L.
d Total phosphorus in milligrams per liter.
e Temperature in degrees Celsius.
f milligrams per liter.
g colonies per 100 milliliters.

Point and Nonpoint Sources

Sublett Reservoir is a §303(d)-listed water body; two sixth field HUCs (170402100403 and 170402100404) form its watershed. The land use from within these watersheds is considered to contribute to Sublett Reservoir as the reservoir is the pour point for both sixth field HUCs. The GIS coverage indicate that 100 percent of the land use in both sixth field HUCs is rangelands. The major sources of nonpoint source pollution in the watershed come from activities associated with these land uses. Additional sediment sources include unstable banks and reentrainment from the riverbed itself. However, quantification of these sources has not been completed. As of yet, no CAFOs or other point sources are known to exist within the watershed.

2.4 Data Gaps

Given the limited amount of data collected in the Raft River Subbasin data gaps abound. The most significant of these is the overall lack of data in wet or even normal water years. Consequently, any conclusions drawn on the current data set could be viewed as flawed. However, a lack of data has not been viewed as a reason not to proceed with TMDLs.

Lack of flow information is the most critical data gap. One of the reasons for this data gap is little USGS gauge coverage. Consequently, little or no statistical relationships could be formed with other ungauged watersheds. Drought conditions also affected our flow information as many streams were dry for extended periods of time; in normal or wet years these creeks may have water in them. As a result, some creeks show poorer water quality in comparison with BURP data collected in wetter years. However, this situation may revert to conditions seen before the drought. Further monitoring in these systems is required to assure DEQ that the conclusions drawn based on the current water cycle holds true under wetter or more normal years.

Nutrients are a listed pollutant on many of the streams within the subbasin. However, current water quality data do not support the listing of most streams for excess nutrients. Chlorophyll *a* information also supports the contention that nutrients are not degrading the water quality in most streams in the subbasin. However, the chlorophyll *a* data was very limited (a single sample in a single year). A fuller collection of both sestonic and benthic chlorophyll *a* samples is needed to make the SBA conclusions tighter. In addition to better chlorophyll *a* collections, an assessment of the emergent aquatic vegetation within the reservoir is needed. Currently it is assumed that the emergent vegetation is at nuisance levels due to a visual observation of the reservoir area covered by the vegetation. A quantification of this coverage needs to be completed during the implementation phases of the TMDL process.

A final data gap concerning biological communities exists. Fisheries information is very weak within the subbasin. It is unclear if some streams contain, or ever contained, salmonids. Current fisheries information needs to be collected to determine if salmonid spawning is an existing use.

3. Subbasin Assessment – Pollutant Source Inventory

There are three categories of potential pollution inputs to the waters of the Raft River Subbasin: background, non-point sources, and point sources. There are no known point sources that discharge to streams or rivers within the Raft River Subbasin.

Confined animal feeding operations (CAFOs) (for dairy and meat production), septic systems, and activities such as farming and grazing have the potential to produce pollutants in the watershed. Total surface discharges from these activities are minimal (with the exception of the growing season return flows from irrigated agriculture) and have relatively minor impacts on the reaches. It is unknown at this time how many sources within the subbasin land-apply their waste. Although the total discharges are minimal, the high concentrations of pollutants can make the loadings significant, particularly at lower flows. As noted, the region is arid, and most surface flow is intercepted and consumed in the agricultural process, evapotranspired, or infiltrated to the subsurface.

The contributions of the nonpoint source impacts; however, are often integrated from the many entry sites into the larger discrete flows of the tributaries and drains. This integration often hides the magnitude of the impacts of single activities or sources. For example, home sewer systems and animal feedlots are legally forbidden to produce direct surface discharge. However, manure from the latter activity is eventually spread on agricultural lands as fertilizer and becomes inseparable from other nutrient production that results from application of chemical fertilizer in the agricultural process. The great majority of lands used exclusively for grazing in this arid area produce no surface runoff at all, although rangelands (including mixed rangeland and forest lands) comprise approximately 60 percent of the land use of the subbasin. Where grazing (post-harvest) occurs in combination with agriculture, the effects of manure and trampling of riparian areas may be inseparable from, and concurrent with, the effects of fertilizer application and plowing up to the stream sides.

Natural erosive processes by the streams in the subbasin would include scouring stream banks and beds, overland sediment transport, and mass wasting (earth movement down-gradient). The natural introduction of nutrients and sediment into the watershed would include those from precipitation and wind transportation. Most of these processes are also, to some respect, enhanced or accelerated by human alterations of the landscape (e.g., grazing and farming operations that effect riparian growth and streamside cover), often making specific attribution of pollutant production difficult.

3.1 Sources of Pollutants of Concern

The following sections will discuss the point sources and major nonpoint sources within each watershed of the Raft River Subbasin. These sources or land uses will serve as the basis for the load allocations in the required TMDLs.

Point Sources

As stated previously, there are no known point sources within the subbasin that discharge to a water body. Confined animal feeding operations and other point sources which land apply exist within the subbasin. However, these sources are allowed zero discharge to a receiving water body through current rules and regulations. Consequently, any CAFO or land application site would receive a zero WLA in any TMDL developed as a result of this assessment.

Nonpoint Sources

Nonpoint pollution in the Raft River Subbasin has not been clearly identified. Rather it is assumed to be coming from the different land uses at equal rates. Given enough time, the differing rates would have been used to set load allocations. However, due to the water quality lawsuits, gross allocations based upon land use will be the preferred allocation scheme used by DEQ in the Raft River TMDLs. Therefore, any LAs can be made based on the percentage of differing land uses within a watershed or critical area. See Figure 9 for the location of watersheds within the Raft River subbasin. In some cases, the watershed area contains several water quality limited water bodies. In other cases, the water quality limited segment is not the mainstem of the watershed. In these instances, it was more appropriate to determine the land use breakdown from a set buffer of critical acres. In other TMDLs, this buffer zone was set at 1 mile on either side of the stream in question. This buffer zone would incorporate those acres most likely to influence the water quality of the stream. Table 38 describes the land use breakdown of each watershed or buffer zone that contains a water quality limited water body within the Raft River Subbasin.

Table 38. Land uses of each watershed containing §303(d) listed water bodies.

Watershed/ water body	Percent Dry-Land Agriculture	Percent Forest	Percent Range	Percent Urban	Percent Irrigated Sprinkler	Percent Irrigated Gravity
Raft River, Utah to Malta	43.0	4.1	42.0	0.3	9.2	1.3
Raft River, Malta to Snake River		20.0	60.9	1.2	14.1	3.8
Sublett Creek, Reservoir to Lower Bounds	40.3	0.2	44.6		3.7	11.2
Cassia Creek, Conner Creek to Raft River		11.3	86.1		1.6	1.0
Fall Creek, Headwaters to Lake Fork Creek			100.0			
Lake Fork Creek, Headwaters to Reservoir			100.0			
Sublett Reservoir			100.0			
Sublett Creek, Headwaters to Reservoir			100.0			

3.2 Data Gaps

This section contains a description of the data gaps concerning pollution sources and transport. Due to the brevity of the assessment period, sources and the mechanisms concerning transport are weakly understood. Previous TMDLs have simply used land use as the tool to allocate loads. This approach relies heavily on post-TMDL monitoring and adaptive management to refine the LAs once better information, such as pollutant transport mechanisms, is developed.

- Little is known concerning the relative yield of pollutants from identified sources (by source type and/or subwatershed). An equal percentage has been applied in past TMDLs.
- Little is known about seasonal pollutant delivery from identified sources.
- The relationships between pollutants specific to identified sources (i.e., physical or chemical associations) need to be better defined.
- Stream reaches most sensitive to impairment need to be identified.

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

Past and present pollution control activities in the Raft River Subbasin have involved both public and private entities. Some of the activities have included changes in grazing management regimes, building off-creek water troughs, fencing, and reducing numbers of animals or time spent on the range. The next several pages contain information on pollution control efforts submitted by the USFS. This write-up explains the efforts some of the land managers have taken to improve water quality in the Raft River Subbasin.

United States BLM Efforts to Improve Water Quality.

The US BLM has made many efforts to improve water quality within the Raft River Subbasin. Some of these include excluding grazing on BLM administered land near the perennial segments of Raft River and implementing riparian pasture BMPs along Cassia Creek.

United States Forest Service Efforts to Improve Water Quality

The following pages concerning the USFS pollution control activities were taken from a document prepared by Trudy Flock of the USFS Minidoka Ranger District for the Twin Falls Regional Office of DEQ.

PROJECT NAME	USFS DIVISION	DOCUMENT &/OR YEAR	ALLOTMENT	POLLUTION CONTROL MEASURE	LOCATION
Projects files- Structural, Non-Structural, and Water					
Deer Hollow Troughs/Pipeline	Black Pine	1994	Kelsaw C&H	Sixmile Creek Trough/Pipeline and Riparian Fence (1 trough, 0.1 mi of pipeline and 1.25 miles of fence). Will create a riparian exclosure to improve the ecological condition of Sixmile riparian area and further improve existing fisheries habitat by excluding livestock from Sixmile riparian area	T15S R12W Section 10, 11 & 15.
Shirley Creek Riparian Project	Sublett	1997	Lake Fork C&H	S. Boundary; .60 mile of drift fence on south side of Shirley creek and trough on south side of fence, abt. 50 yds. east of forest boundary. Done to provide off site water source and the fence will prevent cattle from accessing the creek in this location. N. Boundary; .75 mi of fence from E. side of the private land in section 17 to ridge top where it will tie in with existing fence. Creation of the Shirley Creek Riparian unit will prevent cattle accessing Shirley Creek from the North end of the Unit	T12S R29E Sections 16, 17, and 20
Fall Creek water Development and Drift/Exclosure Fence	Sublett	1994	Lake Fork C&H	Install 3 water troughs, one headbox spring development, 2.5 miles of pipeline and .75 miles of drift/spring exclosure fence. The water development will provide water for wildlife and livestock in an upland area away from riparian habitat while the drift fence will serve as a barrier to prevent cattle from easy access to riparian areas and small exclosures will protect Fall Creek Spring from being damaged by concentrated livestock use... to improve soil and watershed condition of Fall Creek and Lake Fork Creek riparian areas. (NOTE: Fall Creek Spring provides a great deal of water and is a major tributary of Lake Fork Creek.)	T12S R29E Sections 15, 16, 21, and 22

Flat and New Canyon Riparian Fences	Albion	1993	Elba C&H	2.5 miles of new fence in both to improve and enhance riparian values by controlling cattle grazing in these area, moving cattle to uplands, thereby improving the quality of the riparian community	T13S R24E Sections 19, 20, 29, 30, and 31
Kelsaw, Moberg, Black Pine Boundary Fence	Black Pine		Boundary Fence: Kelsaw, Moberg and Black PIne	Construction of 3.0 miles of allotment boundary fence to complete the division of the Kelsaw, Moberg and Black, Pine Allotments to prevent cattle drifting between allotments. The lower portion of the fence 1.0-1.5 miles separating the Kelsaw and Mobert Allotments to improve range condition on low seral grazing land to at least mid-seral and high seral ecological condition and to bring riparian area ecological class from low to mid and high seral by controlling the timing and intensity of livestock utilization by the fence.	T15S R28E Sections 34, 35, and 36
Sixmile Creek Water Developm ent and Fence	Black Pine	After 1992?	Kelsaw C&H	Deer Hollow Troughs and pipeline; 3 troughs and 1.5 miles pipeline. To improve cattle distribution, to improve ecological condition of low seral rangelands and to improve plant vigor of crested wheat seeding. Sixmile Creek trough/pipeline and riparian fence; To improve the ecological condition of sixmile riparian area and further improve fisheries habitat. The above objectives to be accomplished by proper forage utilization and livestock exclusion from the Sixmile riparian area. The AMP/EA objective states, to improve range conditions on low seral grazing lands to at least mid seral and to bring ecological class of riparian area from low seral to at least mid-seral and high seral.	Deer Hollow: T15S R28E Section 28 and 33 Sixmile: T15S R28E Sections 10 and 15

South Heglar Riparian Fence and Gather Pasture	Sublett	1998	South Heglar C&H	.2 miles of fence to be used as a gathering pasture to help control livestock grazing: to ensure riparian area improvement (incorporates about 3 acres).	T12S R29E SW corner of section 9
South Heglar Riparian Pasture	Sublett	1995	South Heglar C&H	-Construction of 3.25 miles of riparian fence (it was noted that it was constructed at the time of the EA for South Heglar Spring Pipeline, 2000). The fence would contro llivestock and allow riparian standards and guidelines to be achieved while allowing livestock grazing.	T12S R29E Section 9
South Heglar Riparian Pasture	Sublett	1997	South Heglar C&H	-Willow planting test plots . Approximately two miles along stream.	T12S R29E Section 4
Elba Medusahead Project Seeding	Albion	1996	Elba C&H	Seeding of 160 acres (17#/ac) of Hycrest Crested Wheatgrass (13#/ac) and Western Wheatgrass (5#/ac). Purpose: seeding to stabilize soil and provide competitive cover to protect area from invasion by medusahead and other noxious	T13S R24E Sections 19 and 20
From Allotment Files					
Lake Fork Allotment File	Sublett	1991 Addendum #1 to 1981 AMP	Lake Fork C&H	Incorporate Forest Plan General Management of riparian areas by category (pgs IV-68 to IV-75).	

Lake Fork Allotment File	Sublett	1997- 2002 Annual Operating Instructions	Lake Fork C& H	Riparian sites: Move livestock when any of the 3 criteria listed below are met: Fall Creek (Fall Creek Unit) Lake Fork Creek (Fall Cr. and Van Camp Units) Van Camp Creek (Van Camp Unit) Shirley Creek (Shirley Creek Unit) -Sedge Communities (wet sites -6 in. stubble height (30% utilization) -Bluegrass meadow communities -4-5 in. stubble height (includes U. Lake Fork Meadows) (30-35% utilization) -*All stream banks -10% stream bank trampling *Compliance with the stubble height standards listed above should ensure that stream bank trampling does not exceed 10% for these sites. However, if stream bank trampling exceeds 10% before stubble heights are achieved, livestock must be removed.	
Lake Fork Allotment File	Sublett	2002 Annual Operating Instructions	Lake Fork C&H	Rest fire area (Sublett Fire) for three grazing seasons. (see Baer Section -Sublett Reservoir Fire)l	
Lake Fork Allotment File	Sublett	1996 Annual Operating Instructions	Lake Fork C&H	Fall Creek (Fall Creek Unit) Lake Fork Creek (Fall cr. And Van Camp units) Van Camp Creek (Van Camp Unit) Shirley Creek (Shirley Creek Unit): 45% use of all species (45% equates to about 4” stubble height)	
Lake Fork Allotment File	Sublett	1995Annual Operating Instructions	Lake Fork C&H	Fall Creek, Upper Lake Fork and Lower Lake Fork:: 45% allowable use of all species (45% equates to about 4 inch stubble height)	

South Heglar Allotment File	Sublett	1995	South Heglar C&H	40% forage utilization standard for South Heglar riparian area. Grazing system would be modified to ensure conditions of South Heglar riparian area improves to meet Class 3 riparian Potential Class while allowing continued livestock grazing.	
Eight Mile Allotment File	Black Pine	1997-2002 Annual Operating Instructions	Eight Mile C&H	Eight Mile and Little Eight Mile Creek (Little Eight Mile & riparian units) riparian sites: -4-6 inch stubble height or 30% utilization -20% stream bank trampling Compliance with stubble height standards listed above should ensure that stream bank trampling does not exceed 20% for theses sites. However, if stream bank trampling exceeds 20% before stubble heights are achieved, livestock must be removed. -Use Little Eight Mile and riparian pasture cautiously due to tendency for cattle to congregate in these areas. The riparian zones need to be monitored closely and move the “bottom hugger” cattle off the allotment as necessary.	
Eight Mile Allotment File	Black Pine	1994-1994 Annual Operating instructions	Eight Mile C&H	Eight mile creek: Allowable use of riparian vegetation is 45% (equal to about 4 inch stubble height)	
Kelsaw Allotment File	Black Pine	1997-2002 Annual Operating Instructions	Kelsaw C&H	Riparian Sites: Sixmile Creek and Kelsaw Creek: - 4-6 in. stubble Height (30% utilization) Stream banks- 20% stream bank trampling. Compliance with stubble height standards listed above should ensure that stream bank trampling does not exceed 20% for theses sites. However, if stream bank trampling exceeds 20% before stubble heights are achieved, livestock must be removed.	

