Jordan Creek Subbasin Assessment and Total Maximum Daily Load

Final

Department of Environmental Quality

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Cover Photo: Jordan Creek at Jacob Gulch. Photo by Hawk Stone, Boise Regional Office, DEQ.

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Abbreviations, Acronyms, and Symbols

§303(d)	Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
µ	micro, one-one thousandth
§	Section (usually a section of federal or state rules or statutes)
AU	assessment unit
BLM	United States Bureau of Land Management
BMP	best management practice
BURP	Beneficial Use Reconnaissance Program
C	Celsius
CFR	Code of Federal Regulations (refers to citations in the federal administrative rules)
cfs	cubic feet per second
CWA	Clean Water Act
CWAL	cold water aquatic life
DEQ	Department of Environmental Quality
DO	dissolved oxygen
DOI	U.S. Department of the Interior
DWS	domestic water supply
EPA	United States Environmental Protection Agency
F	Fahrenheit
FWS	U.S. Fish and Wildlife Service
GIS	Geographical Information Systems
HUC	Hydrologic Unit Code
I.C.	Idaho Code
IDAPA	Refers to citations of Idaho administrative rules
IDFG	Idaho Department of Fish and Game
IDHW	Idaho Department of Health and Welfare
IDL	Idaho Department of Lands
IDWR	Idaho Department of Water Resources
Km	kilometer
Km2	square kilometer
LA	load allocation
LC	load capacity
m	meter
m^3	cubic meter
mi	mile
mi^2	square miles
MBI	Macroinvertebrate Biotic Index
MGD	million gallons per day
mg/L	milligrams per liter
MOS	margin of safety
MWMT	maximum weekly maximum temperature
NA	not assessed
NB	natural background
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
PCR	primary contact recreation
PNV	potential natural vegetation
ppm	part(s) per million
QA	quality assurance
QC	quality control
RDI	DEQ's River Diatom Index
RFI	DEQ's River Fish Index
RMI	DEQ's River Macroinvertebrate Index
SBA	subbasin assessment
SCR	secondary contact recreation
SFI	DEQ's Stream Fish Index
SHI	DEQ's Stream Habitat Index

SMI	DEQ's Stream Macroinvertebrate Index
SS	suspended sediment
TMDL	total maximum daily load
TSS	total suspended solids
U.S.	United States
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USGS	United States Geological Survey
WAG	Watershed Advisory Group
WBID	water body identification number
WLA	wasteload allocation
WQS	water quality standard

Executive Summary

The federal Clean Water Act requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the Clean Water Act, 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 Clean Water Act 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 for the pollutants, set at a level to achieve water quality standards.

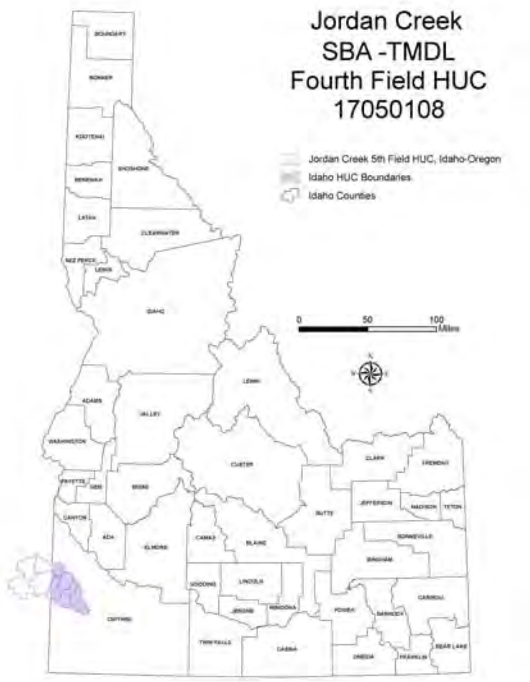
This document addresses the water bodies in the Jordan Creek watershed that have been placed on what is known as the "§303(d) list."

This subbasin assessment (SBA) and total maximum daily load (TMDL) analysis has been developed to comply with Idaho's total maximum daily load schedule. This assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Jordan Creek watershed located in southwest Idaho.

The first part of this document, the subbasin assessment, is an important first step in leading to the total maximum daily load. The starting point for this assessment was Idaho's 1998 and 2002 §303(d) list of water quality limited water bodies. Eight stream reaches of the Jordan Creek watershed were on those lists. Since the original document went to public comment, the new 2008 § 303(d) list was approved, and the final document has been revised to reflect the current list. The subbasin assessment portion of this document examines the current status of §303(d) listed waters and defines the extent of impairment and causes of water quality limitation throughout the subbasin.

The loading analysis in the second part of the document quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

Subbasin at a Glance



Jordan Creek Watershed	
Hydrologic Unit Code (HUC)	17050108
2008 303(d) Listed Water Bodies:	Jordan Creek (4 assessment units [AUs]), Cow Creek (2 AUs), Soda Creek (2 AUs), Rock Creek, Spring Creek (2 AUs), and Louisa Creek
Pollutant Sources:	Nonpoint Sources and Legacy Mining/Milling Activity
Ecoregions:	Snake River-High Desert
Size:	740,349 total acres 373,269 acres Idaho 367,080 acres Oregon

Figure A. Jordan Creek Watershed Vicinity Map

Watershed Description

The Jordan Creek watershed, hydrologic unit code 17050108, encompasses a large area in southwest Idaho and southeast Oregon (Figure A). The headwaters of Jordan Creek originate in the western section of the Owyhee Mountains, in southwest Idaho, flowing mostly west into Oregon, entering near Jordan Valley. The watershed size is approximately 740,000 acres with a little under 50 percent located within Idaho. There are no Native American tribal lands within the watershed.

Land uses in the Jordan Creek watershed consist of irrigated agriculture, rangeland, forest, mining, and riparian. Land ownership is a mix of private, federal, and state managed lands. A majority of the population is associated with small homesteads, ranches, and farms scattered throughout the watershed. Jordan Valley, Oregon is the only identifiable municipality with permanent year-round residents. The historic town of Silver City, Idaho is composed mostly of part-time or weekend residents.

Assessment Scope

This document addresses only those water bodies identified within Idaho. There was no assessment or interpretation of the status of beneficial uses for water bodies within Oregon. References to downstream waters in Oregon are made, but these references are intended to assist the stakeholders in understanding holistic conditions in the watershed.

Overall, there are twelve assessment units (stream reaches) within the Jordan Creek watershed that are placed on the Idaho 2008 §303(d) list, including four segments of Jordan Creek (Figure B). Two reaches of Jordan Creek were found to be impaired but are unlisted. TMDLs were developed for those reaches. The remaining water bodies are tributaries to Jordan Creek. In the Jordan Creek Subbasin, Jordan Creek and Soda Creek were placed on the 1998 303d list of impaired waters by EPA for reasons associated with temperature criteria violations.

Listed Pollutants

The pollutants of concern for the listed segments are sediment, fecal coliform, flow alteration, oil and grease, unknown, mercury, and temperature (Table A). The subbasin assessment process analyzes any available data to determine the support status of the beneficial uses in a stream segment. These uses include cold water aquatic life, primary or secondary contact recreation, salmonid spawning, water supply, wildlife, and aesthetics.

Water body segments comprise one or more Assessment Units (AUs). AUs are groups of similar streams that have similar land use practices, ownership, or land management.

Determination of Stream Support Status

The support status of each stream was determined by comparing water quality data and biological assessment information to state of Idaho water quality criteria. Water bodies not fully supporting their designated or existing beneficial uses and/or not meeting applicable water quality standards are required to have a total maximum daily load developed.