Moberg Allotment File	Black Pine	Moberg Annual Operating Instructions 2002, 2001, 1999, 1997, 1995 & 1993	Moberg Cattle C&H	South Unit: Watersets must be located to get the maximum distribution throughout the south unit	
Moberg Allotment File	Black Pine	Moberg Annual Operating Instructions 2002, 1998, 1996, 1994, 1992	Moberg Cattle C&H	North Unit: Watersets must be located to get the maximum distribution throughout the North unit	
Elba Allotment File	Albion	Elba/Cross Creek Permit Issuance Fonsi – 1996	Elba C&H	-Decision to divided allotment into several grazing units to improve distribution of cattle for more even forage utilization. -Allowing multiple use while improving ecological condition of riparian areas; new S&G's to incorporate into the permit include: 1.) Limit riparian vegetation utilization to 40% on Flat Canyon, New Canyon and Clyde Creek and 50% on Green Creekk, Stinson, Dry Creek, Cross Creek, Conner Creek, Cold Springs Creek, Cottonwood Creek and Cottonwood Swamp. 2.) Standards describing desired ecological conditions at the spring source with a prescribed livestock impact limit (trampling will not exceed 10% at the spring head). The ecological condition for upland areas will also be maintained or improved.	

Cross Creek Allotment File	Albion	1997-2002 Annual Operating Instructions (2000? Was not located but was assumed to follow previous years instructions)	Cross Creek C&H	Move livestock when the following standards have been met: -Cross Creek Sedge Communities (wet sites) -5 in. stubble height (30-35% utilization) -Bluegrass meadow communities -4 in. stubble height -*Stream banks -20% stream bank trampling *Compliance with the stubble height standards listed above should ensure that stream bank trampling does not exceed 20% for these sites. However, if stream bank trampling exceeds 20% before stubble heights are achieved, livestock must be removed.	
Pine Hollow Allotment File	Albion	1991 Addendum #1 to the 1983 Approved AMP	Pine Hollow C&H	Standards and Guides for Riparian Areas	
Grape Creek Allotment File	Albion	1991 Addendum #1 to the 1977 Approved AMP	Grape Creek C&H	Standards and Guides for Riparian Areas	

Grape Creek Allotment File	Albion	1997, 1999-2002 Annual Operating Plan		Riparian Sites: Grape Creek Sedge Communities (wet sites) 4 -5 in stubble height (30-35% utilization) -Bluegrass meadow communities - 3-5 in stubble height -Stream banks -20% stream bank trampling Compliance with the stubble height standards listed above should ensure that stream bank trampling does not exceed 20% for these sites. However, if stream bank trampling exceeds 20% before stubble heights are achieved, livestock must be removed.	
Chokecherry Allotment File	Albion	1991 Addendum #1 to the 1987 Approved AMP	Chokecherry C&H	See Attachment C for "Standards and Guides for Riparian Areas"	
Chokecherry Allotment File	Albion	1997-2002 Annual Operating Plan	Chokecherry C&H	Chokecherry, Center and Waterfall Creeks. Sedge Communities (wet sites) 5 in. stubble height (30-35% utilization) -Bluegrass meadow communities -4 in. stubble height (30-40% utilization) -Stream banks-20% stream bank trampling Compliance with the stubble height standards listed above should ensure that stream bank trampling does not exceed 20% for these sites. However, if stream bank trampling exceeds 20% before stubble heights are achieved, livestock must be removed.	

Almo Park Allotment File	Albion	1997-2002 Annual Operating Plan	Almo Park C&H	Riparian Area: Head of Almo Creek and wet meadow in Almo Park: 30% use on all species.	
Walters Creek Allotment File	Albion	2001, 2002 Annual Operating Plan		Riparian Sites, Walters Creek Unit: Sedge Communities (wet sites)-4 in. stubble height (30% utilization) -Bluegrass meadow communities -4 in. stubble height (30% utilization)	
Pothole-Bedke Allotment File	Albion	1997-2002 Annual Operating Plan 1998? Was not located but was assumed to follow previous years instructions)	Potehole-Bedke	Riparian Sites, Head of Stinson Creek riparian: Sedge Communities (wet sites) -6-7 in. stubble height (20-% utilization) -Bluegrass meadow communities -4-5 in. stubble height (30-35% utilization) - All Stream banks -20% stream bank trampling Compliance with the stubble height standards listed above should ensure that stream bank trampling does not exceed 20% for these sites. However, if stream bank trampling exceeds 20% before stubble heights are achieved, livestock must be removed.	
Pothole-Bedke Allotment File	Albion		Potehole-Bedke C&H	Riparian Fence Exclosures: (.5mile each-2) head of Stinson Creek	T14S R24E Sec 6
From Timber/Silviculture Files					

Post and Poles		1995		Roads will not be traveled when wet and damage may occur.	Black Pine and Sweetzer Canyon
Post and Poles		1993 1995		Roads will not be traveled when wet and damage may occur.	Almo Park Pole area
Post and Poles		1995 Permit: District wide for dead poles only		-No skidding across live streams. -If skidding with equipment or horses and a skid trail develops, it must be properly water-barred	District-wide
Post and Poles		1995 Permit for New Canyon and Dry Canyon	Albion	No skidding across live streams. -If skidding with equipment or horses and a skid trail develops, it must be properly water-barred	New Canyon and Dry Canyon
Post, Poles and Ornamentals				-No skidding on slopes >40% -Roads will not be traveled when wet and damage may occur. -Skid trails must be properly water-barred and all disturbed areas will be reseeded (seed will be provided by USFS).	T12S R30E Section 29 No. Fork of Sublett Creek
Post, Poles and Ornamentals		1993		Roads will not be traveled when wet and damage may occur.	Designated post and pole areas
Burned Area Emergency Rehabiliatation (BAER)					
Sublett Reservoir Fire Baer Project	Sublett	2001 - Sublett Reservoir Fire - Baer Burned Area Report		2749 NFS Acres Burned - -Limit erosion by providing adequate road drainage Road and Trail Treatment- water bar and other drainage along five miles of low standard roads alongside the burn to accommodate increased flows from burn. To limit erosion associated with roads. Rest two grazing units for three years	

The following is a list of provisions that would have been included in most timber sale contracts.

WO-CT6.34 – Sanitation and Servicing (12/00). Purchaser shall take all reasonable precautions to prevent pollution of air, soil, and water by Purchaser's Operations. If facilities for employees are established on Sale Area, they shall be operated in a sanitary manner. Purchaser shall not service tractors, trucks, or other equipment on National Forest lands where servicing is likely to result in pollution to soil or water. Purchaser shall remove from National Forest lands all refuse resulting from use, servicing, repair, or abandonment of equipment. In the event that Purchaser's Operations or servicing of equipment result in pollution to soil or water, Purchaser shall conduct cleanup to restore the polluted site to the satisfaction of USFS.

WO-CT6.342 – Hazardous Substances (5/01) Purchaser shall notify Forest Service, in an annual Operating Schedule, of any hazardous substances, as defined in 29 CFR 1910.120, to be used on Sale Area and will have Material Safety Data Sheets for those materials available at the landing and any road construction site. All such materials shall be labeled in accordance with Federal and State regulations.

Before commencing operations Purchaser shall provide a Hazardous Substances Plan. The Plan must include, but is not limited to, hazardous substances to be used in the Sale Area and identification of Purchaser's representatives responsible for supervising initial containment action for releases and subsequent cleanup.

Purchaser shall not release abnormal quantities of petroleum products or other hazardous substances on land or into rivers, streams, or impoundments or into natural or man-made channels leading thereto. Purchaser will take whatever initial action may be safely accomplished to contain all abnormal releases. Purchaser shall conduct cleanup, to the satisfaction of Forest Service, to restore the site polluted by the abnormal release of petroleum products or other hazardous substances resulting from Purchaser's Operations, including releases caused by Purchaser's employees and contractors. Purchaser shall pay all damages and costs incurred by the Government.

Purchaser shall immediately notify appropriate agencies, including Contracting Officer or designated representative, of all abnormal spills or leaks or other releases of petroleum products or other hazardous substances on or in the vicinity of National Forest land that are caused by Purchaser's employees, directly or indirectly, as a result of Purchaser's Operations.

Purchaser shall maintain all equipment operating on Sale Area in good repair and free of abnormal leakage of lubricants, fuel, coolants, and hydraulic fluid. Purchaser shall properly dispose of all contaminated soil, vegetation, debris, vehicle oil filters (drained of free-flowing oil), oily rags, and waste oil in accordance with local, State, and Federal regulations off of Government property and shall transport such substances in accordance with State and Federal regulations.

Purchaser shall furnish oil-absorbing mats, approved by Forest Service, for use under all stationary landing equipment or equipment being serviced to prevent leaking or spilled petroleum-based products from contaminating soil and water resources.

RO-CT6.344 - Prevention of Oil Spills (Idaho Forests) (1/01). If Purchaser maintains storage facilities for petroleum or petroleum products on Sale Area, Purchaser shall take appropriate preventive measures to ensure that any spill of such petroleum or petroleum products does not enter any stream or other waters of the United States or any of the individual States.

Petroleum or petroleum product storage containers with capacities of more than 200 gallons, but less than 1,320 gallons, stationary or mobile, shall be located no closer than 100 feet from stream, watercourse, or area of open water. Dikes, berms, or embankments shall be constructed to contain the volume of petroleum products stored within the tanks. Diked areas shall be sufficiently impervious and of adequate capacity to contain spilled petroleum products.

If the total petroleum or petroleum products storage exceeds 1,320 gallons, or if any single container exceeds a capacity of 660 gallons, Purchaser shall prepare a Spill Prevention Control and Countermeasures (SPCC) Plan. Such plan shall meet applicable EPA requirements (40CFR 112), including certification by a registered professional engineer.

RO-CT6.50# - Streamside Management Zones (11/98). A Streamside Management Zone (SMZ) is a zone that contains riparian vegetation and other special characteristics. Areas identified as Streamside Management Zones (SMZ's) are shown on the Sale Area Map and designated.

Timber designation, conduct of logging, and/or slash treatment may differ in the SMZ from the rest of the unit. Unless otherwise agreed to in writing and notwithstanding the contract requirements otherwise applicable to each cutting unit, the following special requirements apply to the SMZ of the cutting units specified below:

	Streamside Management
Cutting Unit(s)	Zone Requirements

RO-CT6.6# - Erosion Prevention and Control (11/98).

A. Purchaser shall locate Temporary Roads on locations approved by the Forest Service. Such location shall include the marking of road centerline or grade-line and the setting of such construction stakes as are necessary to provide a suitable basis for economical construction and the protection of National Forest lands.

B. Skidding with tractors within feet of live streams shall not be permitted except in places designated in advance by Forest Service, and in no event shall skid roads be located in live or intermittent streamcourses. Skid trails shall be located high enough out of draws, swales, and valley bottoms to permit diversion of runoff water to natural undisturbed forest ground cover.

C. Prior to periods of accelerated water runoff, especially during the spring runoff and periods of heavy rainfall, Purchaser shall inspect and open culverts and drainage structures, construct special cross ditches for road runoff, and take other reasonable measures needed to prevent soil erosion and siltation of streams.

D. Temporary Road surface width shall be limited to truck bunk width plus four (4) feet, except for needed turnouts which shall not exceed two (2) times the bunk width plus four (4) feet. If shovels or cranes with revolving carriage are used to skid or load, Temporary Road surface width equal to track width plus tail swing shall be permitted.

E. Unless otherwise agreed in writing, Purchaser shall keep erosion control work current with his operations under the sale and in any case not later than 15 days after completion of skidding on each payment unit or cutting unit.

RO-CT6.601# - Erosion Control Seeding (11/98). Following completion of skidding and yarding operations in an area, Purchaser shall seed and fertilize all exposed areas of raw soil as designated by the Forest Service on skid trails, landings, firebreaks, slides, slumps, Temporary Roads and traveled ways of Specified Roads

following closure specified in CT5.51#. Soil on areas to be seeded shall be left in a roughened condition favorable to the retention and germination of the seed. Scarification of traveled ways on Specified Roads listed above shall be to a minimum depth of inches and a maximum depth of inches.

Seed and fertilizer shall be spread evenly at the rate of pounds of seed and pounds of fertilizer per acre.

When fertilizer and seed are applied in separate operations, the second operation shall be carried out within 72 hours of the first.

Seeding shall be done during the period to and under the above specified conditions unless otherwise approved.

The kinds and amounts of seed to be sown in terms of pure live seed (PLS) shall be:

Species of Seed	PLS Pounds Per Acre

All seed purchased will be certified to be free of the noxious weed seeds from weeds listed on the current "All States Noxious Weeds List." Test results from a certified seed analyst and seed analysis labels attached to the bags will be provided to the Forest Service.

The following kinds and amounts of standard commercial fertilizer shall be used with guaranteed analysis of contents clearly marked on containers:

Type of Fertilizer	Pounds Per Acre

Road provisions; the specific restrictions vary by sale. (Note: CT5.12# has been used frequently to control use on roads in meadows or other wet areas).

WO-CT5.12# - Use of Roads by Purchaser (6/99). Purchaser's use of existing roads identified on Sale Area Map by the following codes is prohibited or subject to restrictive limitations, unless agreed otherwise:

Code	Use Limitations
X	Hauling prohibited
R	Hauling restricted
U	Unsuitable for hauling prior to completion of agreed reconstruction
P	Use prohibited
A	Public use restriction
W	Regulation waiver

Roads coded A will be signed by the Forest Service to inform the public of use restrictions. Purchaser's use of roads coded R, A, or W shall be in accordance with the following restrictions:

Restricted Road List

Road Number	Road Name	Termini		Map Legend	Description of Restrictions
		From	To		

RO-CT5.124 - Existing Roads (11/98). Notwithstanding BT5.12, existing roads not shown on Sale Area Map may be used upon written agreement of use restrictions and closure requirements following completion of use.

RO-CT5.44# - Obliteration of Temporary Roads (11/98). Unless otherwise agreed in writing, temporary roads constructed to access units(s) , as shown on the Sale Area Map, shall be restored to original contour. This work shall include but not be limited to, ripping the surface for seeding, pulling material from the fill slope and brow of the cut slope on to the running surface of the road, removal of drainage structures, and placing slash, stumps, or cull logs on the road surface.

RO-CT5.45# - Closure of Temporary Roads (11/98). Unless otherwise agreed to in writing, temporary roads associated with the cutting unit(s) listed in the following table shall be closed using the the closure method described.

Unit	Closure Method

RO-CT5.46# - Snow Removal (11/98). Snow removal shall be done in a manner to preserve and protect the roads to insure safe and efficient transportation and to prevent unacceptable erosion damage to roads, streams, and adjacent lands.

A. Description. Snow removal work by Purchaser shall include:

1. Removal of snow from entire road surface width including turnouts.

2. Removal of snow slides, minor earth slides, fallen timber and boulders that obstruct normal road surface width including turnouts.

3. Maintain drainage so that the drainage system will function efficiently.

B. Performance. All items of snow removal shall be done currently as necessary to insure safe, efficient transportation. Work shall be done in accordance with the following minimum standards of performance.

1. Removal of material. All debris, except snow and ice, that is removed from the road surface and ditches shall be deposited away from stream channels at agreed locations.

2. During snow removal operations, banks shall not be undercut nor shall gravel or other selected surfacing material be bladed off the roadway surface.

3. Ditches and culverts shall be kept functional during and following roadway use.

4. Snow berms shall not be left on the road surface. Berms left on the shoulder of road shall be removed and/or drainage holes shall be opened and maintained. Drainage holes shall be spaced as required to obtain satisfactory surface drainage without discharge on erodible fills.

5. Dozers and skidders shall not be used to plow snow on system roads without written approval of Forest Service. Upon approval, dozers and skidders must be equipped with shoes or runners to keep the plow blade a minimum of inches above the road surface unless specifically removed from the requirements in writing.

6. Snow must not be removed to the road surface. A minimum inch depth must be left to protect the roadway.

7. Purchaser's damage from, or as a result of, snow removal shall be restored in a timely manner.

T.S. Contract – Division CT – Special provisions for: South Heglar Salvage Timber Sale: 1993-1994 – HUC - Raft River

Temp Roads:

Temporary roads maximum ruling grade shall not exceed 8% except short pitches for not more than 200 feet in length.

In no case shall grades be such to cause accelerated soil erosion or damage to the NFC and values.

Side ditch and/or cross drainage structures shall bee proved for permanent seeps.

Road Maintenance:

Removal of earth and debris from ditches and culverts so that the drainage systems will function efficiently at all times.
Restoration of eroded fills and repair and protection of should berms, berm outlets, stabilized waterways, vegetated slopes and other erosion control features.

Removal of Material – Maintenance Performance:
Earth, rocks, trees, brush and debris removed from Roadways and ditches shall not be deposited in stream channels or upon slope stabilization and erosion control features.