Table B shows a breakdown of the findings in the subbasin assessment and actions to be taken, such as delisting, listing, or developing a total maximum daily load.

On the DEQ 1998 303d list, Cow Creek (ID17050108SW021_02 & 03), Meadow Creek (ID17050108SW015_02 & 03), Louisa Creek (ID17050108SW014_02), and a portion of Rock Creek (ID17050108SW013_02, headwaters to Triangle Reservoir) were listed for reasons associated with temperature. EPA made additions to that 1998 list for temperature by adding all of Jordan Creek in Idaho (ID17050108SW004_02, 03, 04, 05 and ID17050108SW001_05) and all of Soda Creek (ID17050108SW022_02 & 03).

The DEQ 2002 and 2008 303d lists (or Section 5 of the Integrated Report) retained both AUs of Cow Creek, the AU of Rock Creek, the AU of Louisa Creek, and added both AUs of Spring Creek (ID17050108SW015_02 & 03).

Since Spring Creek AUs are the same as Meadow Creek, there may have been some confusion about stream name associated with these AUs. Meadow Creek is, in fact, a tributary of Spring Creek.

Although Jordan Creek, Soda Creek, and Meadow Creek were not listed in subsequent listings after 1998 or EPA additions thereto, we have included temperature TMDLs for those streams based on these earlier listings and data that suggests they are impaired.

Development of Total Maximum Daily Loads

Total maximum daily loads were developed to address elevated methyl mercury levels in fish tissue on Jordan Creek, and a sediment TMDL for Soda Creek. A Potential Natural Vegetation (PNV) temperature TMDL was completed in the watershed to address temperature on Jordan Creek, Soda Creek, Cow Creek, Rock Creek, Meadow Creek/Spring Creek, and Louisa Creek.

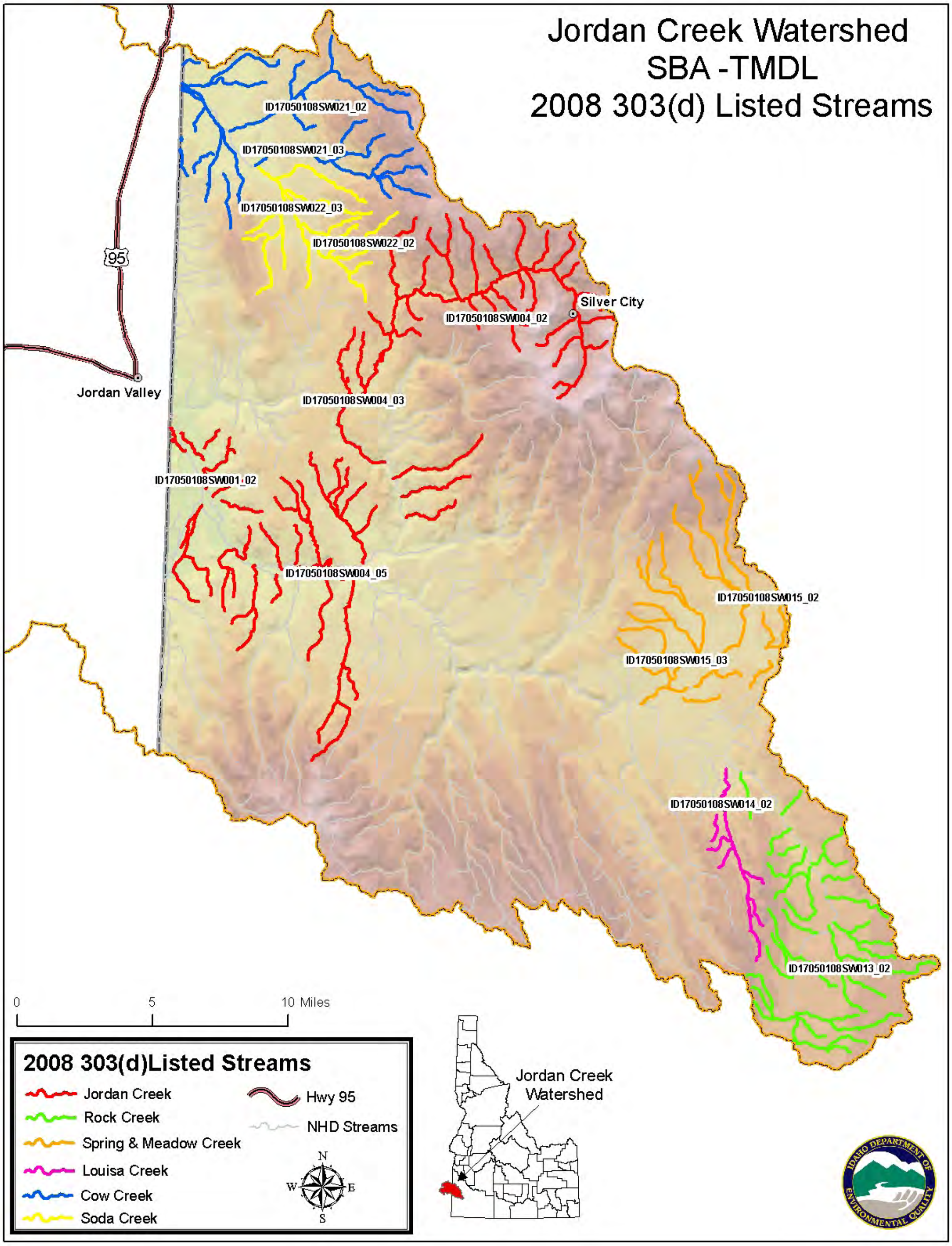


Figure B. Idaho 2008 §303(d) listed water bodies, Jordan Creek Watershed.

Table A. Idaho 2008 § 303(d) Listed Segments

Water Body Name	Assessment Unit ID Number	Boundaries	Pollutant(s)	Listing Basis
Cow Creek	ID17050108SW021_02 ID17050108SW021_03	Headwaters to Oregon Line	Sediment and temperature	Water body carry over from 1998 303(d) list
Jordan Creek	ID17050108SW004_02	1st and 2nd Order tributaries above Williams Creek	Fecal coliform, mercury, oil/grease, unknown (pesticides) , sediment	Water body carry over from 1998 303(d) list
Jordan Creek	ID17050108SW004_03	3rd Order (Pole Creek to Louse Creek)	Fecal coliform, mercury, oil/grease, unknown, (pesticides), sediment,	Water body carry over from 1998 303(d) list
Jordan Creek	ID17050108SW004_05	5th Order (Rail Creek to Williams Creek)	Fecal coliform, mercury, oil/grease, unknown (pesticides),sediment,	Water body carry over from 1998 303(d) list
Jordan Creek	ID17050108SW001_02	1st and 2nd Order tributaries (Williams Creek to Oregon Line)	Fecal coliform, mercury, oil/grease, unknown, (pesticides) sediment,	Water body carry over from 1998 303(d) list
Louisa Creek	ID17050108SW014_02	Headwaters to Triangle Reservoir	Sediment and temperature	Water body carry over from 1998 303(d) list
Rock Creek	ID17050108SW013_02	Headwaters to Triangle Reservoir	Sediment and temperature	Water body carry over from 1998 303(d) list
Soda Creek	ID17050108SW022_02 ID17050108SW022_03	Headwaters to Cow Creek	Sediment and temperature	Water body carry over from 1998 303(d) list Unlisted but impaired for temperature
Spring Creek and Meadow Creek	ID17050108SW015_02 ID17050108SW015_03	Headwaters to mouth	Temperature	Water body carry over from 1998 303(d) list; Original listing was for Meadow Creek, a tributary

Table B. Summary of assessment outcomes for the Jordan Creek Watershed.