Ditches, culverts, drop inlets, trash rocks, downspouts an splatter structures shall be kept clear of earth, slash and other debris so that drainage systems will function efficiently during and immediately following periods of road use by purchases. This includes correcting and eliminating causes of erosion or plugging of the structure and actual repair of the structure and riprap if damaged.

Any washing or settling of Roadway fills will be corrected promptly to prevent additional soil erosion or roadway damage should berms, berm outlets, and stabilized waterways shall be protected during road maintenance operations and if damage such structure shall be promptly restored to their original condition, including repairs and reseeding of vegetation established to control slope erosion. No earth rocks, or other debris shall be deposited upon any roadside slope stabilization structure or feature.

Prevention of Oil Spills:

If purchaser maintains storage facilities for oil or oil products on sale area, purchaser shall take appropriate preventative measures to ensure that any spill of such oil or oil product does not enter any stream or other waters of the US or State.

If oil/Oil Product >320 gallons or single container exceeds 660 gallons, the purchaser shall prepare a spill prevention and control and counter measures plan and it shall meet applicable EPA requirements.

Erosion Prevention and Control:

Forest Service shall designate and Purchaser shall construct erosion control structures in accordance with the follow items:

Specification for outsloping and Berm Removal; Equipment blade used for removing berm and cutting roadbed to form required outsloping shall be so angled that material resulting from such work will be moved toward the inside of the road. The bladed material shall then be spread over the surface of the road which will result in uniformly sloping the entire width of the road to the outside to divert water from the road surface. Where road compaction prevents equipment blades from cutting into the road, ripping shall be performed prior to blade work.

Erosion Control seed: Purchaser shall furnish and sow suitable seed were staked or otherwise marked on skid trails, firelines , landings and roadways, embankments, and fill sections of Temporary roads. Such seed composition shall be evenly spread at the rate of 10 lbs per acre in the early spring when moisture conditions are favorable, or in the early fall.

5. Total Maximum Daily Loads

A TMDL prescribes an upper limit on discharge of a pollutant from all sources to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a waste load allocation (WLA); and nonpoint sources, which receive a load allocation (LA). Natural background (NB), when present, is considered part of the 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 relationship of specific loads to attainment of water quality standards, the rules regarding TMDLs (40 CFR part 130) require a margin of safety (MOS) be a part of the TMDL.

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

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

A load is fundamentally a quantity of a pollutant discharged over some period of time, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for “other appropriate measures” to be used when necessary. These “other measures” must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads, and allow “gross allotment” as a LA 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 Instream Water Quality Targets

Instream water quality targets are the basis for load calculations. From these targets, loads for the various water bodies are calculated. Although TMDLs are expressed in a mass per unit time, as required by the CWA and EPA, the instream targets are typically what the local stakeholders look to when they assess data collected on their streams of concern. As a result, instream water quality targets should be something understandable such as water quality standards or other straightforward targets. Complex targets can be just as confusing and as unworkable as load calculations and should be avoided. Instream water quality targets for the Raft River Subbasin were chosen from a variety of sources. Principally, the Idaho Water Quality Standards were used to set instream targets. When the water quality standards related beneficial use impairment to a narrative standard; however, (e.g., IDAPA 58.01.02.200.03 "...surface waters shall be free from deleterious materials in concentrations that impair beneficial uses"), other sources were consulted to determine appropriate instream water quality targets. Other sources used to determine appropriate instream water quality targets were the CWA, the Code of Federal Regulations, EPA technical support documents and guidelines, other states' water quality standards, other TMDLs written by the state of Idaho and submitted to or approved by EPA, and scientific papers from refereed journals. Instream water quality targets developed from sources other than the state of Idaho's water quality standards will be reviewed at such time that numeric standards are adopted and codified by the state of Idaho following negotiated rule making.

Targets were developed for four pollutants found to be impairing the beneficial uses of the listed water bodies identified in previous sections of the SBA. These pollutants are nutrients, bacteria, sediment, and temperature. Other pollutants have been demonstrated to be not degrading the beneficial uses in the various listed water bodies. The EPA considers certain unnatural conditions, such as flow alteration, a lack of flow, or habitat alteration, that are not the result of the discharge of specific pollutants, as "pollution". TMDLs are not required for water bodies impaired by pollution but not specific pollutants.

Design Conditions

Typically, design conditions are based upon the critical periods for specific beneficial uses respective of the pollutants and water bodies or upon some reference system within the subbasin or creek. Design conditions often vary from stream to stream for various pollutants. One of the reasons for such variability is the different land use practices along each stream. Other factors also increase loadings at different times of the year from pollutant to pollutant. For example, TP and sediment may impair a beneficial use on a stream at different times of the year. Typically, sediment is more likely to impact a system in the spring runoff during higher flow, while TP will impact a stream at during summer growing season. Therefore, the critical periods for each stream and each pollutant will be discussed separately. In addition, much of the sediment design was based upon reference reaches within each creek. In some cases prototypical reference conditions for stream bank erosion were used. These conditions will be outlined in the following sections.

Raft River

In the upper portion of Raft River flow alteration plays a significant role in water quality. For the most part flow is removed from the system from the Utah section of the river. In most years little, if any, water enters Idaho for the greater part of the year. Often times the only flow entering Idaho is winter base flow and some early spring runoff. Because of this flow regime, beneficial uses are not impacted by pollutants for which TMDLs can easily be written. However, bed load sediment does impact the beneficial uses during the limited time water is present within the system. This is typically during spring runoff events due to the substantial amount of raw and exposed banks. These bank conditions are exacerbated by the flow alteration problems seen throughout Raft River, in that the bank stabilizing vegetation is reduced or growth is limited because of the lack of water. However, at several locations along the upper portion of Raft River substantial springs emerge and recharge the system. These springs are located mainly at the area known as The Narrows. The Raft River then flows for several miles year round before it is again diverted and dewatered. Along these sections the riparian community is often healthy and vigorous. Any TMDLs developed for other constituents, such as temperature and bacteria will be applicable for the section of Raft River near The Narrows. Other sections flow alteration problems proceed any other pollutant. At such time that perennial flow is returned to the system the nonsediment TMDLs will be reviewed to determine if the LAs can be extrapolated to the remainder of the system.

Because of the impacts from flow alteration the design condition for Raft River for the other pollutants is the nonirrigation season through early spring when water is present within the system. The creek is impaired by bed load sediments during this time. Typically, sediments are more likely to impair the beneficial uses at higher flows. These uses are impaired by the elevated suspended load that occurs during the high spring flows. These flows also redistribute the bed load stored within the system throughout the year. Most of this load is coming from bank erosion of Raft River. Due to flow alteration, limited TSS data are available on the upper segment. Load allocations will be developed using bank erosion rates developed by the NRCS and refined for TMDL use by the DEQ Idaho Falls Regional Office staff. The loads to the creek are derived from high flow events eroding unstable banks throughout the system. These loads can be estimated from bank heights and the percent unstable bank length within a system. The loads would then be reflective of average peak flow from the predicted hydrograph and USGS data.

In the case of Raft River temperature issues, cold water aquatic life and salmonid spawning are the designated beneficial uses affected by increased temperature. The salmonid population consists or consisted of stocked and naturalized populations of rainbow and brown trout, as well as native populations of cutthroat trout. Currently it is unknown if brown and cutthroat trout inhabit Raft River. It is unlikely that naturalized rainbows exist within the water body. The spawning and incubation periods of these three salmonids range from early spring, to the middle of the summer, to the fall. These times should be considered the critical periods for the beneficial uses of the stream. Temperature exceedances, of both the cold water aquatic life use and salmonid spawning, typically occur throughout the summer months. This period also corresponds with the end of spawning and incubation period of the rainbow and cutthroat trout.

The land use practices along the reach may have long term effects on the ability of Raft River to meet state water quality standards. Agricultural practices (both grazing and farming practices) have removed significant portions of the riparian vegetation, changing the potential shade of the stream. These land use practices do not necessarily occur only during the critical period but have occurred throughout the year and over the past several decades. As a result, the potential vegetation along much of the river may be row crops, short pasture grasses, and rangeland communities, rather than a taller willow dominated riparian community. The temperature target selection will need to reflect this historic change in potential riparian community and how it is applied through the solar pathfinder model.

Raft River is designated for primary contact recreation. Bacteria contamination occurrences in Raft River correspond with the time of year that temperature increases. Although the causal mechanisms are not the same, the BMPs that would be used to alleviate the temperature issues would likely alleviate the bacteria issues as well. As riparian cover increases, the ability for fecal material to be deposited or migrate into the creek will decrease. Although the two constituents will respond in a similar manner a statistical link between the two cannot be made. Therefore, LAs will have to be made on both, rather than using one as a surrogate for the other as can be done with other constituents (e.g., sediment and TP). However, it is likely that one implementation plan could cover both constituents.

The design conditions for the bacteria TMDL will be based on the period when (if) swimming might occur. Primary contact recreation is generally applicable only during May 30 to September 1, as people are only likely to swim in the warmest months. In Raft River, this period corresponds with the descending limb of the hydrograph and summer low flow. Therefore, the TMDL's LC will be based upon the average summer flow conditions (June through August). In Raft River by The Narrows, this is approximately 0.46 m^3/second.

Sublett Creek

The data collected and presented by DEQ in this report suggest that Sublett Creek below the reservoir is impaired only by flow alteration. As previously described, DEQ and EPA do not have mechanisms in place to deal with flow alteration TMDLs. However, nutrient contamination does occur in the reservoir. Because of this, the upper reaches of Sublett Creek will have a nutrient TMDL completed to meet the beneficial uses of the reservoir. The design conditions for the upper section will be discussed in following sections.

Cassia Creek

It has been determined that the listed portion of Cassia Creek is impaired by flow alteration, nutrients, sediment, and bacteria. Flow alteration, in the lower listed segment, is the dominant factor impairing beneficial uses. The other constituents are present when water is present within Cassia Creek. However, the lack of flow for a significant portion of the year masks the affect the other constituents may have on the beneficial uses of Cassia Creek. This is especially true in the lower 6 miles of the listed portion of the creek. In this area, water is removed from the channel, depending on the water year, from April until October. Given this flow regime, little, if any, affects will be seen by other constituents. However, in the upper 5 miles of the system, water appears to be within the channel throughout the year

(Etcheverry 2001). In this section, TMDLs for the other constituents will be meaningful. In addition, as the TMDLs are implemented in the upper section of the system, perennial flow in the lower section may be restored.

Because of the impacts from flow alteration the design condition for Cassia Creek for the other pollutants is the nonirrigation season through early spring when water is present within the system. The creek is impaired by both nutrients and sediments during this time. Typically, sediments are more likely to impair the beneficial uses at higher flows, while nutrients are more likely to impair a system during lower flows. In the case of Cassia Creek, the time when nutrients typically impair the system corresponds with the time flow is most likely zero due to irrigation demands. Therefore, the LC of nutrients will be based upon average springtime flows when water and nutrients are present in the system.

Sediment also appears to impair the beneficial uses of lower Cassia Creek. These uses are impaired by the elevated suspended load that occurs during the high spring flows. These flows also redistribute the bed load stored within the system throughout the year. Much of this load is coming from bank erosion of Cassia Creek. Due to flow alteration, limited TSS data are available on the lower segment. Load allocations will be developed using bank erosion rates developed by the NRCS and refined for TMDL use by the DEQ Idaho Falls Regional Office staff. The loads to the creek are derived from high flow events eroding unstable banks throughout the system. These loads can be estimated from bank heights and the percent unstable bank length within a system. The loads would then be reflective of average peak flow from the predicted hydrograph and USGS data.

The upper unlisted portion is also impaired by bacteria. Bacteria seem to impact the upper segment in the spring and again in the fall. These times correspond with the presence of cattle. Other times of the year, the cattle are on the ranges in different portions of the watershed. The critical period for the recreational beneficial uses falls typically within May to October. Recreation activities during this period include hiking, biking, fishing, and hunting. It is equally likely that water would be ingested at any time during this period, but the highest concentrations of bacteria typically occur earlier in the year. This may be because runoff from pastures and uplands occurs following spring rainstorms. At other times of the year runoff from pastures is less likely because of a lack of precipitation during the summer and fall. Therefore, to be protective of the beneficial use, the design conditions should fall within the critical period when the bacteria contamination is most likely to occur. In both the upper and lower segments this appears to be during the month of May. Consequently, the design flows for the TMDL will be those average discharges from the late spring.

Fall Creek

The data collected and presented by DEQ in this report indicate that bacteria and nutrients impair the beneficial uses of Fall Creek. The critical period for the recreational beneficial uses falls typically within May to October. Nutrients also impair systems during this period as plant growth is optimized by the increasing water temperature found during the period. The hydrology of Fall Creek is unique in that there does not appear to be a strong link to watershed precipitation. As a spring creek, Fall Creek discharges approximately 0.03

m^3/second year round. Load capacities for bacteria and nutrients will be developed with that value and can be extrapolated to any season due to the limited variability in the hydrograph.

Lake Fork Creek

The data collected and presented by DEQ in this report suggests that Lake Fork Creek is not impaired by nutrients. However, the nutrients in Lake Fork Creek are elevated enough to cause beneficial use impairment in Sublett Reservoir. Because of this, the upper reaches of Lake Fork Creek with have a nutrient TMDL completed to meet the beneficial uses of the reservoir. The design conditions for the upper section will be discussed in following sections.

Sublett Reservoir

It has been determined that Sublett Reservoir is impaired by flow alteration and nutrients. Flow alteration is the dominant factor impairing beneficial uses. The reservoir often undergoes several drawdowns throughout the summer. In dry years, the reservoir can be drained almost 100 percent. The lack of pool volume during late summer may mask the nutrient effects on the beneficial uses of the reservoir.

The reservoir is fed by two streams: Sublett Creek and Lake Fork Creek. These two streams lack the hyrological variability of most normal streams. They are spring fed systems with limited influence from precipitation events within their watersheds. Therefore, the design conditions used to determine load capacities for the reservoir and the creeks can be based upon the annual average flow in each creek. The lack of variability makes this value applicable throughout the year regardless of season.

Target Selection

Nutrients

Three water bodies within the Raft River Subbasin do not meet the narrative standard for nutrients. Therefore, these segments will be considered for application of a TMDL for restoration and protection of designated beneficial uses. Water quality will be restored through the TMDL process and the subsequent implementation plans developed by the land management agencies. The TMDLs will establish a limit on the quantity of nutrients that may enter the segments from sources in the local watersheds. The nutrient limits will be set at a level such that the segments will not exceed the estimated load capacities supportive of a good to excellent fisheries and will allow the water quality to improve to restore degraded beneficial uses. These targets shall be a monthly average of not more than 0.05 mg/L TP with a daily maximum of 0.08 mg/L to allow for natural variability in Lake Fork Creek and Sublett Creek. The average monthly target is within the range identified by the EPA as supporting beneficial uses of water flowing into lakes and reservoirs. This will restore the beneficial uses of Sublett Reservoir. Total phosphorus targets for Fall Creek and Cassia Creek shall be set at not more than 0.100 mg/L of TP with a daily maximum of 0.160 mg/L TP to allow for natural variability in those streams. The average monthly target is within the range identified by EPA as supporting beneficial uses of free flowing streams and rivers.

The TP target values of 0.05 mg/L and 0.100 mg/L do not imply that degradation by TP may occur up to the target value. Rather, TP values should be less than the respective targets on an average monthly basis and daily maximum, which will allow for some exceedances of the instream standards to account for seasonal and daily variation. However, it is DEQ's administrative policy under IDAPA 58.01.02.050.01 that the adoption of water quality standards and the enforcement of such standards is not intended to conflict with the apportionment of water to the state through any of the interstate compacts or court decrees. or to interfere with the rights of Idaho appropriators, either now of in the future, in the utilization of the water appropriations which have been granted to them under the statutory procedure. Yet, IDAPA 58.01.02.50.02.a states: "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 biota." The existing and designated beneficial uses of these segments will be protected through the TMDL process as legally described. Acts of God and or uncontrollable flood/drought events will be exempt during the period of impact until such time that the impact is stabilized and the imminent and substantial danger to the public health or environment (IDAPA 58.01.02.350.02.a) is minimized so that the activity may be conducted in compliance with approved BMPs…to fully protect the beneficial uses (IDAPA 58.01.02.350.02.b.ii. (2)).

Other activities that may cause degradation, but which are outside the scope of IDAPA 58.01.02.050.01 and which there is foreknowledge of the event's occurrence will require a formal written letter from the individual, organization, or agency to the Twin Falls Regional Office (TFRO) about the nature of the potential event. If the activity violates IDAPA 58.01.02.350.02.b.i, such that it will occur in a manner not in accordance with approved BMPs, or in a manner which does not demonstrate a knowledgeable and reasonable effort to minimize the resulting adverse water quality impacts, then DEQ's TFRO will seek intervention by the director of DEQ for preparation of a compliance schedule (as provided in Idaho Code 39-116). DEQ may also institute administrative or civil proceedings including injunctive relief as provided in Idaho Code 39-108.