Water Body Segment/AU	TMDLs/ Allocations Completed	Recommended Changes to §303(d) List	Justification
Cow Creek ID17050108SW021_02 ID17050108SW021_03	Potential Natural Vegetation temperature TMDL completed	Remove sediment as a pollutant of concern; Move temperature TMDL to § 4a	Water body is intermittent, Data does not indicate sediment impairment
Soda Creek ID17050108SW022_02 ID17050108SW022_03	Potential Natural Vegetation temperature TMDL completed; Sediment TMDL completed	Move to § 4a	Water body is intermittent, Data does indicate sediment is impairing expected biological composition Impaired but unlisted for Temperature
Rock Creek ID17050108SW013_02	Potential Natural Vegetation temperature TMDL completed	Remove sediment as a pollutant of concern; Move temperature TMDL to § 4a	Water body is intermittent, Data does not support sediment impairment
Louisa Creek ID17050108SW014_02	Potential Natural Vegetation temperature TMDL completed	Support status requires verification; Move temperature TMDL to § 4a	Lack of sediment data
Spring Creek (Meadow Creek) ID17050108SW015_02 ID17050108SW015_03	Potential Natural Vegetation temperature TMDL completed	Move to § 4a	TMDL completed
Jordan Creek ID17050108SW004_02	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Remove oil and grease, unknown, sediment and bacteria as pollutants of concern. Move mercury and temperature TMDLs to § 4a	Water quality data showed no exceedance of numeric criteria
Jordan Creek ID17050108SW004_03	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Remove oil and grease, unknown, sediment and bacteria as pollutants of concern. Move mercury and temperature TMDLs to § 4a	Water quality data showed no exceedance of numeric criteria
Jordan Creek ID17050108SW004_04	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Move to § 4a	Impaired but unlisted for mercury and temperature
Jordan Creek ID17050108SW004_05	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Remove oil and grease, pesticides, sediment and bacteria as pollutants of concern. Move mercury and temperature TMDLs to § 4a	Water quality data showed no exceedance of numeric criteria
Jordan Creek ID17050108SW001_02	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Remove oil and grease, pesticides, sediment and bacteria as pollutants of concern. Move mercury and temperature TMDLs to § 4a.	Water quality data showed no exceedance of numeric criteria
Jordan Creek ID17050108SW001_05	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed,	De-listed in 2002 for oil and grease, pesticides, sediment and bacteria as pollutants of concern; add Flow and habitat alteration; Move to § 4a for temperature and mercury	Water quality data showed no exceedance of numeric criteria; Impaired but unlisted for mercury and temperature

Key Findings

Key findings for each 2008 §303(d) listed water body are addressed below. Pollutants of concern are discussed, with additional data and information provided in Section 2. Recommendations are also provided, along with the rationale for those recommendations.

Temperature

Effective shade targets were established for Jordan Creek, Cow Creek, Soda Creek, Rock Creek, Louisa Creek, and Spring Creek (Meadow Creek) based on the concept that maximum shading under potential natural vegetation equals natural background temperature levels. Shade targets were derived from effective shade curves developed for similar vegetation types in southern Idaho. Existing shade was determined from aerial photo interpretation that was field verified against solar pathfinder data.

Jordan Creek and Rock Creek had the largest excess loads, due to their size; percent reductions to achieve loading capacities were 41% and 11%, respectively. To prioritize water bodies, those streams with high excess loading and segments with large differences between existing and target shade should be examined for possible shade recovery. Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should key in on the largest differences between existing and target shade as locations to prioritize implementation efforts. Additionally, high percent reductions maybe more a function of the lack of water due to intermittent or ephemeral portions (e.g. Soda Creek). Each stream needs to be examined and further field verified to establish and prioritize any needed implementation activities.

Cow Creek

Table C presents a summary of the findings and recommendations for Cow Creek. According to the Idaho Water Quality Standards (WQS), no designated uses have been assigned to Cow Creek. Therefore, cold water aquatic life and primary and/or secondary contact recreation are the presumed uses. DEQ did not obtain any fish data.

Table C. Cow Creek: Summary of findings and recommendations.

Water Body	Cow Creek, Headwaters to the Oregon-Idaho State Line
Assessment Units	ID17050108SW021_02 ID17050108SW021_03
Miles of impaired water body	58.54 miles
Listed pollutants	Sediment and temperature
Impaired designated uses	No designated uses, presumed existing uses: cold water aquatic life
TMDL/Allocations goals	Potential Natural Vegetation temperature TMDL developed
Further listing recommendations	Apply appropriate water quality standards and criteria for intermittent water bodies, remove sediments as a pollutant of concern
Potential sources	Overland flow, riparian-stream bank erosion, irrigation water return

Available biological data indicate Cow Creek is not impaired by sediment. The interpretation of the community structure and diversity for both periphyton and macroinvertebrates indicate minimal impact from sediment and organic enrichment, but no impairment.

Because Cow Creek is intermittent, Idaho Water Quality Standards for intermittent water bodies apply when water is present. Estimated daily average discharge for this water body (0.05 cfs) is below the criteria for applying numeric criteria in accordance with Water Body Assessment Guidance. Aquatic life occupies intermittent water bodies during periods when it is physically possible (adequate flow and habitat). These water bodies could be utilized by aquatic life for refuge from high flows, predators, and/or turbid conditions, but their presence is short term, and their long-term survival is not reliant on these water bodies.

Water temperature data supplied by the Bureau of Land Management (BLM) during two different monitoring years showed exceedance of water temperature criteria and verified Cow Creek is dry for a minimum duration of at least seven days. Although not required, a Potential Natural Vegetation Temperature TMDL was completed.

Soda Creek

Table D presents a summary of the findings and recommendations for Soda Creek. According to the Idaho Water Quality Standards, no designated uses have been assigned to Soda Creek. Therefore, cold water aquatic life and, primary and/or secondary contact recreation are the presumed existing uses.

Table D. Soda Creek: Summary of findings and recommendations.

Water Body	Soda Creek, Headwaters to Cow Creek
Assessment Units	ID17050108SW022_02 ID17050108SW022_03
Miles of impaired water body	40.0 miles
Listed pollutants	Sediment
Impaired designated uses	No designated uses, presumed existing uses: cold water aquatic life
TMDL/Allocation goals	Sediment Targets; 50 mg/l and 80 mg/l Potential Natural Vegetation temperature TMDL completed (possibly impaired but unlisted)
Further listing recommendations	Apply appropriate water quality standards and criteria for intermittent water bodies

Because Soda Creek is intermittent, Idaho Water Quality Standards for intermittent water bodies apply. Numeric criteria only apply to Soda Creek during optimum flows because the estimated daily average discharge (0.3 cfs) is below the criteria for applying numeric criteria.

Aquatic life will occupy intermittent water bodies during periods when it is physically possible (adequate flow and habitat). These water bodies could be utilized by aquatic life for refuge from high flows, predators, or turbid conditions, but their presence is short term and their long-term survival is not reliant on those intermittent water bodies.

Water temperature data supplied by BLM during two different monitoring years showed exceedance of water temperature criteria and verified that Soda Creek is dry for a minimum duration of at least seven days. Although not required, a Potential Natural Vegetation temperature TMDL was completed for Soda Creek. However, excessive dry periods may exacerbate lose of riparian vegetation. The stream's ability to support shade producing vegetation should be carefully examined.

Available biological data indicate Soda Creek is impaired by sediment. The interpretation of the community structure and diversity for both periphyton and macroinvertebrates indicate impairment from sediments. However, the Idaho Water Quality Standards state that the general surface water criteria will apply to all water bodies, including those identified as intermittent. The biological data indicate the community structure is populated with those species tolerant to fine sediments.