Bacteria

The state of Idaho has a water quality standard for *E. coli* that covers both primary and secondary contact recreation. All of the systems in the subbasin are undesignated water bodies except the Raft River. These undesignated water bodies are afforded protection for primary and secondary contact recreation according to IDAPA 58.01.02.101.01.a. After a review of the physical properties of the listed systems, DEQ-TFRO has determined that likely recreational activities include fishing, wading, and infrequent swimming. These recreational activities are descriptive of the existing uses consistent with secondary contact recreation. As a result, the water quality bacteria targets will be those water quality criteria for secondary contact recreation. Thus, the number of colonies of *E. coli* shall not exceed a single instantaneous sample of 576 col/100 ml and the geometric mean of five samples collected in a 30 day period of 126 col/100 ml.

Additionally, the target bacteria load (576 col/100 ml) will be segregated into percentages based on land uses. Thus, if 40 percent of the land use is attributable to agriculture, then 230 col/100 ml of the target will be distributed to agriculture. The remainder (576 - 230 = 346 col/100 ml) will be distributed to the other land uses where appropriate. An essential assumption in this method of distribution is that the water quality standard is the LC of a system. By using a percentage of the target or “load capacity,” the calculations become unitless percentages, which overcomes the inherent problems of calculating loads from a parameter which does not lend itself to loading calculations. Allocations can then be made from this percentage of the load according to land use in the watershed. The MOS (10 percent in all cases) would be used to hold back a percent of the load from the LC.

Compliance with the water quality target and the TMDL will be based on the geometric mean (126 col/100 ml) for secondary contact recreation as described in the IDAPA regulations. Because the major exceedances occur primarily during the grazing season (April through September), monitoring of the water bodies will occur primarily during the grazing season, although year-round monitoring may be developed so that comparisons between the grazed and nongrazed seasons can be assessed. It is recognized that bacteria are a singular parameter that has a statistically significant linkage to TSS. (See *Upper Snake Rock Watershed Management Plan* [Buhidar 1999] for a review of surrogate use of TSS for bacteria reductions.) During the implementation phase of this TMDL, land management agencies will provide guidance as to site-specific BMPs that will effectively reduce *E. coli*, such that conjunction with TSS reductions will yield *E. coli* reductions, and eventually reach beneficial uses and/or state water quality standards.

Sediment

The antidegradation policy for the state of Idaho (IDAPA 58.01.02.051(01)) indicates that the existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected. Most of the listed segments in the Raft River Subbasin appear to be meeting the narrative standard for suspended sediment although they are listed for sediment on the 1998 §303(d) list. Because of this, higher water quality for suspended sediment degradation of the water quality beyond these conditions shall not occur but shall be maintained at or below these levels throughout the implementation of the TMDL. The sediment limit, in the listed segments of the subbasin, will be set at a level such that the rivers and streams will not exceed the estimated LC supportive of a good fishery and will not allow the water quality to degrade worse than current levels. This target shall be a monthly average of less than 50 mg/L of TSS with a daily maximum of 83 mg/L to allow for natural variability. The average monthly target is within the range identified by the European Inland Fisheries Advisory Commission (EIFAC 1965) and the Committee on Water Quality Criteria from the Environmental Studies Board of the National Academy of Science and National Academy of Engineers (NAS/NAE 1973) as supporting a moderate fishery. Total suspend solids values less than 50 mg/L do not imply that degradation by TSS may occur up to 50 mg/L. Rather, TSS values should be less than 50 mg/L on an average monthly basis, which will allow for some exceedances of the in-stream standard to account for seasonal and daily variation.

However, it is DEQ’s administrative policy under IDAPA 58.01.02.050.01 that the adoption of water quality standards and the enforcement of such standards is not intended to conflict with the apportionment of water to the state through any of the interstate compacts or court decrees, or to interfere with the rights of Idaho appropriators, either now of in the future, in the utilization of the water appropriations which have been granted to them under the statutory procedure. Yet, IDAPA 58.01.02.50.02.a states "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 biota." The existing and designated beneficial uses of the subbasin will be protected through the antidegradation as previously described. Acts of God and or uncontrollable flood/drought events will be exempt during the period of impact until such time that the impact is stabilized and the imminent and substantial danger to the public health or environment (IDAPA 58.01.02.350.02.a) is minimized so that the activity may be conducted in compliance with approved BMPs…to fully protect the beneficial uses (IDAPA 58.01.02.350.02.b.ii. (2)).

Other activities that may cause degradation but which are outside the scope of IDAPA 58.01.02.050.01 and which there is foreknowledge of the event's occurrence will require a formal written letter from the individual, organization, or agency to DEQ-TFRO about the nature of the potential event. If the activity violates IDAPA 58.01.02.350.02.b.i, such that it will occur in a manner not in accordance with approved BMPs, or in a manner which does not demonstrate a knowledgeable and reasonable effort to minimize the resulting adverse water quality impacts then DEQ-TFRO will seek intervention by the Director of DEQ for preparation of a compliance schedule (as provided in Idaho Code 39-116). DEQ may also institute administrative or civil proceedings including injunctive relief as provided in Idaho Code 39-108.

Cassia Creek is the lone exception in the subbasin in that it is seasonally affected by excess suspended sediment. As a result, sediment targets will be developed and load capacities determined. However, these targets will be based on the nutrient reduction TMDL proposed for Cassia Creek and therefore the nutrient targets will serve as surrogates for any proposed suspended sediment reduction targets, load capacities, and allocations. These targets shall be a monthly average TP concentration of no more that 0.100 mg/L with a daily maximum of no more that 0.160 mg/L TP. As seen in Figure 37 a strong relationship exists between TSS and TP in Cassia Creek. This relationship is based in part to the physical nature of TP molecules to adhere to suspended sediment particles and the land use practices in the watershed that contribute both TP and suspended sediment. Therefore, any reduction in TP is most likely to come from the same BMPs that would reduce sediment. Furthermore, as seen in the TP: TSS relationship (Figure 37.), TP reductions to approximately 0.151 mg/L should result in TSS levels meeting the above targets (< 50 mg/L monthly average) for support of salmonid populations (cold water aquatic life and salmonid spawning). However, further TP reductions are proposed for Cassia Creek. The current target for the stream is set at a 0.100 mg/L monthly average. This level of phosphorus reduction should, theoretically, reduce TSS levels to background levels (near 20 mg/L). Because the nutrient TMDL goals far exceed the goals that will be established for a suspended sediment reductions TMDL compliance with the sediment reduction goals shall be determined when Cassia Creek attains < 50 mg/L TSS monthly average and an 80 mg/L daily maximum.

Bed load sediment impairs both Cassia Creek and Raft River. Bed load sediment loads will be developed to meet bank stability targets using a stream bank erosion estimate developed by the NRCS and refined for TMDLs by DEQ's Idaho Falls Regional Office. The current state of science does not allow specification of a sediment load or LC to meet the narrative criteria for sediment and to fully support beneficial uses for cold water aquatic life and salmonid spawning. All that can be said is that the LC lies somewhere between current loading and levels that relate to natural stream bank erosion levels. It is assumed that beneficial uses were or would be fully supported at natural background sediment loading rates. These rates were assumed to equate to the 70 percent bank stability regimes required to meet state water quality standards.

Beneficial uses may be fully supported at higher rates of sediment loading. The strategy is to establish a declining trend in sediment load indicator targets (i.e., percent fines or TSS), and to regularly monitor water quality and beneficial uses' support status. If it is established that fully supported uses are achieved at intermediate sediment loads above natural background levels, and that the narrative sediment standards are being met, the TMDL will be revised accordingly.

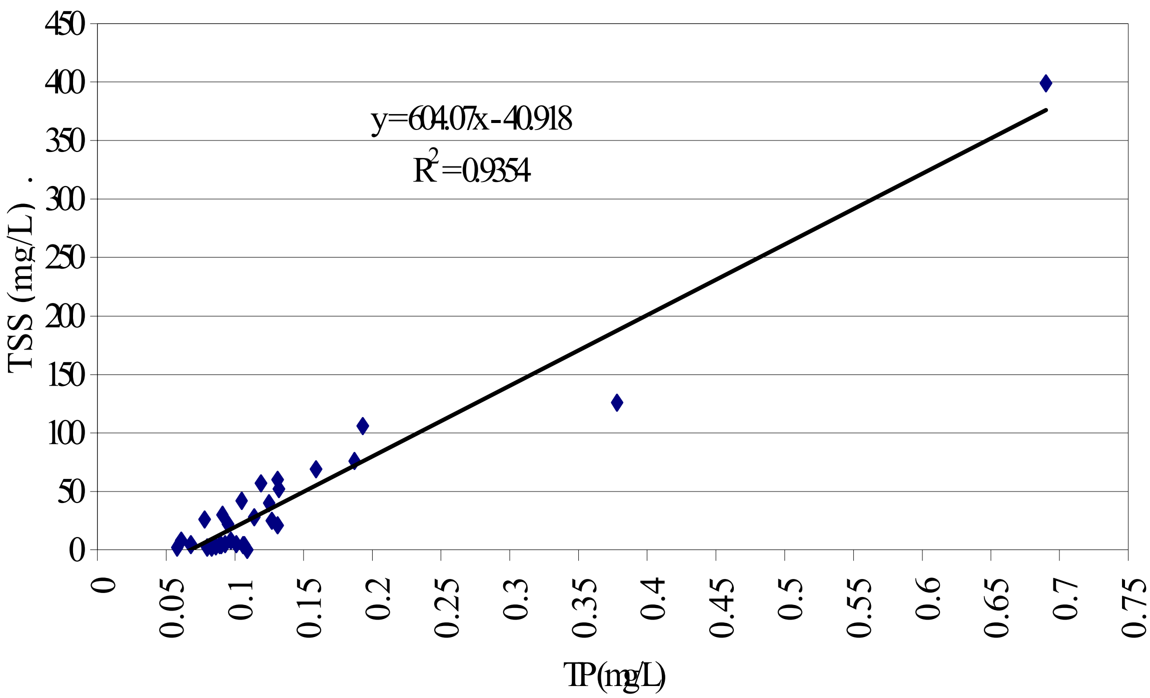


Figure 37. Total phosphorus: total suspended solids relationship of Cassia Creek.

Temperature

The state of Idaho has water quality standards that are applicable to the water bodies of the Raft River Subbasin. Specifically, Raft River exceeds the water quality standards for its designated beneficial uses of cold water aquatic life and salmonid spawning (see Raft River existing water quality data). State water quality standards for cold water aquatic life are 22 °C or less with a daily average of no greater than 19 °C. Those standards established for salmonid spawning are water temperatures no greater than 13 °C and a maximum daily average no greater than 9 °C during the spawning and incubation period of the particular salmonid community within the water body.

In addition to the state water quality standards, a solar pathfinder based data will be used to determine instream temperatures based on reference location average shade. The numeric standards do not apply in all cases because they realistically cannot be met throughout the reach, even under ideal shading. In these cases, the "best achievable thermal load" is used as the target. The best achievable thermal load is based on the practical amount of shading possible as defined in the TMDL by shade and solar pathfinder data collected on reference streams within the region.

Site potential shading characteristics are derived from similar riparian communities within the Goose Creek, Raft River, and Upper Snake-Rock Subbasins. Site potential shading is not an estimate of presettlement conditions. These subbasins have seen changes because of anthropogenic impacts (e.g. channel armoring, straightening, entrenchment, and prescribed fire) and the historic condition is no longer attainable or attainable in the very long term. Thus, site potential shading is based upon maximum vegetation heights, maximum density, and optimal vegetative offset of the riparian community based upon a group of streams with fully supported beneficial uses, located within south central Idaho. These factors also influence the bank stability of a system. Potential changes in width/depth ratios are also taken into account for the particular channel type, but changes in the existing channel type are not modeled. The Raft River temperature TMDL will be based upon the site potential shading or thermal load from five streams with fully supported beneficial uses. These streams are examples of high quality waters that are available to develop the maximum thermal load target for south central Idaho. Extrapolation outside of this area should be undertaken with some reservations until reference shade can be determined for a greater area. The first of these five reference streams was the upper fully supporting segment of Trapper Creek, which is in the Goose Creek Subbasin. The percent shade, as determined from solar pathfinder data, indicates that Trapper Creek averages 28 percent shade June through August. The second was the fully supporting segments of Stinson Creek, which is in the Raft River Subbasin. Stinson Creek is 34 percent shaded. Cross Creek was the third streams used as it was another fully supporting stream within the Raft River Subbasin. It was determined that Cross Creek is also 28 percent shaded. Two Streams were selected in the Upper Snake-Rock subbasin, The upper portions of rock Creek and North Cottonwood Creek. Both have been assessed using WBAG II and within the Upper Snake Rock TMDL and have been determined to meet beneficial uses and have no temperature related impacts to the beneficial uses. It was determined that Rock Creek is 64 percent shaded while North Cottonwood Creek is 55 percent shaded. As other streams are located within the general area, the maximum thermal load will become more robust as the values from those streams are incorporated into the average of the reference streams. The current reference stream average is 42 percent shade during the months of June, July, and August.

The Raft River Subbasin has always had high summer temperatures, high solar radiation, and low summer flows. Temperatures are exacerbated by certain land use practices including flow diversion, but water temperatures have most likely never been cold during the hottest part of the year. Native fishes have either physiologically adapted to the high temperatures or have take thermal refuge in and near the spring sources located throughout the length of Raft River. Factoring in these natural conditions, the temperature targets are based upon the temperature decrease expected under optimal habitat conditions, which, while above the state numeric criteria, are protective of the native fish community and its reproduction.

Monitoring Points

The following are the compliance points to be used to determine if the various LAs and WLAs are being met following implementation of the TMDLs.

Raft River

The Raft River will be monitored at The Narrows area for compliance with the TMDL. Following complete implementation it is expected that perennial flow will be established above and below this point. When that should occur, the LAs will be extrapolated to the flow altered segments and the compliance point will be moved downstream. At The Narrows location temperature loggers will be placed annually to determine compliance with the temperature TMDL. In addition, at this location, *E. coli* samples will be taken to determine if state water quality standards and the TMDL are being met.

Cassia Creek

Cassia Creek will be monitored at two locations for compliance with the TMDLs. The first of these will be at the bridge crossing near the Conner Creek Junction. This location will serve as the compliance point for the upstream bacteria TMDL. At this location *E. coli* samples will be taken to determine if state water quality standards are being met. The second location that will serve as a compliance point for the lower perennial segment of Cassia Creek is the bridge crossing on the Hudspeth cutoff road. It is in this area that Cassia Creek is dewatered for the majority of the year. Upstream from this location water often flows into the summer months. Following implementation it is expected that perennial flow will be established below this point. When that should occur the LAs will be extrapolated to the lower, flow altered segment and the compliance point will be moved downstream. At the Hudspeth cutoff point, the stream will be monitored for sediment (TSS) and nutrient (TP) concentrations during the critical period.

Fall Creek

Fall Creek will be monitored for *E. coli* bacteria and TP near the mouth of the creek above the confluence with Lake Fork Creek.

Sublett Reservoir

Three compliance points will be established for Sublett Reservoir. The first of these will be at the mouth of Lake Fork Creek above the influence of the reservoir. This location will be monitored for TP concentrations to determine if the reductions in the Lake Fork Creek Watershed are being met. The second location will be at the mouth of Sublett Creek above the influence of the reservoir. This location will be monitored for TP concentrations to determine if the reductions in the Sublett Creek Watershed are being met. The third location will be used as the adaptive management or feedback loop for the TMDL and the load reduction requirements for the two watersheds. This location will be at Zmax (the deepest location in the main body of the reservoir). At this location, the parameters required to calculate the Carlson's TSI will be collected. These parameters are secchi depth, TP, TN, and chlorophyll *a*. The frequency of monitoring at this location will be much lower than at the other two locations.