It is proposed that water column targets be established during the optimum flow period, when impairment to the presumed uses can occur. These periods occur when Soda Creek exceeds 1 cfs. The targets would consist of two criteria: a geometric mean of 50 mg/L suspended sediment or total suspended solids for no longer than 60 consecutive days, and a geometric mean of 80 mg/L suspended sediment or total suspended solids for no longer than 14 consecutive days.

Spring Creek

Table E summarizes the findings and recommendations for Spring Creek. According to the Water Quality Standards, no designated uses have been assigned to Spring Creek. Therefore, cold water aquatic life and primary and/or secondary contact recreation are the presumed uses.

Table E. Spring Creek: Summary of findings and recommendations.

Water Body	**Meadow Creek, Headwaters to Rock Creek**
Assessment Units	ID17050108SW015_02 ID17050108SW015_03
Miles of Impaired Water Body	57.17 miles
Listed Pollutants	Flow modification and temperature
Impaired Designated Uses	Presumed cold water aquatic life
TMDL Goal	A Potential Natural Vegetation temperature TMDL was developed.
Further listing recommendations	None
Potential Sources	Solar Radiation

Because Spring Creek is intermittent, Water Quality Standards for intermittent water bodies apply. Numeric criteria only apply to Spring Creek during optimum flows, and the estimated daily average discharge (<0.1 cfs) is below the criteria for applying numeric criteria.

Aquatic life will occupy intermittent water bodies during periods when it is physically possible (adequate flow and habitat). These water bodies could be utilized by aquatic life for refuge from high flows, predators or turbid conditions, but their presence is short term and their long term survival is not reliant on those intermittent water bodies. Although not required, a Potential Natural Vegetation temperature TMDL was developed.

No biological, water quality, or physical data are available to assess the support status of Spring Creek. The listing is based on the assessment conducted on Meadow Creek and the listing as impaired is based on the assessment for Assessment Units ID17050108SW015_02 and ID17050108SW015_03, which includes Meadow Creek.

Rock Creek

Table F summarizes the findings and recommendations for Rock Creek. According to the Water Quality Standards, no designated uses have been assigned to Rock Creek, so cold water aquatic and contact recreation, primary and/or secondary, are the presumed existing uses.

Table F. Rock Creek: Summary of findings and recommendations.

Water Body	Rock Creek, Headwaters to Triangle Reservoir
Assessment Units	ID17050108SW013_02
Miles of impaired water body	64.23 miles
Listed pollutants	Flow Modification, Sediment and Temperature
Impaired designated uses	Presumed Cold Water Aquatic Life
TMDL goal	A Potential Natural Vegetation temperature TMDL was developed.
Further listing recommendations	Water body is intermittent, remove sediment as a pollutant of concern
Potential sources	Overland flow, riparian-stream bank erosion

Based on the Water Body Assessment Guidance, Rock Creek has a Condition Rating of 2, as determined by averaging at least two indices—in this case, the stream macroinvertebrate index and the stream habitat index scores. Therefore, habitat does not appear impaired by sediment.

Additional analysis of the periphyton and macroinvertebrate data indicated only minor stressors, but no impairment.

However, temperature standards are exceeded based on other data supplied to DEQ. In 2004, BLM temperature data indicated 32% of the dates exceeded the 22^{o} C maximum daily maximum temperature (MDMT) criteria, and 22% exceeded the 19^{o} C maximum daily average temperature criteria (MDAT). A Potential Natural Vegetation Temperature TMDL was completed.

Based on hydrologic modeling and actual discharge measurements, optimum flow conditions are not present for at least 7 days during a calendar year. Since Rock Creek is intermittent, Water Quality Standards for intermittent water bodies would apply.

It is recognized that aquatic life will occupy intermittent water bodies during periods when it is physically possible (adequate flow and habitat). These water bodies could be utilized by aquatic life for refuge from high flows, predators or turbid conditions, but their presence is short term and their long term survival is not reliant on those intermittent water bodies. Although not required, a Potential Natural Vegetation temperature TMDL was developed.

Louisa Creek

Table G summarizes findings and recommendations for Louisa Creek. According to the Idaho Water Quality Standards, no designated uses have been assigned to Louisa Creek. Therefore, cold water aquatic life and primary and/or secondary contact recreation are the presumed uses.

Table G. Louisa Creek: Summary of findings and recommendations.

Water Body	**Louisa Creek, Headwaters to Triangle Reservoir**
Assessment Units	ID17050108SW014_02
Miles of impaired water body	13.81 miles
Listed pollutants	Sediment and temperature
Impaired designated uses	Presumed Cold Water Aquatic Life
TMDL goal	A Potential Natural Vegetation temperature TMDL was developed.
Further listing recommendations	Verification required of sediment impairment
Potential sources	solar radiation

Except for the 2001 BLM temperature data, there is no other data to evaluate. The reason for Louisa Creek's placement on the 2002 §303(d) list is not known. Additional data are needed to determine any impairment prior to the development of a TMDL for Louisa Creek. However, based on hydrologic modeling, the water body appears to be intermittent with an estimated daily average discharge of <0.1 cfs. Although not required, a Potential Natural Vegetation temperature TMDL was developed.

Upper Jordan Creek

Table H summarizes the findings and recommendations for Upper Jordan Creek, which consists of three AUs. The stream macroinvertebrate and habitat indices scores were used to determine the final condition rating for upper Jordan Creek. The site below Blue Gulch has a final condition rating of 3. The site above Louse Creek has a final condition rating of 2. These scores would typically indicate full support in accordance with the Water Body Assessment Guidance. However, elevated levels of methylmercury in fish tissue exceed the water quality standards.

Table H. Upper Jordan Creek: Summary of findings and recommendations.

Water Body	**Upper Jordan Creek, Headwaters to Williams Creek**
Assessment Units	ID17050108SW004_02 ID17050108SW004_03 ID17050108SW004_04 - unlisted ID17050108SW004_05
Miles of impaired water body	125.28 miles
Listed pollutants	Sediment, mercury, oil and grease, unknown, and fecal coliform
Impaired designated uses	Cold Water Aquatic Life, Contact Recreation

TMDL/Allocation goals	A Potential Natural Vegetation temperature TMDL and mercury TMDL were developed.
Further listing recommendations	Remove oil and grease, sediment and fecal coliform as pollutants of concern
Potential Sources	Overland flow, riparian-stream, bank erosion, legacy mining activity

Examination of the different biological community structures provides some evidence that sediments and metal toxicity are present in Upper Jordan Creek, but not at levels that would cause impairment or significant alteration of the expected biological indicators. Further evaluation of stream sediments and the presences of metals in those sediments, would be beneficial in determining the source of this minor stressor, especially below Blue Gulch. Additionally, an evaluation of the stream substrate, physical and habitat conditions do not show impairment.

Salmonid spawning appears to be an existing use in Upper Jordan Creek. The presence of a diverse age class of salmonid species throughout the upper segments strongly indicates the upper segments and tributaries of the watershed are widely used and support spawning.

Bacteria levels in Upper Jordan Creek are meeting water quality standards. The listing of oil and grease as a pollutant of concern indicates that portions of the general surface water criteria are not being met. However, the sample results met water quality standards and did not show concentrations of concern.

Pesticides were suspected as a pollutant of concern; however, the sample results indicate that most pesticides were below the detectable limit. Only two pesticides were reported above the detection limit, but they were well below the established criteria.

Temperature data provided by BLM showed one site with continuous temperature data that exceeded the maximum daily maximum temperature of 22 degrees C on 22% of the dates. A Potential Natural Vegetation Temperature TMDL was completed.

Fish tissue collected in 2005 exceeded the mercury criterion of 0.3 mg/kg. Water and sediment samples provided additional data confirming the presence of high concentrations of total mercury, dissolved mercury and methyl mercury from Williams Creek to the headwaters near historic mining activity.

The analysis of water, sediment, and fish tissue results show the contamination is not a watershed issue as a whole, *but is confined to the Jordan Creek water body itself*. DEQ has developed a mercury TMDL to address the elevated levels of methylmercury in fish tissue.

Lower Jordan Creek

Table I summarizes the findings and recommendations for Lower Jordan Creek. Several pollutants of concern—oil and grease, and pesticides—were evaluated through water quality monitoring to determine if these pollutants were violating water quality standards. Using U.S. Environmental Protection Agency (EPA) recommended analytical methods, neither pollutant was detected. It is recommended these pollutants be removed from the §303 (d) list.

Table I. Lower Jordan Creek: Summary of findings and recommendations.

Water Body	Lower Jordan Creek, Williams Creek to Oregon-Idaho State Line
Assessment Units	ID17050108SW001_02 ID17050108SW001_05 (De-listed in 2002)
Miles of impaired water body	47.72 miles
Listed pollutants	Sediment, oil and grease, fecal coliform, unknown, and mercury
Impaired designated uses	Cold Water Aquatic Life, Contact Recreation
TMDL/Allocation goals	Potential Natural Vegetation temperature and mercury TMDLs were developed.
Further listing recommendations	Remove oil and grease, sediment and fecal coliform as pollutants of concern, add flow and habitat alteration
Potential Sources	Overland flow, riparian-stream bank erosion, legacy mining/milling activity

Samples to evaluate possible impacts to contact recreation showed no exceedance of the geometric mean criteria for E. coli of 126 colony-forming units per 100 milliliters (CFU/100 ml). It is recommended that fecal coliform be removed from the §303 (d) list.

When evaluating sediments, the general surface water quality criterion is applied. For the lower Jordan Creek segment, a quantitative analysis is lacking to compare to literature-referenced targets, such as percent fines, suspended sediment concentrations, embeddedness, and turbidity. It appears that these targets are not a factor in impairing beneficial uses in lower Jordan Creek.

The lack of aquatic habitat associated with current stream morphology and the management for seasonal flood control and irrigation water diversions appears to be a source of impairment. It is recommended sediment be removed as a pollutant of concern. It is also recommended that Jordan Creek be added to the §303(d) list Section 4c for flow and habitat alteration.

Temperature data for the lower Jordan Creek segments shows exceedance of both the maximum daily average temperature and the maximum daily maximum temperature. A Potential Natural Vegetation Temperature TMDL was completed.

Mercury is a listed pollutant of concern on the 2008 §303(d) list. The predictive model used to estimate mercury levels in fish for lower Jordan Creek indicates an exceedance of the fish tissue criterion of 0.3 mg/kg. DEQ has developed a TMDL for mercury to address the elevated levels of mercury in fish tissue.

Timeframe for Meeting Water Quality Standards

The development of an implementation plan can be completed in a timely manner. However, implementation of best management practices may take several years and is dependent on available resources, funding, and prioritization from land management agencies.

To address the mercury TMDL, a phased implementation approach warrants consideration. Further source assessments should occur to evaluate those areas associated with the primary and secondary mercury sources within the Jordan Creek watershed, as well as air sources that may be contributing. A long-term monitoring plan for fish tissue mercury is desirable once sources are evaluated and actions taken to reduce/abate mercury loads. Long term monitoring activity will be needed to determine if the total maximum daily loads should be refined and to assure goals and targets of the total maximum daily loads are being achieved.

Some biological indicators may respond quickly to reduced sediment input and habitat improvement. Warm water intolerant species may take longer and may not re-establish until benefits from reduced solar radiation and increased ground water effectively cool the water.

Implementation Strategy

The implementation strategy addresses the initial development of a source assessment and implementation plan for the Jordan Creek watershed. State and federal agencies and the public will assist in implementing best management practices to achieve the targets and goals identified. The agencies that will be involved include BLM, the Natural Resources Conservation Service (NRCS), Idaho Soil Conservation Commission (ISCC), Department of Lands, EPA, and DEQ.

As with any implementation plan addressing nonpoint sources, an adaptive management approach will be a critical component of any implementation plan developed for the watershed. As more data are collected, future modifications to the load allocation may occur, which will include more accurate water body sediment and mercury loading information. Although their use is not anticipated, possible regulatory strategies are in place and can be applied through current regulatory authority.

Much of the implementation of best management practices will be dependent on the availability of funding and personnel resources. Current state and federal cost share programs will assist private landowners in addressing load allocations on private holdings. It is expected that the identified state and federal agencies will work closely with the Department of Environmental Quality during all phases of the development of an implementation strategy plan.

Monitoring of the goals and targets stated in the total maximum daily load needs to be conducted to determine the following:

- if the overall goal of achieving and maintaining compliance with state water quality standards is being meet
- if the implemented best management practices are working as designed or if modification needs to occur
- if load allocations need to be adjusted
- if best management practices are being implemented in a timely manner to address water quality concerns

Identified Data Gaps

Through the Jordan Creek watershed assessment process, numerous data gaps were identified:

- Collection of higher trophic levels of fish in the lower segments of Jordan Creek and conducting tissue analysis of mercury levels is desirable.
- Identifying and quantifying the fate and transport of the mercury load during differing discharge events is desirable. This is especially true during the high discharge period of March through May.
- Identifying the primary source of elemental mercury in the watershed is recommended.

Public and Watershed Advisory Group Involvement

Public involvement in the development of this TMDL started with a September 2005 meeting at the Pleasant Valley School and continued through a December 2006 meeting at the Marsing office of the NRCS. Additional information on public involvement is presented in Appendix G.

Revisions to Jordan Creek temperature TMDL for inclusion in errata. November 2010.

The initial submittal to EPA of the Jordan Creek temperature TMDL contained reaches of stream that were labeled as dry and which received no load allocation. These "dry" reaches were found on Soda Creek, Rock Creek, Spring Creek, and Meadow Creek. EPA determined in its review of the submitted temperature TMDL that this was inconsistent with current policy of having a PNV-style temperature TMDL with continuous shade target allocations for the whole length of stream in question. The loads provided for these four streams in the submittal were considered unacceptable because they were not for continuous lengths of stream.

In this errata we have corrected this situation by applying a sagebrush grass vegetation type and corresponding shade target for these "dry" sections of stream. The loads associated with the sagebrush/grass shade targets were incorporated into the load tables for the four streams. Additionally, figures depicting target shade, existing shade, and the difference between them were modified to reflect these new sagebrush/grass targets. Text changes associated with new load values were incorporated into Section 5.4 text and Table 45. The portion of Section 5.4 where changes occurred is included here as well.

By adding in new sections of stream to the loading analysis, existing and target loads increased, but not substantially. The percent in excess changed modestly. For Soda Creek, the previous submittal showed 25.5% of the existing load was in excess. With new reaches added the percent in excess changed to 26.4%. Rock Creek changed from 10.5% in excess to 11.7%. Relative amounts of excess load decreased for both Spring Creek and Meadow Creek. Spring Creek excess load decreased from 27.6% to 24.5%, and Meadow Creek excess load decreased from 13.2% to 11.7%.