5.2 Load Capacity

The CWA requires that a TMDL be developed from a LC. A LC is the greatest amount of load that a water body can carry without violating water quality standards. In those instances where there are numeric water quality standards, the LC of a water body for different pollutants can be very straightforward. Most of the pollutants in the Raft River TMDL; however, do not have numeric water quality standards; rather, they have the narrative standards (e.g., IDAPA 58.01.02.200.03 "...surface waters shall be free from deleterious materials in concentrations that impair beneficial uses"), as referenced in this document. As a result, the LC of the various segments and tributaries in the Raft River Subbasin, presented in Table 39, were estimated from extrapolations from the flow records available from USGS or DEQ and a variety of sources relating concentrations of pollutant to effects on beneficial uses or aquatic communities. Other sources used for concentrations were the CWA, the Code of Federal Regulations, EPA recommendations and guidelines, other states water quality standards, other TMDLs written by the state of Idaho and submitted to or approved by EPA, and scientific papers from refereed journals. Load capacities developed from sources other than the state of Idaho's water quality standards will be reviewed at such time that numeric standards are adopted and codified by the state of Idaho following negotiated rule making. Additionally, load capacities were developed from flow regimes identified as critical periods. In some cases, these critical periods were low flow conditions during a particular season. In other cases, the flow regime during the critical period was determined to be at or near zero. In these cases, the lowest flow to which the water quality standards apply in intermittent streams, 0.14 m^3/second for recreational uses and 0.03 m^3/second for aquatic life uses (IDAPA 58.01.02.070.07), was used to determine LC.

The LC and loading analysis models for the various streams and pollutants were derived from a mass balance approach of monitoring data, upstream monitoring, downstream monitoring, source monitoring, and estimations of loads from that data. Links to the water quality targets and beneficial uses were drawn from other TMDLs completed by the state of Idaho, EPA guidelines and recommendations, and scientific literature.

Temperature

The primary source of temperature increases under anthropogenic control are those that increase the amount of solar radiation reaching the stream surface. Thus, the load of this resultant excess “heat” is calculated in kilowatts per hour per square meter per day (kwh/m^2/day). The LC is the amount of heat in the stream when the criteria or the best achievable temperature is met.

Based upon the solar table and the reference streams’ average shade conditions, the annual average thermal LC for streams in the Raft River Subbasin is estimated to be 2.4 kwh/m^2/day. During the critical period of June, July, and August, the average LC is 4.1 kwh/m^2/day

Nutrients

The LC for nutrients was determined by calculation using the target of 0.1 mg/L TP for free flowing streams and critical period flow values (calculated from predicted annual hydrographs). For streams flowing into Sublett Reservoir the LC was determined using the 0.05 mg/L TP target and critical period flow values (calculated from predicted annual hydrographs).

The phosphorus LC’s were identified for an average summer flow scenario. While these values are helpful in giving a relative understanding of the reductions required, and will apply reasonably over most water years, it should be noted that the absolute level of reduction required will depend on flow and concentration values specific to a given water year. The target shown to result in attainment of water quality standards and support of designated uses in the reach is an instream concentration of less than or equal to 0.1 mg/L TP. Transport and deposition of phosphorus, and the resulting algal growth within the reach, is seasonal in nature. Therefore, application of the 0.1 mg/L or 0.05 mg/L TP target is also seasonal in nature, extending from the beginning of May through the end of September. The length of this period was also determined by when BMPs would be most effective.

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, epiphytes, and *Cerratophyllum* sp.) will likely be the first to decline. Because nutrients persist longer in sediments, plants that obtain nutrients from the sediments will persist longer. Nevertheless, as reductions in TP (and sediment) continue, sediment-bound nutrients will gradually be depleted as plant uptake outpaces recharge rates.

Sediment

The LC for sediment was determined based on the origin of the sediment. In those instances where the sediment is generated from stream bank erosion, the LC is based on the load generated from banks that are greater than 70 percent stable. This load defines the LC for the remaining segments of the stream. In instances where a numeric water column target is defined, the LC is based on the instream load that would be present when the target is met.

For example, the instream sediment target for Cassia Creek is 70 percent stable banks. The LC for Cassia Creek is based on maintaining 70 percent stable banks throughout the stream.

Bacteria

The LC for bacteria is based on the state water quality standard for *E. coli*. The bacteria LC is expressed in terms of percent of colony forming units. However, this is simply an accounting mechanism to convert a unit of measurement (colony forming units per 100 ml) to a unitless measurement because of the impracticality of converting to a mass per unit time measurement.

Table 39. Load capacities and critical periods.

Stream Name	Parameter	Critical Period	Load Capacity[a]
Raft River	Bacteria	June-August	576 col/100 ml
Raft River	Temperature	June-August	4.1 $kwh/m^2/day$
Cassia Creek	Sediment	March-May	2,160 kg/day
Cassia Creek	Bacteria	June-August	576 col/100 ml
Cassia Creek	Nutrients	March-May	4.32 kg/day
Fall Creek	Bacteria	June-August	576 col/100 ml
Fall Creek	Nutrients	June-September	0.26 kg/day
Lake Fork Creek	Nutrients	June-September	0.17 kg/day
Sublett creek Upper	Nutrients	June-September	0.48 kg/day

[a] col/100ml = colonies of bacteria per 100 milliliters of water, $kwh/m^2/day$ = kilowatt hours per square meter per day, kg/day = kilograms per day.

5.3 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," (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 to larger units. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads. In the Raft River Subbasin, data available to distinguish between nonpoint sources and background is very limited. In most cases, the anthropogenic stresses are applicable from the headwaters of a stream to its mouth. In these cases, it is assumed that the background levels of the various parameters are similar to other streams in south central Idaho. As such, background will be estimated for some streams until a better estimation or scientific evaluation can be made for each stream's background load (Table 40).

There are no point sources located within the Raft River Subbasin which discharge to any receiving water body regulated under the National pollution discharge elimination system (NPDES) permit process. However, there are several CAFOs that have NPDES permits.

These facilities are allowed zero discharges and therefore would have a 0 kg per day WLA. It is uncertain at this time if there are any land application sites in the subbasin. These permitted facilities would also be allowed 0 kg per day discharge to the surface waters under their governing permits. Consequently, CAFOs and land application sites will not be addressed in the wasteload allocations (WLA).

Fall Creek provides the clearest methods for estimating bacteria loads. Natural background was estimated from average bacteria counts collected during the noncritical period (April through June and October and November, December through March were not sampled). The nonpoint source load was estimated from the difference in the previous number and average bacteria counts collected during the critical period (July through August). Raft River and Cassia Creek are more complex in that several sampling locations exist, and some out of Idaho. Natural background was estimated from the noncritical period average at the upstream sampling location. The nonpoint source estimate was made from the difference between the "background" average and the data used to calculate the geometric mean standard violation. It should be noted that in other streams in south central Idaho, natural background counts of bacteria are near zero. Therefore, the additional background counts used in these TMDLs should be considered part of the implicit MOS.

In the upper segment of Raft River and Cassia Creek the primary source of sediment is from bank erosion; existing sediment loads were determined using the bank erosion inventory process. This method provides an estimation of erosion rates within the sampling reaches. These erosion rates were then used to calculate the current instream delivery of sediment within the system. In other TMDLs, the background load was assumed to be similar to that from streams or reaches with slight to moderate bank erosion rates and 70 percent stable banks.

In those streams determined to need nutrient TMDLs, natural background was assumed to be similar to that of the major drainages nearby. These drainages contain significant natural phosphorus deposits as well as some anthropogenic stresses. The background concentration has been determined to be very low (0.02 mg/L). Nutrient background determinations will be discussed in greater depth in following sections. The nonpoint source load was assumed to be the difference between the existing load and natural background. The existing load was calculated from the critical flow and the average annual concentration of TP in the different streams.

Existing temperature loads were estimated from the solar pathfinder model run with current vegetation cover, or solar view, to determine current kilowatt hours per square meter per day (Table 41). Natural background was considered the system potential load (Table 42) derived from the solar pathfinder model run with system potential cover.

Table 40. Background and nonpoint source loads in the Raft River Subbasin.

Stream Name	Pollutant	Natural Background[a]	Existing Nonpoint Source Load[a]	Existing Wasteload[a]
Raft River	Bacteria	69 col/100 ml	967 col/100 ml	0 col/100 ml
Raft River	Temperature	4.1 kwh/m^2/day	6.9 kwh/m^2/day	0 kwh/m^2/day
Raft River	Sediment	951 Mg/year	5,626 Mg/year	0 Mg/year
Cassia Creek	Sediment	437 Mg/year	2,763 Mg/year	0 Mg/year
Cassia Creek	Nutrients	0.86 kg/day	8.42 kg/day	0 kg/day
Cassia Creek	Bacteria	41 col/100 ml	937 col/100 ml	0 col/100 ml
Fall Creek	Nutrients	0.05 kg/day	0.29 kg/day	0 kg/day
Fall Creek	Bacteria	84 col/100 ml	1,114 col/100 ml	0 col/100 ml
Lake Fork Creek	Nutrients	0.07 kg/day	0.27 kg/day	0 kg/day
Sublett Creek Upper	Nutrients	0.19 kg/day	0.39 kg/day	0 kg/day

[a] col/100ml = colonies of bacteria per 100 milliliters of water, kwh/m^2/day = kilowatt hours per square meter per day, kg/day = kilograms per day., Mg/year = metric tons per year.

Table 41. Stream potential and existing solar view.

Month	Potential Solar View[a]	Raft River Existing Solar View[a]
January	15	93
February	29	93
March	46	97
April	61	99
May	58	99
June	61	99
July	59	99
August	54	98
September	45	98
October	33	94
November	18	94
December	15	93

[a] Units = percent sun as measured by a solar pathfinder.

Table 42. Potential and existing monthly solar load.

Month	Solar Load Capacity	Raft River Existing Solar Load
January	0.3	1.5
February	0.7	2.4
March	1.7	3.5
April	3.2	5.1
May	3.7	6.3
June	4.3	7.0
July	4.4	7.4
August	3.5	6.3
September	2.3	4.9
October	1.1	3.2
November	0.3	1.8
December	0.2	1.3

[a] Units = kilowatt hours per square meter per day

5.4 Load Allocation

The total allocations must include a MOS to take into account seasonal variability and uncertainty. Uncertainty arises in selection of water quality targets, LC, and estimates of existing loads, and may be attributed to incomplete knowledge or understanding of the system, such as uncertainties regarding assimilation, sketchy data, or variability in data. The MOS is effectively a reduction in LC that "comes off the top" (i.e., before any allocation to sources). Second in line is the background load, a further reduction in LC available for allocation. It is also prudent to allow for growth by reserving a portion of the remaining available load for future sources.

Apportion LC among existing and future pollutant sources. Allocations may take into account equitable cost, cost effectiveness, and credit for prior efforts, but all within the ceiling of remaining available load. These allocations may take the form of percent reductions rather than actual loads. Each point source must receive an allocation. Nonpoint sources may be allocated by subwatershed, land use, responsibility for actions, or a combination. It is not necessary to allocate a reduction in load for all nonpoint sources so long as water quality targets can be met with the reductions that are specified.

Margin of Safety

In addition to estimating a LC a given water body can carry, the CWA includes statutory requirements for a MOS in a TMDL. The MOS is intended to account for uncertainties in available data or in the actual effect controls will have on load reductions and the receiving water body's water quality. The MOS may be implicit, such as conservative assumptions used in various calculations, specifically those of natural background, LC, WLAs, and LAs. Otherwise, a MOS must be clearly defined. For the Raft River Subbasin TMDLs, an explicit MOS will be set at 10 percent for all pollutant/water body combinations. In addition, any conservative approaches used in the various calculations required by a TMDL will be included as an implicit component of the MOS. The implicit MOS; however, will not be clarified further. Rather, it will be assumed that conservative approaches taken throughout the document will have been sufficiently identified in appropriate sections.

Seasonal Variation

Total maximum daily loads must be established with consideration of seasonal variation. In the Raft River Subbasin there are seasonal influences on nearly every pollutant addressed. The summer growing season is when concentrations of bacteria, sediment, and nutrients are the highest. This is also when water temperatures are elevated. The increase in temperature is due to a combination of agricultural return flow and warmer air temperatures. Seasonal variation as it relates to development of these TMDLs is addressed simply by ensuring that 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 LAs.

Critical Period

The critical period for each water body is based on the time when beneficial uses must be protected and when pollutant loads are the highest. Each respective TMDL was developed such that the water quality standards will be achieved year around, yet the critical period defines when loading reductions must occur. Table 43 shows the critical period for each water body.

Background

Several recent Idaho TMDLs have discussed background levels for the various constituents. Much of that information is applicable to the Raft River Subbasin as well. Therefore the information was used in whole or in part *from The Big Wood River Watershed Management Plan* (Buhidar 2001)TMDL, the *Mid Snake Succor Creek TMDL* (Horsburgh 2003*), Snake River Hells Canyon TMDL* (Idaho DEQ and Oregon DEQ 2003) or *The Pahsimeroir River Subbasin Assessment and Total Maximum Daily Load* (Shumar and Reaney 2001) for the Raft River TMDLs.

Sediment

Background sediment production from stream banks equates to the load at 70 percent stream bank stability as described in Overton et al. (1995), where stable banks are expressed as a percentage of the total estimated bank length. Natural condition stream bank stability potential is generally at 80 percent or greater for A, B, and C channel types in plutonic, volcanic, metamorphic, and sedimentary geology types. Table 44 shows the sediment delivery loads for Cassia Creek based upon current and proposed bank stability ratings.

Nutrients

The following discussion comes from the *Snake River Hells Canyon TMDL* (Idaho DEQ and Oregon DEQ 2003) (SR-HC TMDL). The SR-HC TMDL assessed natural phosphorus conditions in the mainstem Snake River by looking at concentrations in the Blackfoot and Portneuf watersheds where there are high naturally occurring concentrations of phosphorus. Natural sources of nutrients include erosion of phosphorus-containing rock and soils through wind, precipitation, temperature extremes and other weathering events.

Natural deposits of phosphorus (Hovland and Moore, 1987) have been identified in the Snake River drainage near Pocatello, Idaho (river mile [RM] 731.2). Geological deposits in the Blackfoot River watershed (inflow at RM 750.6) contain phosphorus in sufficient concentrations that they have been mined. The Snake River flows through this area some distance upstream of the SR-HC TMDL reach.

In an effort to assess the potential magnitude of natural phosphorus concentrations in the mainstem Snake River due to these geological deposits, TP concentrations occurring in the mainstem near the Blackfoot and Portneuf River inflows (RMs 750.6 and 731.2, respectively) were evaluated. Data were available for the Snake River near Blackfoot, Idaho (USGS gage No. 13069500, RM 750.1) and for the Blackfoot and Portneuf Rivers (USGS 2001). The mainstem Snake River and these tributary river systems, where they flow through the natural mineral deposits represent a worst-case scenario for evaluation of natural phosphorus loading and were identified as potential sources of naturally-occurring phosphorus to the SR-HC reach. The USGS gauged flow data and water quality data from the 1970s to the late 1990s is available for the Blackfoot and Portneuf Rivers (USGS gage No. 13068500, and No.13075500, respectively). Because both the mainstem and tributary watersheds have been settled for some time, and land and water management has occurred extensively, the data compiled represent both natural and anthropogenic loading.

Total phosphorus concentrations in the Snake River mainstem, measured near Blackfoot, Idaho (RM 750.1), from 1990 to 1998 averaged 0.035 mg/L (range ≤ 0.01 to 0.11 mg/L, median = 0.03 mg/L, mode = 0.02 mg/L) (USGS 2001). Nearly 40 percent (23 samples) of the total data set showed TP concentrations less than or equal to 0.02 mg/L. The data represent year-round sampling. Winter sampling was slightly less frequent (approximately 19 percent of the total) than spring, summer, or fall.

Natural phosphorus concentrations were not assessed as part of the Blackfoot River TMDL (DEQ 2001). Total phosphorus concentrations in the Blackfoot River, measured near the mouth from 1990 to 1999, averaged 0.069 mg/L (range ≤ 0.01 to 0.43 mg/L, median = 0.04 mg/L, mode = 0.03 mg/L) (USGS 2001). Nearly 23 percent (12 samples) of the total data set showed TP concentrations less than or equal to 0.02 mg/L. The data represent year-round sampling. Winter sampling was less frequent (approximately 13 percent of the total) than spring, summer or fall.

Natural phosphorus concentrations were not assessed for the Portneuf River TMDL (DEQ 1999). Total phosphorus concentrations in the Portneuf River, measured near the mouth from 1990 to 1998, averaged 0.085 mg/L (range ≤ 0.01 to 0.28 mg/L, median = 0.069 mg/L, mode = 0.03 mg/L) (USGS 2001). Nearly 21 percent (6 samples) of the total data set showed TP concentrations less than or equal to 0.02 mg/L. The data represent year-round sampling. Winter sampling represented approximately 22 percent of the total.

The fact that very low total phosphorus concentrations were observed routinely (more than 20 percent of the time) in the mainstem Snake River, the Blackfoot River, and the Portneuf River, all watersheds with a high level of use and management, shows that the natural loading levels are likely below detection limit concentrations. The additional fact that these low concentrations were observed in watersheds in much closer proximity to the rich geological phosphorus deposits than those in the Raft River Subbasin indicates that these deposits likely do not represent a significant source of high, natural loading to the Raft River TMDL reaches, located in close proximity to the watersheds identified.

Given the above discussion, the natural background concentration for TP in the mainstem Snake River has been estimated as at or below 0.02 mg/L for both the Mid Snake River/Succor Creek and SR-HC TMDL reaches. This value is based on the available data set. Data from the Snake River upstream of RM 409 were included in this data set to address the concern of enrichment of surface waters by the phosphoric deposits located in central and eastern Idaho (Hovland and Moore 1987). Due to the fact that there are substantial anthropogenic influences in Snake River Basin, the lower 15th percentile value for total phosphorus concentration was selected as a conservative estimate of the natural phosphorus concentration. In this manner, natural concentration levels for the mainstem Snake River were calculated conservatively. This initial estimate will be reviewed as additional data become available and revisions will be made as appropriate.

The estimated natural background loading concentration for the mainstem Snake River (0.02 mg/L) is most likely an overestimation of the natural loading but represents a conservative estimate for the purposes of load calculation. In addition, this concentration correlates well with other studies that have been completed and closely approximates the TP concentration identified for a reference system (relatively unimpacted) by the EPA (USEPA 2000; Dunne and Leopold 1978). Because phosphorus concentrations had dropped to below the detection limit in the Blackfoot watershed after implementation of BMPs, background was assessed at 0.02 mg/L based on the lowest 15th percentile value for phosphorus. This choice of percentile addressed bias introduced by using a lower percentile that contained values below the detection limit and a lack of data located directly below the natural source of phosphorus.

Bacteria

Background bacteria colonies enter the stream from many sources not controllable through the TMDL process. Generally, these sources are from the wildlife that use the stream. In some cases, waterfowl have been shown to be a significant contributor of *E. coli* (Campbell 2001). Other studies have indicated that skunks, ground squirrels, and other small mammals may be significant contributors. No work has been done in the Raft River Subbasin to partition these sources from the overall counts. This would entail genetic differentiation of the *E. coli* found within each watershed. Rather than a detailed genetic study of the *E. coli*, DEQ opted to make some simple assumptions about the sources. The first of these is that the contributions from wildlife sources of *E. coli* are similar throughout the year. The second is that anthropogenic sources (recreation and grazing) are more heavily concentrated during the summer. If these two assumptions are met, then the uncontrollable portion, that from the wildlife sources, could be identified as the average counts for the period when anthropogenic sources are minimized. This count would vary from watershed to watershed depending on the utilization of the watershed by the local wildlife population.

Temperature

Background for temperature is considered to be the amount of heat in the water when the maximum riparian potential is met. Thus, the background temperature is the same as the LC.

Reserve

An allowance in the TMDL for a portion of the LC to be set aside for future growth is permissible and encouraged. Careful documentation of the decision making process must accompany the TMDL. This allowance for future growth must be based on existing or readily available data at the time of the TMDL development if it is to be applicable to the assumptions and calculations used to develop the TMDL loads. In the Raft River Subbasin, little discussion with the local stakeholders has occurred in regards to a reserve load. In fact, the Lake Walcott WAG has chosen to forgo the use of a reserve in the past. Further discussions with the Raft River stakeholders are required. If it is deemed feasible, a reserve may be developed in a fashion similar to the reserve the Wood River WAG used (the reserve will be developed during the implementation of the TMDL). Nevertheless, it should be noted that developing a reserve post hoc will result in more stringent load reductions than presented in the various TMDLs.

Remaining Available Load

Table 43 is a tabular summarization of the SBA and TMDL processes. The table also meets the legal definition of a TMDL such that:

$$TMDL = LC = NB + MOS + LA + WLA$$

Table 43. Raft River Subbasin TMDLs.

Creek	Pollutants	Critical Period	Critical Flow (m^3/s)[a]	Load Capacity	Background	Total Load	Margin of Safety[b]	Nonpoint Source Load Allocation	Load Reduction	Percent Reduction	Units[c]
Raft River	Bacteria	Jun-Aug	0.46	576	69	967	58	449	518	54	col/100 ml
Raft River	Temperature	Jun-Aug	0.46	4.1	4.1	6.9	0.4	3.7	3.2	46	$kwh/m^2/day$
Raft River	Sediment	Mar-May	0.46	951	951	5,626	Imp	951	4,675	83	Mg/year
Cassia Creek	Sediment	Mar-May	0.5	437	437	2,763	Imp	437	2,326	84	Mg/year
Cassia Creek	Nutrients	Mar-May	0.5	4.32	0.86	8.42	0.43	3.02	5.40	64	kg/day
Cassia Creek	Bacteria	Mar-May	0.5	576	41	937	58	477	460	49	col/100 ml
Fall Creek	Nutrients	May-Oct	0.03	0.13	0.05	0.29	0.01	0.06	0.23	78	kg/day
Fall Creek	Bacteria	May-Oct	0.03	576	84	1114	58	434	680	61	col/100 ml
Lake Fork Creek	Nutrients	May-Oct	0.04	0.17	0.07	0.27	0.02	0.09	0.18	68	kg/day
Sublett Creek Upper	Nutrients	May-Oct	0.11	0.48	0.19	0.39	0.05	0.24	0.15	39	kg/day

[a] m^3/s = cubic meters per second. [b] imp = implicit. [C] kg/day = kilograms per day, col/100 ml = colonies of bacteria per 100 milliliters, $kwh/m^2/day$ = kilowatt hours per square meter per day, Mg/year = metric tons per year.

There are no point sources within the watersheds. Therefore, no WLAs were made. Nonpoint sources were allocated by subwatershed. It is incumbent upon the land management agencies and private individuals to develop the appropriate BMPs to meet the nonpoint source LAs during the implementation plan development. A finer allocation based upon land ownership, land use, or another mechanism is not needed so long as water quality targets can be met by the aggregate reductions of those sources that are prescribed a reduction in load through the implementation plan. Reach by reach sediment allocations based upon stream bank erosion inventories are presented in Tables 44 and 45 for Raft River and Cassia Creek.

Table 44. Raft River Stream Bank Erosion Estimates.

Reach	Existing		Proposed			
	Erosion Rate (Mg/mi/y)[a]	Total Erosion (Mg/y)[b]	Erosion Rate (Mg/mi/y)[a]	Total Erosion (Mg/y)[b]	Erosion Rate Percent Reduction	Percent of Existing Total Load
Utah/Idaho Border to The Narrows	197.6	2171.2	32.6	357.8	84	38.59
The Narrows	8.3	146.6	19.5	344.1	0	2.61
The Narrows to Malta	385.3	5,479.3	42.7	606.9	89	97.39
	Total Erosion (Mg/y)[b]	5,625.9		951.0	83.10	100.00

[a] Metric tons per mile per year
[b] Metric tons per year

Table 45. Cassia Creek Stream Bank Erosion Estimates.

Reach	Existing		Proposed			
	Erosion Rate (Mg/mi/y)[a]	Total Erosion (Mg/y)[b]	Erosion Rate (Mg/mi/y)[a]	Total Erosion (Mg/y)[b]	Erosion Rate Percent Reduction	Percent of Existing Total Load
Public Lands Reference	2.5	7.3	7.9	23.6	0	0.26
BLM to Cross Creek	3.4	7.4	7.3	15.9	0	0.27
Cross Creek to Clyde Creek	0.5	1.1	6.3	15.3	0	0.04
Clyde Creek to Jones Hollow	0.9	2.3	6.3	16.0	0	0.08
Jones Hollow to Conner Creek	11.8	33.7	10.7	30.6	0	1.22
Conner Creek to Park Creek	5.5	43.1	14.9	116.2	0	1.56
Park Creek to	12.7	27.1	20.7	44.1	0	0.98

Reach	Existing		Proposed			
	Erosion Rate (Mg/mi/y)[a]	Total Erosion (Mg/y)[b]	Erosion Rate (Mg/mi/y)[a]	Total Erosion (Mg/y)[b]	Erosion Rate Percent Reduction	Percent of Existing Total Load
Hudspeth Cutoff						
Hudspeth Cutoff to Malta	63.2	186.0	39.3	39.3	38	6.73
Malta to Raft River	442.4	2,455.2	24.5	136.0	94	88.85
	Total Erosion (Mg/y)[b]	2,763.2		437.0	84.19	100.00

[a] Metric tons per mile per year
[b] Metric tons per year

5.5 Implementation Strategies

The purpose of this implementation strategy is to outline the pathway 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 the TMDL) and a schedule of those actions and will specify monitoring needed to document actions and progress toward meeting state water quality standards. These details are typically set forth in the plan that follows approval of the TMDL. In the meantime, a cursory implementation strategy is developed to identify responsible parties, set a time line, and establish a monitoring strategy for determining progress toward meeting the TMDL goals outlined in this document.

Overview

The objective of the Raft River TMDLs is to allocate allowable loads among different pollutant sources so that the appropriate control actions can be taken and water quality standards achieved. The total pollutant load on these water bodies is derived from nonpoint and background sources. The creators of the Raft River Subbasin TMDLs have attempted to consider the effect of all activities and processes that cause or contribute to the water quality limited conditions of not just the water bodies listed on the 1998 §303(d) list, but the effects of these activities and processes on all water bodies within the §303(d) listed watersheds. Control measures to implement this TMDL do not contain NPDES authorities, but are based on the reasonable assurance that state and local authorities will take actions to reduce nonpoint source pollution. The Raft River TMDLs have LAs calculated with margins of safety to meet water quality standards. The allocations; however, are based on estimates that have used available data and information. Therefore, monitoring for the collection of new data is necessary and required. The reasonable assurance that the Raft River Subbasin TMDLs will meet the water quality standards is based on two components: 1) nonpoint source implementation of BMPs based on land management agencies' assurance that reductions will occur; and 2) trend monitoring that will be used to document relative changes in wtaer quality over a 25-year period.

Responsible Parties

Development of the final implementation plan for the Raft River Subbasin TMDLs will proceed under the existing practice established for the state of Idaho. The plan will be cooperatively developed by DEQ, the Raft River committee of the Lake Walcott WAG, the affected private landowners, and other "designated agencies" with input via the established public process. Of the four entities, the WAG committee will act as the integral part 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 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 land management agencies are:

- Idaho Department of Lands (IDL): timber harvest, oil and gas exploration and development, mining.
- Idaho Soil Conservation Commission (ISCC): grazing and agriculture.
- Idaho Department of Transportation (IDT): public roads.
- Idaho Department of Agriculture (IDA): aquaculture, animal feeding operations (AFOs), CAFOs.
- 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, USFS, 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 Raft River Subbasin have a responsibility for implementing the TMDLs. DEQ and the designated agencies in Idaho have primary responsibility for overseeing implementation in cooperation with landowners and managers. The general responsibilities of the designated agencies 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, IDA, and NRCS, 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.

- IDT 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 members, 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 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.

Feedback Loop and Adaptive Management

The feedback loop is a component of the Raft River Subbasin TMDL strategy that provides for accountability of plan goals for various pollutants. As part of the TMDL process, the Raft River TMDLs will use adaptive management as a style and process whereby management of the watershed is initiated by the state, federal agencies, and the water user industries. then, an evaluation process will ascertain the direction in which the reductions are progressing, and, based on monitoring information collected from various agencies, organizations, and water users, the goals, targets, and BMPs will be refined based on short-term and long-term objectives for ecosystem management of the Raft River Subbasin. Past management experiences may be used to evaluate both success and failure and to explore new management options where necessary. By learning from both successes and failures, the Raft River TMDL will be iterative to allow implementation of those techniques which may be most useful and helpful, as well as gain insights into which practices best promote recovery for restoration of beneficial uses and state water quality standards (Williams et al. 1997).

For the Raft River Subbasin the main goals are to reach the preliminary in-stream water quality target of 576 col/100 ml *E. coli* for all tributaries and to maintain the low TSS annual mean value already existing in most of the other systems. An additional goal is to reach the preliminary in-stream water quality target of 0.05 mg/L TP for the stream systems feeding Sublett Reservoir. These preliminary targets are set up in this way to allow for modifications in the targets over the next 10-15 years as necessary to attain beneficial uses and state water quality standards. The final goal is to develop and implement BMPs along Cassia Creek and Raft River that enable perennial flow to be maintained in these two systems. At that time the nutrient, temperature, bacteria, and sediment TMDLs will become realistic management goals.

In order for the feedback loop to be successful in the Raft River TMDLs, a concrete mechanism has to be designed with short-term and long-term goals for DEQ, other agencies, and the Raft River citizen groups. These entities must regularly review implementation progress and monitoring results and evaluate plan effectiveness. Sufficient flexibility in management plans must be incorporated to allow for corrections in management strategies that may not be effective in achieving beneficial uses or meeting state water quality standards. Nonpoint source industries will follow the feedback loop by: 1) identifying critical water quality parameter(s), 2) developing site-specific BMPs, 3) applying and monitoring BMPs, and 4) evaluating effectiveness of BMPs by comparing established water quality standards and modifying the BMPs where needed to achieve water quality goals.

DEQ will review all monitoring results and will provide an opportunity for the Raft River residents and EPA to review and comment. Each industry should provide summary review reports to DEQ on its monitoring efforts, strategies, and on-going reduction mechanisms. Each industry should provide its own data in its reports. Based on these reports and other data, the Raft River Subbasin TMDL will be revised accordingly as an iterative plan. All industry plans will also be iterative and further developed through adaptive management as new knowledge and technology is discovered for pollution reduction efforts.

Additionally, because of the diverse nature of the partnerships and commitments within the Raft River Subbasin citizen groups from various agencies, organizations, and water users, both restoration and education efforts will be guided by DEQ via the SCC. The citizen groups will take advantage of technical knowledge, experience, existing management plans, and resources in determining which types of activities are appropriate for continued implementation of the Raft River Subbasin TMDL. The Raft River committee of the Lake Walcott WAG will continue to meet as needed. If needed, a technical advisory committee may be developed through the SCC and DEQ. As a result, the citizen groups would have available to them the technical expertise of biologists, hydrologists, range conservationists, foresters, and other water quality and watershed specialists. Monitoring done by the various agencies, organizations, and water users will be evaluated by DEQ, the technical advisory committee (if formed), and citizen groups as a feedback mechanism. This will provide to the citizens of the Raft River Subbasin an evaluation that is scientifically based, an understanding of local constraints. Scientific knowledge will be adapted to the task of watershed restoration by the residents of the subbasin almost immediately.

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, and other actions taken to improve or protect water quality. The mechanism for tracking specific implementation efforts will be 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 Raft River Subbasin TMDLs, 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 loadings, 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 used, 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

Reports on progress toward TMDL implementation will be prepared to provide the basis for assessing and evaluating 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.

Implementation 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 timeline should be as specific as possible and should include a schedule for BMP implementation and/or evaluation, monitoring schedules, reporting dates, and milestones for evaluating progress. An initial general timeline is presented in Table 45. There may be disparity in the timelines for different subwatersheds. This is acceptable as long as there is reasonable assurance that milestones will be achieved. 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.

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 before effective techniques are developed.

Table 46. Implementation strategy goals for nonpoint sources.

Industry	Year 1.5	Year 3	Year 5	Year 15	Year 25
Agriculture	Develop implementation plan for private lands	Begin BMP[a] implementation	Document BMP implementation progress for DEQ database	Reevaluate targets and reductions	Meet reviewed TMDL targets; beneficial uses fully supported
Grazing	Federal agencies review allotment management plans	Begin allotment management adjustments as necessary	Document BMP implementation progress for DEQ database	Reevaluate targets and reductions	Meet reviewed TMDL targets; beneficial uses fully supported
DEQ	Maintain database; review NPS[b] efficacy data; seek funding	Collect data to determine water quality trend	Collect data to determine water quality trend, BMP effectiveness, and beneficial use support	Reevaluate targets and reductions, assess beneficial uses	Collect data to determine water quality trend, BMP effectiveness, and beneficial use support

[a] BMP = Best management practices.
[b] NPS = nonpoint source

5.6 Conclusions

The Raft River SBA and TMDL analysis has been developed to comply with Idaho's TMDL schedule. The SBA describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Raft River Subbasin located in south central Idaho. The first part of this document, the SBA, is an important first step in leading to the actual development of TMDLs or pollution budgets for the water quality limited streams of the subbasin. The starting point for this assessment was Idaho's current 1998 §303(d) list of water quality limited water bodies. Six segments in the Raft River Subbasin were on this list. However, there were 24 water body/pollutant combinations. An additional water body, Lake Fork Creek, was assessed due to reservoir monitoring needs, bringing the total number of potential TMDLs to 25. The SBA portion of this document examined the current status of all of these waters, and defined the extent of impairment and causes of water quality limitation throughout the subbasin. Sediment, nutrients, temperature, and bacteria are the listed pollutants in the subbasin. These pollutants were listed for the listed water bodies within the subbasin on the 1996 §303(d) list. Other listed pollutants and stressors include habitat alteration, flow alteration, ammonia, salinity, and unknown. By far the most influential stressor, as noted by the SBA, was flow alteration. In general, the impacts to the beneficial uses were determined by assessing the biological communities and the limited water chemistry data available. When these two data sets were in agreement with one another, appropriate actions, such as completing a TMDL or delisting the stream, were undertaken.