Table 1. Existing and Potential Solar Loads for Soda Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Soda Creek**
1550	0.1	5.742	0.39	3.8918	-1.8502	2	2	3100	17800.2	3100	12064.58	-5735.62	-29	sage/grass
180	0.3	4.466	0.39	3.8918	-0.5742	2	2	360	1607.76	360	1401.048	-206.712	-9	
130	0.1	5.742	0.39	3.8918	-1.8502	2	2	260	1492.92	260	1011.868	-481.052	-29	
100	0.3	4.466	0.39	3.8918	-0.5742	2	2	200	893.2	200	778.36	-114.84	-9	
580	0.1	5.742	0.39	3.8918	-1.8502	2	2	1160	6660.72	1160	4514.488	-2146.232	-29	
210	0.5	3.19	0.73	1.7226	-1.4674	2	2	420	1339.8	420	723.492	-616.308	-23	yellow willow
430	0	6.38	0.39	3.8918	-2.4882	2	2	860	5486.8	860	3346.948	-2139.852	-39	sage/grass
100	0.7	1.914	0.73	1.7226	-0.1914	2	2	200	382.8	200	344.52	-38.28	-3	yellow willow
120	0.3	4.466	0.73	1.7226	-2.7434	2	2	240	1071.84	240	413.424	-658.416	-43	
810	0	6.38	0.39	3.8918	-2.4882	2	2	1620	10335.6	1620	6304.716	-4030.884	-39	sage/grass
1180	0.7	1.914	0.73	1.7226	-0.1914	2	2	2360	4517.04	2360	4065.336	-451.704	-3	yellow willow
240	0.2	5.104	0.27	4.6574	-0.4466	3	3	720	3674.88	720	3353.328	-321.552	-7	sage/grass
470	0.4	3.828	0.56	2.8072	-1.0208	3	3	1410	5397.48	1410	3958.152	-1439.328	-16	yellow willow
120	0	6.38	0.56	2.8072	-3.5728	3	3	360	2296.8	360	1010.592	-1286.208	-56	
200	0.2	5.104	0.56	2.8072	-2.2968	3	3	600	3062.4	600	1684.32	-1378.08	-36	
780	0.2	5.104	0.27	4.6574	-0.4466	3	3	2340	11943.36	2340	10898.316	-1045.044	-7	sage/grass
510	0.4	3.828	0.46	3.4452	-0.3828	4	4	2040	7809.12	2040	7028.208	-780.912	-6	yellow willow
1200	0.3	4.466	0.46	3.4452	-1.0208	4	4	4800	21436.8	4800	16536.96	-4899.84	-16	
360	0.2	5.104	0.39	3.8918	-1.2122	5	5	1800	9187.2	1800	7005.24	-2181.96	-19	
190	0.1	5.742	0.39	3.8918	-1.8502	5	5	950	5454.9	950	3697.21	-1757.69	-29	
450	0	6.38	0.39	3.8918	-2.4882	5	5	2250	14355	2250	8756.55	-5598.45	-39	
360	0.1	5.742	0.39	3.8918	-1.8502	5	5	1800	10335.6	1800	7005.24	-3330.36	-29	
510	0.3	4.466	0.39	3.8918	-0.5742	5	5	2550	11388.3	2550	9924.09	-1464.21	-9	
50	0	6.38	0.34	4.2108	-2.1692	6	6	300	1914	300	1263.24	-650.76	-34	
150	0.3	4.466	0.34	4.2108	-0.2552	6	6	900	4019.4	900	3789.72	-229.68	-4	
420	0.1	5.742	0.34	4.2108	-1.5312	6	6	2520	14469.84	2520	10611.216	-3858.624	-24	
540	0	6.38	0.34	4.2108	-2.1692	6	6	3240	20671.2	3240	13642.992	-7028.208	-34	
460	0.2	5.104	0.34	4.2108	-0.8932	6	6	2760	14087.04	2760	11621.808	-2465.232	-14	
							Total	**42,120**	**213,092**	**42,120**	**156,756**	**-56,336**	**-23**	

Table 2. Existing and Potential Solar Loads for Rock Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load ($kWh/m^2/day$)	Potential Shade (fraction)	Potential Summer Load ($kWh/m^2/day$)	Potential Load minus Existing load ($kWh/m^2/day$)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Rock Creek**
70	0.5	3.19	0.55	2.871	-0.32	1	1	70	223.3	70	200.97	-22.33	-5	Meadow grass
1700	0.1	5.742	0.55	2.871	-2.87	1	1	1700	9761.4	1700	4880.7	-4880.7	-45	
270	0.3	4.466	0.55	2.871	-1.595	1	1	270	1205.82	270	775.17	-430.65	-25	
870	0.1	5.742	0.55	2.871	-2.871	1	1	870	4995.54	870	2497.77	-2497.77	-45	
880	0	6.38	0.55	2.871	-3.509	1	1	880	5614.4	880	2526.48	-3087.92	-55	
870	0.1	5.742	0.31	4.4022	-1.3398	2	2	1740	9991.08	1740	7659.828	-2331.252	-21	
160	0.2	5.104	0.73	1.7226	-3.3814	2	2	320	1633.28	320	551.232	-1082.048	-53	Yellow willow
160	0.1	5.742	0.73	1.7226	-4.0194	2	2	320	1837.44	320	551.232	-1286.208	-63	
230	0.2	5.104	0.73	1.7226	-3.3814	2	2	460	2347.84	460	792.396	-1555.444	-53	
480	0.1	5.742	0.31	4.4022	-1.3398	2	2	960	5512.32	960	4226.112	-1286.208	-21	Meadow grass
540	0.2	5.104	0.31	4.4022	-0.7018	2	2	1080	5512.32	1080	4754.376	-757.944	-11	
420	0.1	5.742	0.31	4.4022	-1.3398	2	2	840	4823.28	840	3697.848	-1125.432	-21	
470	0	6.38	0.56	2.8072	-3.5728	3	3	1410	8995.8	1410	3958.152	-5037.648	-56	Yellow willow
190	0.2	5.104	0.56	2.8072	-2.2968	3	3	570	2909.28	570	1600.104	-1309.176	-36	
290	0.1	5.742	0.56	2.8072	-2.9348	3	3	870	4995.54	870	2442.264	-2553.276	-46	
220	0	6.38	0.56	2.8072	-3.5728	3	3	660	4210.8	660	1852.752	-2358.048	-56	
120	0.1	5.742	0.56	2.8072	-2.9348	3	3	360	2067.12	360	1010.592	-1056.528	-46	
110	0	6.38	0.56	2.8072	-3.5728	3	3	330	2105.4	330	926.376	-1179.024	-56	
100	0.1	5.742	0.56	2.8072	-2.9348	3	3	300	1722.6	300	842.16	-880.44	-46	
540	0.2	5.104	0.56	2.8072	-2.2968	3	3	1620	8268.48	1620	4547.664	-3720.816	-36	
590	0.1	5.742	0.56	2.8072	-2.9348	3	3	1770	10163.34	1770	4968.744	-5194.596	-46	
2210	0.3	4.466	0.46	3.4452	-1.0208	4	4	8840	39479.44	8840	30455.568	-9023.872	-16	
1560	0.4	3.828	0.39	3.8918	0.0638	5	5	7800	29858.4	7800	30356.04	497.64	0	
230	0.3	4.466	0.39	3.8918	-0.5742	5	5	1150	5135.9	1150	4475.57	-660.33	-9	
1050	0.2	5.104	0.39	3.8918	-1.2122	5	5	5250	26796	5250	20431.95	-6364.05	-19	
520	0.3	4.466	0.34	4.2108	-0.2552	6	6	3120	13933.92	3120	13137.696	-796.224	-4	
560	0.4	3.828	0.34	4.2108	0.3828	6	6	3360	12862.08	3360	14148.288	1286.208	0	
510	0.2	5.104	0.34	4.2108	-0.8932	6	6	3060	15618.24	3060	12885.048	-2733.192	-14	
320	0.1	5.742	0.34	4.2108	-1.5312	6	6	1920	11024.64	1920	8084.736	-2939.904	-24	
750	0	6.38	0.34	4.2108	-2.1692	6	6	4500	28710	4500	18948.6	-9761.4	-34	
380	0.1	5.742	0.3	4.466	-1.276	7	7	2660	15273.72	2660	11879.56	-3394.16	-20	
1420	0.4	3.828	0.3	4.466	0.638	7	7	9940	38050.32	9940	44392.04	6341.72	0	
360	0.3	4.466	0.3	4.466	0	7	7	2520	11254.32	2520	11254.32	0	0	
250	0.1	5.742	0.3	4.466	-1.276	7	7	1750	10048.5	1750	7815.5	-2233	-20	
900	0.2	5.104	0.3	4.466	-0.638	7	7	6300	32155.2	6300	28135.8	-4019.4	-10	
4020	0.4	3.828	0.27	4.6574	0.8294	8	8	32160	123108.48	32160	149781.984	26673.504	0	
1380	0.3	4.466	0.24	4.8488	0.3828	9	9	12420	55467.72	12420	60222.096	4754.376	0	
150	0.5	3.19	0.22	4.9764	1.7864	10	10	1500	4785	1500	7464.6	2679.6	0	
440	0.2	5.104	0.22	4.9764	-0.1276	10	10	4400	22457.6	4400	21896.16	-561.44	-2	
340	0.1	5.742	0.22	4.9764	-0.7656	10	10	3400	19522.8	3400	16919.76	-2603.04	-12	
990	0	6.38	0.22	4.9764	-1.4036	10	10	9900	63162	9900	49266.36	-13895.64	-22	
1190	0.1	5.742	0.2	5.104	-0.638	11	11	13090	75162.78	13090	66811.36	-8351.42	-10	
3200	0	6.38	0.19	5.1678	-1.2122	12	12	38400	244992	38400	198443.52	-46548.48	-19	
4730	0	6.38	0.18	5.2316	-1.1484	13	13	61490	392306.2	61490	321691.084	-70615.116	-18	
490	0.1	5.742	0.17	5.2954	-0.4466	14	14	6860	39390.12	6860	36326.444	-3063.676	-7	
610	0	6.38	0.17	5.2954	-1.0846	14	14	8540	54485.2	8540	45222.716	-9262.484	-17	
730	0.2	5.104	0.17	5.2954	0.1914	14	14	10220	52162.88	10220	54118.988	1956.108	0	
180	0	6.38	0.17	5.2954	-1.0846	14	14	2520	16077.6	2520	13344.408	-2733.192	-17	
650	0.2	5.104	0.15	5.423	0.319	15	15	9750	49764	9750	52874.25	3110.25	0	
1680	0.1	5.742	0.15	5.423	-0.319	15	15	25200	144698.4	25200	136659.6	-8038.8	-5	
							Total	**319,420**	**1,746,640**	**319,420**	**1,542,707**	**-203,933**	**-23**	