To this end, it was determined that eight different TMDLs should be completed. Of the original listed water bodies DEQ proposes to delist none of the creeks. It was also determined that Lake Fork Creek, while not impaired by excess nutrients itself, was impairing Sublett Reservoir with excess nutrients. All other parameters studied in Lake Fork Creek were of exceptional quality during the assessment phase.

Often times the beneficial uses of all the creeks were impacted by flow alteration, which obscured the impacts, if any, of the other pollutants. Flow and habitat alteration issues were not discussed at great length in the assessment portion due to current DEQ policy. It is DEQ policy that flow and habitat alterations are pollution, but not pollutants for which TMDLs can be written. These forms of pollution will remain on the §303(d) list; however, TMDLs for these two parameters will not be completed on segments listed with altered flow or habitat as a pollutant at this time.

The next phase was the development of the loading analysis or pollution budgets for the eight different water body/pollutant combinations. The loading analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards. In addition, the pollution budgets must contain background levels, MOS, and seasonallity components.

The LC for each water body/pollutant combination was developed using the information gathered during the assessment phase. The most important of this information was the hydrography of a stream and time of the year in which the various beneficial uses were likely to be impaired by specific pollutants. Only three streams in the subbasin have USGS gauge information available. For the remaining streams a relationship with this gauged data was developed to predict the hydrology. In all but one case the relationship was significant and included much of the variability of the data.

Another component of LC is the targets for the different pollutants. In general, DEQ adopted targets developed in other TMDLs. For example the Raft River and Cassia Creek sediment targets include percent bank stability which was presented in TMDLs from the Idaho Falls Regional Office, and suspended sediment targets of 50 mg/L TSS as presented in TMDLs developed in the TFRO. In addition to these sediment targets, DEQ adopted nutrient targets from guidelines and recommendations from EPA. These targets are 0.100 mg/L TP in free flowing streams and 0.050 mg/L for streams entering into a lake or reservoir.

Seasonality plays a strong role in the Raft River Subbasin. In most cases, the beneficial uses are impacted during the summer months. The pollutants typically causing the impairments are sediment, nutrients, and bacteria. The change in pollutants has a strong correlation to grazing activities in the different watersheds, although no statistical interpretation of this correlation was made. In general, the rise in pollutants also coincided with summer base flow conditions. Therefore, the LC and other subsequent calculations were made using summer base flow or other appropriate design flows as indicated in the state water quality standards, such as greater than 1 cfs for cold water aquatic life.

A MOS is required in the TMDL regulations of the CWA to account for uncertainty in the TMDL and how that budget restores beneficial uses. In the Raft River Subbasin TMDLs the MOS was two-fold. The first of these was an explicit margin of 10 percent. It is often difficult to pin down the MOS in other TMDLs. The explicit margin allows DEQ greater freedom in other aspects of the TMDL process in that the implicit MOS can be assumed rather than arduously explained at every turn. That being said, the Raft River Subbasin TMDLs include an implicit MOS as well. The best example of this may lie in the bacteria TMDLs determination of background. The background levels used in these TMDLs may be slightly higher than actual background levels, as determined from other watersheds. These elevated levels reduce the available load for WLAs and Las, thereby providing an implicit margin for each watershed. In future studies the actual background level may be determined which in turn would reduce the implicit MOS. Therefore the explicit margin is a required element of these TMDLs.

As we move forward with implementation of the Raft River Subbasin TMDLs local stakeholders and concerned publics should see the value of adaptive management. As our understanding of the water quality issues grows so should our ability to change the current TMDLs. This is especiallyimportant as the current TMDLs were based upon a limited amount of data collected in a short amount of time.

Future iterations of the *Raft River Subbasin Assessment and Total Maximum Daily Loads* will include newly listed §303(d) listed water bodies. These will be added as addendum.

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Glossary

305(b)	Refers to section 305 subsection “b” of the Clean Water Act. 305(b) generally describes a report of each state’s water quality, and is the principle means by which the U.S. Environmental Protection Agency, Congress, and the public evaluate whether U.S. waters meet water quality standards, the progress made in maintaining and restoring water quality, and the extent of the remaining problems.
§303(d)	Refers to section 303 subsection “d” of the Clean Water Act. Section 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval.
Acre-Foot	A volume of water that would cover an acre to a depth of one foot. Often used to quantify reservoir storage and the annual discharge of large rivers.
Adsorption	The adhesion of one substance to the surface of another. Clays, for example, can adsorb phosphorus and organic molecules
Aeration	A process by which water becomes charged with air directly from the atmosphere. Dissolved gases, such as oxygen, are then available for reactions in water.
Aerobic	Describes life, processes, or conditions that require the presence of oxygen.
Assessment Database (ADB)	The ADB is a relational database application designed for the U.S. Environmental Protection Agency for tracking water quality assessment data, such as use attainment and causes and sources of impairment. States need to track this information and many other types of assessment data for thousands of water bodies, and integrate it into meaningful reports. The ADB is designed to make this process accurate, straightforward, and user-friendly for participating states, territories, tribes, and basin commissions.
Adfluvial	Describes fish whose life history involves seasonal migration from lakes to streams for spawning.
Adjunct	In the context of water quality, adjunct refers to areas directly adjacent to focal or refuge habitats that have been degraded by human or natural disturbances and do not presently support high diversity or abundance of native species.

Alevin	A newly hatched, incompletely developed fish (usually a salmonid) still in nest or inactive on the bottom of a water body, living off stored yolk.
Algae	Non-vascular (without water-conducting tissue) aquatic plants that occur as single cells, colonies, or filaments.
Alluvium	Unconsolidated recent stream deposition.
Ambient	General conditions in the environment. In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations, or specific disturbances such as a wastewater outfall (Armantrout 1998, EPA 1996).
Anadromous	Fish, such as salmon and sea-run trout, that live part or the majority of their lives in the salt water but return to fresh water to spawn.
Anaerobic	Describes the processes that occur in the absence of molecular oxygen and describes the condition of water that is devoid of molecular oxygen.
Anoxia	The condition of oxygen absence or deficiency.
Anthropogenic	Relating to, or resulting from, the influence of human beings on nature.
Anti-Degradation	Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.56).
Aquatic	Occurring, growing, or living in water.
Aquifer	An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding of water to wells or springs.
Assemblage (aquatic)	An association of interacting populations of organisms in a given water body; for example, a fish assemblage, or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996).
Assimilative Capacity	The ability to process or dissipate pollutants without ill effect to beneficial uses.
Autotrophic	An organism is considered autotrophic if it uses carbon dioxide as its main source of carbon. This most commonly happens through photosynthesis.

Batholith	A large body of intrusive igneous rock that has more than 40 square miles of surface exposure and no known floor. A batholith usually consists of coarse-grained rocks such as granite.
Bed load	Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.
Beneficial Use	Any of the various uses of water, including, but not limited to, aquatic biota, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards.
Beneficial Use Reconnaissance Program (BURP)	A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address lakes, reservoirs, and wadeable streams and rivers
Benthic	Pertaining to or living on or in the bottom sediments of a water body
Benthic Organic Matter.	The organic matter on the bottom of a water body.
Benthos	Organisms living in and on the bottom sediments of lakes and streams. Originally, the term meant the lake bottom, but it is now applied almost uniformly to the animals associated with the lake and stream bottoms.
Best Management Practices (BMPs)	Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.
Best Professional Judgment	A conclusion and/or interpretation derived by a trained and/or technically competent individual by applying interpretation and synthesizing information.
Biochemical Oxygen Demand (BOD)	The amount of dissolved oxygen used by organisms during the decomposition (respiration) of organic matter, expressed as mass of oxygen per volume of water, over some specified period of time.
Biological Integrity	1) The condition of an aquatic community inhabiting unimpaired water bodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).
Biomass	The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often expressed as grams per square meter.
Biota	The animal and plant life of a given region.
Biotic	A term applied to the living components of an area.

Clean Water Act (CWA)	The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.
Coliform Bacteria	A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria).
Colluvium	Material transported to a site by gravity.
Community	A group of interacting organisms living together in a given place.
Conductivity	The ability of an aqueous solution to carry electric current, expressed in micro (µ) mhos/cm at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.
Cretaceous	The final period of the Mesozoic era (after the Jurassic and before the Tertiary period of the Cenozoic era), thought to have covered the span of time between 135 and 65 million years ago.
Criteria	In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. The U.S. Environmental Protection Agency develops criteria guidance; states establish criteria.
Cubic Feet per Second	A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.
Cultural Eutrophication	The process of eutrophication that has been accelerated by human-caused influences. Usually seen as an increase in nutrient loading (also see Eutrophication).
Culturally Induced Erosion	Erosion caused by increased runoff or wind action due to the work of humans in deforestation, cultivation of the land, overgrazing, and disturbance of natural drainages; the excess of erosion over the normal for an area (also see Erosion).
Debris Torrent	The sudden down slope movement of soil, rock, and vegetation on steep slopes, often caused by saturation from heavy rains.

Decomposition	The breakdown of organic molecules (e.g., sugar) to inorganic molecules (e.g., carbon dioxide and water) through biological and nonbiological processes.
Depth Fines	Percent by weight of particles of small size within a vertical core of volume of a streambed or lake bottom sediment. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 6.5 mm depending on the observer and methodology used. The depth sampled varies but is typically about one foot (30 cm).
Designated Uses	Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.
Discharge	The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).
Dissolved Oxygen (DO)	The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.
Disturbance	Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment.
E. coli	Short for *Escherichia Coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans. Their presence is often indicative of fecal contamination.
Ecology	The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature.
Ecological Indicator	A characteristic of an ecosystem that is related to, or derived from, a measure of a biotic or abiotic variable that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability. Ecological indicators are often used within the multimetric index framework.
Ecological Integrity	The condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes (EPA 1996).
Ecosystem	The interacting system of a biological community and its non-living (abiotic) environmental surroundings.
Effluent	A discharge of untreated, partially treated, or treated wastewater into a receiving water body.
Endangered Species	Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act.

Environment	The complete range of external conditions, physical and biological, that affect a particular organism or community.
Eocene	An epoch of the early Tertiary period, after the Paleocene and before the Oligocene.
Eolian	Windblown, referring to the process of erosion, transport, and deposition of material by the wind.
Ephemeral Stream	A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table. (American Geologic Institute 1962).
Erosion	The wearing away of areas of the earth's surface by water, wind, ice, and other forces.
Eutrophic	From Greek for "well nourished," this describes a highly productive body of water in which nutrients do not limit algal growth. It is typified by high algal densities and low clarity.
Eutrophication	1) Natural process of maturing (aging) in a body of water. 2) The natural and human-influenced process of enrichment with nutrients, especially nitrogen and phosphorus, leading to an increased production of organic matter.
Exceedance	A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.
Existing Beneficial Use or Existing Use	A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02).
Exotic Species	A species that is not native (indigenous) to a region.
Extrapolation	Estimation of unknown values by extending or projecting from known values.
Fauna	Animal life, especially the animals characteristic of a region, period, or special environment.
Fecal Coliform Bacteria	Bacteria found in the intestinal tracts of all warm-blooded animals or mammals. Their presence in water is an indicator of pollution and possible contamination by pathogens (also see Coliform Bacteria).
Fecal Streptococci	A species of spherical bacteria including pathogenic strains found in the intestines of warm-blooded animals.
Feedback Loop	In the context of watershed management planning, a feedback loop is a process that provides for tracking progress toward goals and revising actions according to that progress.
Fixed-Location Monitoring	Sampling or measuring environmental conditions continuously or repeatedly at the same location.

Flow	See Discharge.
Fluvial	In fisheries, this describes fish whose life history takes place entirely in streams but migrate to smaller streams for spawning.
Focal	Critical areas supporting a mosaic of high quality habitats that sustain a diverse or unusually productive complement of native species.
Fully Supporting	In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting beneficial uses as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).
Fully Supporting Cold Water	Reliable data indicate functioning, sustainable cold water biological assemblages (e.g., fish, macroinvertebrates, or algae), none of which have been modified significantly beyond the natural range of reference conditions (EPA 1997).
Fully Supporting but Threatened	An intermediate assessment category describing water bodies that fully support beneficial uses, but have a declining trend in water quality conditions, which if not addressed, will lead to a "not fully supporting" status.
Geographical Information Systems (GIS)	A georeferenced database.
Geometric Mean	A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.
Grab Sample	A single sample collected at a particular time and place. It may represent the composition of the water in that water column.
Gradient	The slope of the land, water, or streambed surface.
Ground Water	Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and usually emerges again as stream flow.
Growth Rate	A measure of how quickly something living will develop and grow, such as the amount of new plant or animal tissue produced per a given unit of time, or number of individuals added to a population.
Habitat	The living place of an organism or community.
Headwater	The origin or beginning of a stream.
Hydrologic Basin	The area of land drained by a river system, a reach of a river and its tributaries in that reach, a closed basin, or a group of streams forming a drainage area (also see Watershed).

Hydrologic Cycle	The cycling of water from the atmosphere to the earth (precipitation) and back to the atmosphere (evaporation and plant transpiration). Atmospheric moisture, clouds, rainfall, runoff, surface water, ground water, and water infiltrated in soils are all part of the hydrologic cycle.
Hydrologic Unit	One of a nested series of numbered and named watersheds arising from a national standardization of watershed delineation. The initial 1974 effort (USGS 1987) described four levels (region, subregion, accounting unit, cataloging unit) of watersheds throughout the United States. The fourth level is uniquely identified by an eight-digit code built of two-digit fields for each level in the classification. Originally termed a cataloging unit, fourth field hydrologic units have been more commonly called subbasins. Fifth and sixth field hydrologic units have since been delineated for much of the country and are known as watershed and subwatersheds, respectively.
Hydrologic Unit Code (HUC)	The number assigned to a hydrologic unit. Often used to refer to fourth field hydrologic units.
Hydrology	The science dealing with the properties, distribution, and circulation of water.
Impervious	Describes a surface, such as pavement, that water cannot penetrate.
Influent	A tributary stream.
Inorganic	Materials not derived from biological sources.
Instantaneous	A condition or measurement at a moment (instant) in time.
Intergravel Dissolved Oxygen	The concentration of dissolved oxygen within spawning gravel. Consideration for determining spawning gravel includes species, water depth, velocity, and substrate.
Intermittent Stream	1) A stream that flows only part of the year, such as when the ground water table is high or when the stream receives water from springs or from surface sources such as melting snow in mountainous areas. The stream ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. 2) A stream that has a period of zero flow for at least one week during most years.
Interstate Waters	Waters that flow across or form part of state or international boundaries, including boundaries with Indian nations.
Irrigation Return Flow	Surface (and subsurface) water that leaves a field following the application of irrigation water and eventually flows into streams.

Key Watershed	A watershed that has been designated in Idaho Governor Batt's *State of Idaho Bull Trout Conservation Plan* (1996) as critical to the long-term persistence of regionally important trout populations.
Knickpoint	Any interruption or break of slope.
Land Application	A process or activity involving application of wastewater, surface water, or semi-liquid material to the land surface for the purpose of treatment, pollutant removal, or ground water recharge.
Limiting Factor	A chemical or physical condition that determines the growth potential of an organism. This can result in a complete inhibition of growth, but typically results in less than maximum growth rates.
Limnology	The scientific study of fresh water, especially the history, geology, biology, physics, and chemistry of lakes.
Load Allocation (LA)	A portion of a water body's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).
Load(ing)	The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration.
Loading Capacity (LC)	A determination of how much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, and a margin of safety, it becomes a total maximum daily load.
Loam	Refers to a soil with a texture resulting from a relative balance of sand, silt, and clay. This balance imparts many desirable characteristics for agricultural use.
Loess	A uniform wind-blown deposit of silty material. Silty soils are among the most highly erodible.
Lotic	An aquatic system with flowing water such as a brook, stream, or river where the net flow of water is from the headwaters to the mouth.
Luxury Consumption	A phenomenon in which sufficient nutrients are available in either the sediments or the water column of a water body, such that aquatic plants take up and store an abundance in excess of the plants' current needs.
Macroinvertebrate	An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500µm mesh (U.S. #30) screen.

Macrophytes	Rooted and floating vascular aquatic plants, commonly referred to as water weeds. These plants usually flower and bear seeds. Some forms, such as duckweed and coontail (*Ceratophyllum sp.*), are free-floating forms not rooted in sediment.
Margin of Safety (MOS)	An implicit or explicit portion of a water body's loading capacity set aside to allow the uncertainly about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.
Mass Wasting	A general term for the down slope movement of soil and rock material under the direct influence of gravity.
Mean	Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.
Median	The middle number in a sequence of numbers. If there are an even number of numbers, the median is the average of the two middle numbers. For example, 4 is the median of 1, 2, 4, 14, 16; and 6 is the median of 1, 2, 5, 7, 9, 11.
Metric	1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement.
Milligrams per Liter (mg/L)	A unit of measure for concentration in water, essentially equivalent to parts per million (ppm).
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	A condition indistinguishable from that without human-caused disruptions.

Nitrogen	An element essential to plant growth, and thus is considered a nutrient.
Nodal	Areas that are separated from focal and adjunct habitats, but serve critical life history functions for individual native fish.
Nonpoint Source	A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.
Not Assessed (NA)	A concept and an assessment category describing 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 (EPA 1997).
Nuisance	Anything which is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state.
Nutrient	Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.
Nutrient Cycling	The flow of nutrients from one component of an ecosystem to another, as when macrophytes die and release nutrients that become available to algae (organic to inorganic phase and return).
Oligotrophic	The Greek term for “poorly nourished.” This describes a body of water in which productivity is low and nutrients are limiting to algal growth, as typified by low algal density and high clarity.
Organic Matter	Compounds manufactured by plants and animals that contain principally carbon.

Orthophosphate	A form of soluble inorganic phosphorus most readily used for algal growth.
Oxygen-Demanding Materials	Those materials, mainly organic matter, in a 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.
Pathogens	Disease-producing organisms (e.g., bacteria, viruses, parasites).
Perennial Stream	A stream that flows year-around in most years.
Periphyton	Attached microflora (algae and diatoms) growing on the bottom of a water body or on submerged substrates, including larger plants.
Pesticide	Substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.
pH	The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH= 1) to very alkaline (pH= 14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.
Phased TMDL	A total maximum daily load (TMDL) that identifies interim load allocations and details further monitoring to gauge the success of management actions in achieving load reduction goals and the effect of actual load reductions on the water quality of a water body. Under a phased TMDL, a refinement of load allocations, wasteload allocations, and the margin of safety is planned at the outset.
Phosphorus	An element essential to plant growth, often in limited supply, and thus considered a nutrient.
Physiochemical	In the context of bioassessment, the term is commonly used to mean the physical and chemical factors of the water column that relate to aquatic biota. Examples in bioassessment usage include saturation of dissolved gases, temperature, pH, conductivity, dissolved or suspended solids, forms of nitrogen, and phosphorus. This term is used interchangeable with the terms “physical/chemical” and “physicochemical.”

Plankton	Microscopic algae (phytoplankton) and animals (zooplankton) that float freely in open water of lakes and oceans.
Point Source	A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable "point" of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	A very broad concept that encompasses human-caused changes in the environment which alter the functioning of natural processes and produce undesirable environmental and health effects. This includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.
Population	A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.
Pretreatment	The reduction in the amount of pollutants, elimination of certain pollutants, or alteration of the nature of pollutant properties in wastewater prior to, or in lieu of, discharging or otherwise introducing such wastewater into a publicly owned wastewater treatment plant.
Primary Productivity	The rate at which algae and macrophytes fix carbon dioxide using light energy. Commonly measured as milligrams of carbon per square meter per hour.
Protocol	A series of formal steps for conducting a test or survey.
Qualitative	Descriptive of kind, type, or direction.
Quality Assurance (QA)	A program organized and designed to provide accurate and precise results. Included are the selection of proper technical methods, tests, or laboratory procedures; sample collection and preservation; the selection of limits; data evaluation; quality control; and personnel qualifications and training. The goal of QA is to assure the data provided are of the quality needed and claimed (Rand 1995, EPA 1996).
Quality Control (QC)	Routine application of specific actions required to provide information for the quality assurance program. Included are standardization, calibration, and replicate samples. QC is implemented at the field or bench level (Rand 1995, EPA 1996).
Quantitative	Descriptive of size, magnitude, or degree.
Reach	A stream section with fairly homogenous physical characteristics.

Reconnaissance	An exploratory or preliminary survey of an area.
Reference	A physical or chemical quantity whose value is known, and thus is used to calibrate or standardize instruments.
Reference Condition	1) A condition that fully supports applicable beneficial uses with little affect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).
Reference Site	A specific locality on a water body that is minimally impaired and is representative of reference conditions for similar water bodies.
Representative Sample	A portion of material or water that is as similar in content and consistency as possible to that in the larger body of material or water being sampled.
Resident	A term that describes fish that do not migrate.
Respiration	A process by which organic matter is oxidized by organisms, including plants, animals, and bacteria. The process converts organic matter to energy, carbon dioxide, water, and lesser constituents.
Riffle	A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.
Riparian	Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.
Riparian Habitat Conservation Area (RHCA)	A USFS description of land within the following number of feet up-slope of each of the banks of streams: - 300 feet from perennial fish-bearing streams - 150 feet from perennial non-fish-bearing streams - 100 feet from intermittent streams, wetlands, and ponds in priority watersheds.
River	A large, natural, or human-modified stream that flows in a defined course or channel, or a series of diverging and converging channels.
Runoff	The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.
Sediments	Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.
Settleable Solids	The volume of material that settles out of one liter of water in one hour.

Species	1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.
Spring	Ground water seeping out of the earth where the water table intersects the ground surface.
Stagnation	The absence of mixing in a water body.
Stenothermal	Unable to tolerate a wide temperature range.
Stratification	A Department of Environmental Quality classification method used to characterize comparable units (also called classes or strata).
Stream	A natural water course containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.
Stream Order	Hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher order streams result from the joining of two streams of the same order.
Storm Water Runoff	Rainfall that quickly runs off the land after a storm. In developed watersheds the water flows off roofs and pavement into storm drains that may feed quickly and directly into the stream. The water often carries pollutants picked up from these surfaces.
Stressors	Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.
Subbasin	A large watershed of several hundred thousand acres. This is the name commonly given to 4th field hydrologic units (also see Hydrologic Unit).
SBA (SBA)	A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.
Subwatershed	A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions. Also proposed for adoption as the formal name for 6th field hydrologic units.
Surface Fines	Sediments of small size deposited on the surface of a streambed or lake bottom. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 605 mm depending on the observer and methodology used. Results are typically expressed as a percentage of observation points with fine sediment.

Surface Runoff	Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow.
Surface Water	All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water.
Suspended Sediments	Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.
Taxon	Any formal taxonomic unit or category of organisms (e.g., species, genus, family, order). The plural of taxon is taxa (Armantrout 1998).
Tertiary	An interval of geologic time lasting from 66.4 to 1.6 million years ago. It constitutes the first of two periods of the Cenozoic Era, the second being the Quaternary. The Tertiary has five subdivisions, which from oldest to youngest are the Paleocene, Eocene, Oligocene, Miocene, and Pliocene epochs.
Thalweg	The center of a stream's current, where most of the water flows.
Threatened Species	Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.
Total Maximum Daily Load (TMDL)	A TMDL is a water body's loading capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. TMDL = Loading Capacity = Load Allocation + Wasteload Allocation + Margin of Safety. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.
Total Dissolved Solids	Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

Total Suspended Solids (TSS) The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Greenborg, Clescevi, and Eaton 1992) call for using a filter of 2.0 micron or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

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

Tributary A stream feeding into a larger stream or lake.

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

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

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

Vadose Zone The unsaturated region from the soil surface to the ground water table.

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

Water Body	A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.
Water Column	Water between the interface with the air at the surface and the interface with the sediment layer at the bottom. The idea derives from a vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water.
Water Pollution	Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state, which will or is likely to create a nuisance or to render such waters harmful, detrimental, or injurious to public health, safety, or welfare; to fish and wildlife; or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses.
Water Quality	A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.
Water Quality Criteria	Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.
Water Quality Limited	A label that describes water bodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a §303(d) list.
Water Quality Limited Segment (WQLS)	Any segment placed on a state's §303(d) list for failure to meet applicable water quality standards, and/or is not expected to meet applicable water quality standards in the period prior to the next list. These segments are also referred to as "§303(d) listed."
Water Quality Management Plan	A state or area-wide waste treatment management plan developed and updated in accordance with the provisions of the Clean Water Act.
Water Quality Modeling	The prediction of the response of some characteristics of lake or stream water based on mathematical relations of input variables such as climate, stream flow, and inflow water quality.
Water Quality Standards	State-adopted and U.S. Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.
Water Table	The upper surface of ground water; below this point, the soil is saturated with water.

Watershed	1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller "subwatersheds." 2) The whole geographic region which contributes water to a point of interest in a water body.
Water Body Identification Number (WBID)	A number that uniquely identifies a water body in Idaho and ties in to the Idaho Water Quality Standards and GIS information.
Wetland	An area that is at least some of the time saturated by surface or ground water so as to support with vegetation adapted to saturated soil conditions. Examples include swamps, bogs, fens, and marshes.
Young of the Year	Young fish born the year captured, evidence of spawning activity.

Appendix A. Unit Conversion Chart

Table A-1. Metric - English unit conversions.

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 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)[1]	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	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

[1]1 cfs = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 cfs.

[2]The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water.

Appendix B. Distribution List

Amy Luft. Department of Environmental Quality. Technical Editor. 10/14/2003.

Marti Bridges. Department of Environmental Quality. TMDL Program Manager. 10/14/2003.

Balthasar Buhidar. Department of Environmental Quality. Regional Manager. 10/14/2003.

Mike Etcheverry. Department of Environmental Quality. Implementation specialist. 10/14/2003.

Jennifer Claire. Department of Environmental Quality. TMDL Writer. 10/14/2003.

Sean Woodhead. Department of Environmental Quality. BURP Coordinator. Department of Environmental Quality. 10/14/2003.

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Chuck Pentzer. Idaho Soil Conservation Commission. 20 W. 100 S. Jerome, ID 83338. 12/04/2003.

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Appendix C. Public Comments

The 30-day public comment period closed on January 6, 2004 at 5:00 p.m. During that period comments were received from the US BLM and the US Forest Service. Several of the US BLM and US Forest Service comments were editorial in nature and those changes were incorporated into the document. Electronic copies of the US BLM and US Forest Service technical comments were provided and are included here. DEQ's responses follow in italics.

BLM BURLEY FIELD OFFICE COMMENTS CONCERNING THE DRAFT FOR THE "RAFT RIVER SUBBASIN ASSESSMENT AND TOTAL MAXIMUM DAILY LOADS"

In reference to Raft River species of special concern on page 60:

The scientific name for Davis wavewing is Cymopterus davisii, not C. anserinus. Also, Astragalus anserinus and Penstemon idahoensis do not occur in the subbasin but are endemic to the Goose Creek watershed.

These errors were fixed within the document.

In reference to the discussion of tributaries to Cassia Creek at the top of page 97:

Rice Spring enters Cassia Creek approximately 3 miles east of Connor which appears to be within the listed segment.

These errors were fixed within the document.

In reference to the reservoir discussion within the Cassia Creek discussion on page 103:

The second and third paragraphs on page 103 discuss various aspects of a reservoir on Cassia Creek which appears to be out of place since no such reservoir exists to our knowledge.

These errors were fixed within the document.

In reference to the discussion of TMDL's on the upper segment of Cassia Creek near the bottom of page 103:

BLM would like clarification on this issue. Is the upper segment of Cassia Creek on the 303(d) list? Is this segment treated any differently than other segments if it is not on the list but is included in the nutrient and bacteria TMDL's for Cassia Creek?

The upper segment is not on the 1998 §303(d) list. It was removed following the bioassessment protocols in WBAG I. However, for the Raft River SBA and TMDL the water quality data was collected in the upper segment to determine background loads contributed by the upper segment. This process was similar to the data collected in the upper segment of Trapper Creek in the Goose Creek SBA and TMDLs. As a result of the data collection in the upper segment it was determined that bacteria and *nutrients were impairing the beneficial uses in both the upper and lower segments of Cassia Creek. Consequently, the TMDLs were developed for whole creek.*

In reference to the Summary of Past and Present Pollution Control Efforts beginning on page 127:

BLM has excluded livestock from nearly all perennial portions of Raft River under it's management. Also, the BLM lands along Cassia Creek are part of a riparian pasture within the Middle Hill Allotment.

These past and present pollution control efforts were added to the appropriate sections.

In reference to the Raft River monitoring points discussion on page 158:

The document states that the perennial portions of Raft River are already in fairly good condition which includes the narrows area. Additional work here will have some benefit to this area and potentially downstream but until water is not diverted in Utah, the reach above the narrows to the state line (roughly Edwards Creek to Utah) will not be expected to flow, regardless of what is done at the narrows.

Implementation of the TMDL will begin in the Narrows area and proceed from there. Other critical areas will have to be identified by the appropriate land management agencies. As Raft River was once a perennial water body any implementation plans developed by these agencies will have to address the area above the Narrows as well.

US FOREST SERVICE MINIDOKA RANGER DISTRICT COMMENTS CONCERNING THE DRAFT FOR THE "RAFT RIVER SUBBASIN ASSESSMENT AND TOTAL MAXIMUM DAILY LOADS"

Upon review of the Raft River SBA/TMDL, it was noticed in the tables that were submitted that there were a couple omissions:

On the following pages, the Attachments were not included in the document:

Page 130 – Lake Fork Allotment Pollution control Measure: See Attachment G
Page 134 – Pine Hollow Allotment Pollution Control Measure: see Attachment A
Page 134 – Grape Creek Allotment Pollution Control Measure: see Attachment B

Additional comments:

Page xvi: "The second is Raft River Aquifer below Oakley, which is part of the Eastern Snake River Plain Aquifer". This appears to be copied from the Goose Creek TMDL and needs to be localized.

These errors were fixed within the document.

Page 27: Figure 3. Raft River 1998 303(d) listed streams and reservoirs; This figure shows Cassia Creek as listed up to the headwaters area. Does this figure extend the extent of the listed portion of Cassia Creek too far? The 1998 303(d) list indicates that Cassia Creek is listed from Conner Creek to Raft River.

See Response to BLM Comments

Page 40: The first paragraph under the Sublet Reservoir heading states: "Sublett Reservoir is the only named reservoir in the Raft River Subbasin and is located in Management Area 20 of the Sawtooth National Forest Lands in the Sublett Mountain Range. It is located in Cassia County and the area is administrated by the Sawtooth National Forest Minidoka Ranger District".

The statement is not entirely accurate. Only a northern portion of the reservoir (where Lake Fork enters the reservoir) is located on SNF administered lands, the remainder of the reservoir area is not located on administered SNF lands. Our Land and Resource Management Plan states for Management Area 20 that "Sublett Reservoir is located at the south end of the area, mostly off Forest Administered lands".

Changes were made to the document to reflect that the majority of Sublett Reservoir lies within private lands.

Page 46: Table 15. Soil Orders of the Raft River Subbasin. The first NRCS Soil Order listed is Acidisols (Soil Genesis- Acid Soil). It looks as if this could be a typo and should read Aridisol (Soil Genesis – Arid Soil).

These errors were fixed within the document.

Page 60: Second Paragraph: "These plants and animals are those that are not listed, but that the USFWS suggest that the federal agencies consider in their management and planting activities. The Sawtooth National Forest contains 44 species on this list".

Correction: The Dec. 12, 2003 species list sent to the Sawtooth National Forest by the Boise Office of the USFWS contains 37 species of interest that have no legal status under the ESA, but should be considered in project planning an review (There is a list of approximately 43 plant species listed as Sensitive or watch species in our revised plan but they have no ESA protection and therefore USFWS does not administer them)

These errors were fixed within the document.

Page 67: Subbasin Forestry heading: "The forest is made up of five administrative units. These include the Burley, Twin Falls, Ketchum, and Fairfield Ranger Districts and the Sawtooth National Recreation Area".

The Burley and Twin Falls Ranger Districts have been combined into one District called the Minidoka Ranger District.

These errors were fixed within the document.

Page 127: United State Forest Service Efforts to Improve Water Quality: "…Trudy Flock of the USFS Burley Ranger District for the Twin Falls Regional Office of DEQ."

This is the same as the previous comments and should read the Minidoka Ranger District.

These errors were fixed within the document.

Page 212: The same as the previous two comments applies here as well for Trudy Flock and Scott Nannenga, both are with the Minidoka Ranger District. Also, Scott Nannenga is misspelled on this page. It is spelled Nannega and should read Nannenga.

These errors were fixed within the document.