Table 3. Existing and Potential Solar Loads for Spring Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Spring Creek**
950	0.7	1.914	0.79	1.3398	-0.57	1	1	950	1818.3	950	1272.81	-545.49	-9	tributary-PVG2
280	0.5	3.19	0.89	0.7018	-2.4882	1	1	280	893.2	280	196.504	-696.696	-39	yellow willow
350	0.6	2.552	0.89	0.7018	-1.8502	1	1	350	893.2	350	245.63	-647.57	-29	
850	0.5	3.19	0.89	0.7018	-2.4882	1	1	850	2711.5	850	596.53	-2114.97	-39	
740	0.6	2.552	0.78	1.4036	-1.1484	2	2	1480	3776.96	1480	2077.328	-1699.632	-18	PVG2
610	0.5	3.19	0.78	1.4036	-1.7864	2	2	1220	3891.8	1220	1712.392	-2179.408	-28	
220	0.2	5.104	0.31	4.4022	-0.7018	2	2	440	2245.76	440	1936.968	-308.792	-11	meadow grass
450	0.4	3.828	0.73	1.7226	-2.1054	2	2	900	3445.2	900	1550.34	-1894.86	-33	yellow willow
450	0.1	5.742	0.31	4.4022	-1.3398	2	2	900	5167.8	900	3961.98	-1205.82	-21	meadow
390	0	6.38	0.31	4.4022	-1.9778	2	2	780	4976.4	780	3433.716	-1542.684	-31	grass
440	0.6	2.552	0.79	1.3398	-1.2122	1	1	440	1122.88	440	589.512	-533.368	-19	mainstem-PVG2
1310	0	6.38	0.55	2.871	-3.509	1	1	1310	8357.8	1310	3761.01	-4596.79	-55	meadow grass
440	0.4	3.828	0.89	0.7018	-3.1262	1	1	440	1684.32	440	308.792	-1375.528	-49	yellow willow
180	0.1	5.742	0.89	0.7018	-5.0402	1	1	180	1033.56	180	126.324	-907.236	-79	
960	0.2	5.104	0.73	1.7226	-3.3814	2	2	1920	9799.68	1920	3307.392	-6492.288	-53	
1450	0	6.38	0.31	4.4022	-1.9778	2	2	2900	18502	2900	12766.38	-5735.62	-31	meadow
220	0	6.38	0.21	5.0402	-1.3398	3	3	660	4210.8	660	3326.532	-884.268	-21	grass
260	0.1	5.742	0.21	5.0402	-0.7018	3	3	780	4478.76	780	3931.356	-547.404	-11	
300	0	6.38	0.21	5.0402	-1.3398	3	3	900	5742	900	4536.18	-1205.82	-21	
530	0.1	5.742	0.21	5.0402	-0.7018	3	3	1590	9129.78	1590	8013.918	-1115.862	-11	
200	0	6.38	0.21	5.0402	-1.3398	3	3	600	3828	600	3024.12	-803.88	-21	
510	0.1	5.742	0.16	5.3592	-0.3828	4	4	2040	11713.68	2040	10932.768	-780.912	-6	
830	0	6.38	0.16	5.3592	-1.0208	4	4	3320	21181.6	3320	17792.544	-3389.056	-16	
250	0.1	5.742	0.16	5.3592	-0.3828	4	4	1000	5742	1000	5359.2	-382.8	-6	
640	0.2	5.104	0.39	3.8918	-1.2122	5	5	3200	16332.8	3200	12453.76	-3879.04	-19	yellow willow
870	0	6.38	0.13	5.5506	-0.8294	5	5	4350	27753	4350	24145.11	-3607.89	-13	meadow grass
1300	0.1	5.742	0.17	5.2954	-0.4466	5	5	6500	37323	6500	34420.1	-2902.9	-7	sage/grass
620	0.1	5.742	0.39	3.8918	-1.8502	5	5	3100	17800.2	3100	12064.58	-5735.62	-29	yellow willow
							Total	**43,380**	**235,556**	**43,380**	**177,844**	**-57,712**	**-26**	

Table 4. Existing and Potential Solar Loads for Meadow Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Meadow Creek**
1440	0.7	1.914	0.79	1.3398	-0.57	1	1	1440	2756.16	1440	1929.312	-826.848	-9	PVG2
790	0.5	3.19	0.79	1.3398	-1.8502	1	1	790	2520.1	790	1058.442	-1461.658	-29	
440	0.5	3.19	0.73	1.7226	-1.4674	2	2	880	2807.2	880	1515.888	-1291.312	-23	yellow willow
540	0.2	5.104	0.36	4.0832	-1.0208	2	2	1080	5512.32	1080	4409.856	-1102.464	-16	meadow grass
500	0.5	3.19	0.73	1.7226	-1.4674	2	2	1000	3190	1000	1722.6	-1467.4	-23	yellow willow
280	0.2	5.104	0.73	1.7226	-3.3814	2	2	560	2858.24	560	964.656	-1893.584	-53	
1220	0.5	3.19	0.56	2.8072	-0.3828	3	3	3660	11675.4	3660	10274.352	-1401.048	-6	
370	0.2	5.104	0.27	4.6574	-0.4466	3	3	1110	5665.44	1110	5169.714	-495.726	-7	sage/grass
500	0.3	4.466	0.27	4.6574	0.1914	3	3	1500	6699	1500	6986.1	287.1	0	
160	0.1	5.742	0.21	5.0402	-0.7018	4	4	640	3674.88	640	3225.728	-449.152	-11	
620	0.3	4.466	0.46	3.4452	-1.0208	4	4	2480	11075.68	2480	8544.096	-2531.584	-16	yellow willow
150	0	6.38	0.21	5.0402	-1.3398	4	4	600	3828	600	3024.12	-803.88	-21	sage/grass
320	0.2	5.104	0.46	3.4452	-1.6588	4	4	1280	6533.12	1280	4409.856	-2123.264	-26	yellow willow
1240	0.1	5.742	0.39	3.8918	-1.8502	5	5	6200	35600.4	6200	24129.16	-11471.24	-29	
200	0	6.38	0.39	3.8918	-2.4882	5	5	1000	6380	1000	3891.8	-2488.2	-39	beaver pond
330	0.1	5.742	0.39	3.8918	-1.8502	5	5	1650	9474.3	1650	6421.47	-3052.83	-29	
640	0	6.38	0.11	5.6782	-0.7018	6	6	3840	24499.2	3840	21804.288	-2694.912	-11	meadow
410	0.1	5.742	0.11	5.6782	-0.0638	6	6	2460	14125.32	2460	13968.372	-156.948	-1	grass
460	0.4	3.828	0.34	4.2108	0.3828	6	6	2760	10565.28	2760	11621.808	1056.528	0	yellow willow
940	0.2	5.104	0.34	4.2108	-0.8932	6	6	5640	28786.56	5640	23748.912	-5037.648	-14	
280	0.3	4.466	0.34	4.2108	-0.2552	6	6	1680	7502.88	1680	7074.144	-428.736	-4	
310	0	6.38	0.34	4.2108	-2.1692	6	6	1860	11866.8	1860	7832.088	-4034.712	-34	
820	0.1	5.742	0.34	4.2108	-1.5312	6	6	4920	28250.64	4920	20717.136	-7533.504	-24	
800	0.2	5.104	0.34	4.2108	-0.8932	6	6	4800	24499.2	4800	20211.84	-4287.36	-14	
250	0.3	4.466	0.34	4.2108	-0.2552	6	6	1500	6699	1500	6316.2	-382.8	-4	
550	0.4	3.828	0.34	4.2108	0.3828	6	6	3300	12632.4	3300	13895.64	1263.24	0	
390	0.5	3.19	0.3	4.466	1.276	7	7	2730	8708.7	2730	12192.18	3483.48	0	
990	0.1	5.742	0.1	5.742	0	7	7	6930	39792.06	6930	39792.06	0	0	meadow grass
780	0.3	4.466	0.27	4.6574	0.1914	8	8	6240	27867.84	6240	29062.176	1194.336	0	yellow willow
1150	0.1	5.742	0.08	5.8696	0.1276	8	8	9200	52826.4	9200	54000.32	1173.92	0	meadow grass
							Total	**83,730**	**418,873**	**83,730**	**369,914**	**-48,958**	**-15**	

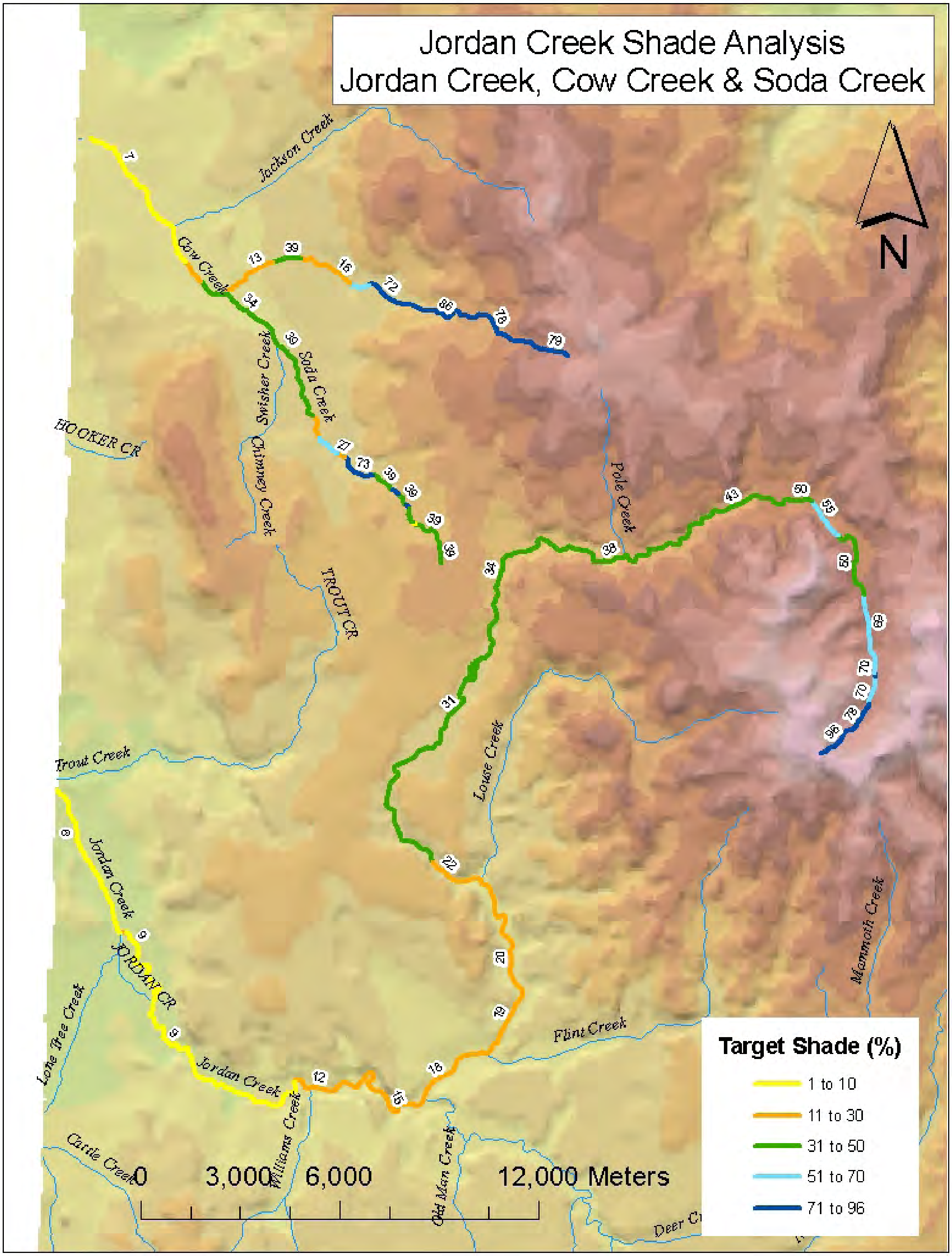


Figure 1. Target Shade for Jordan Creek and Associated Tributaries.

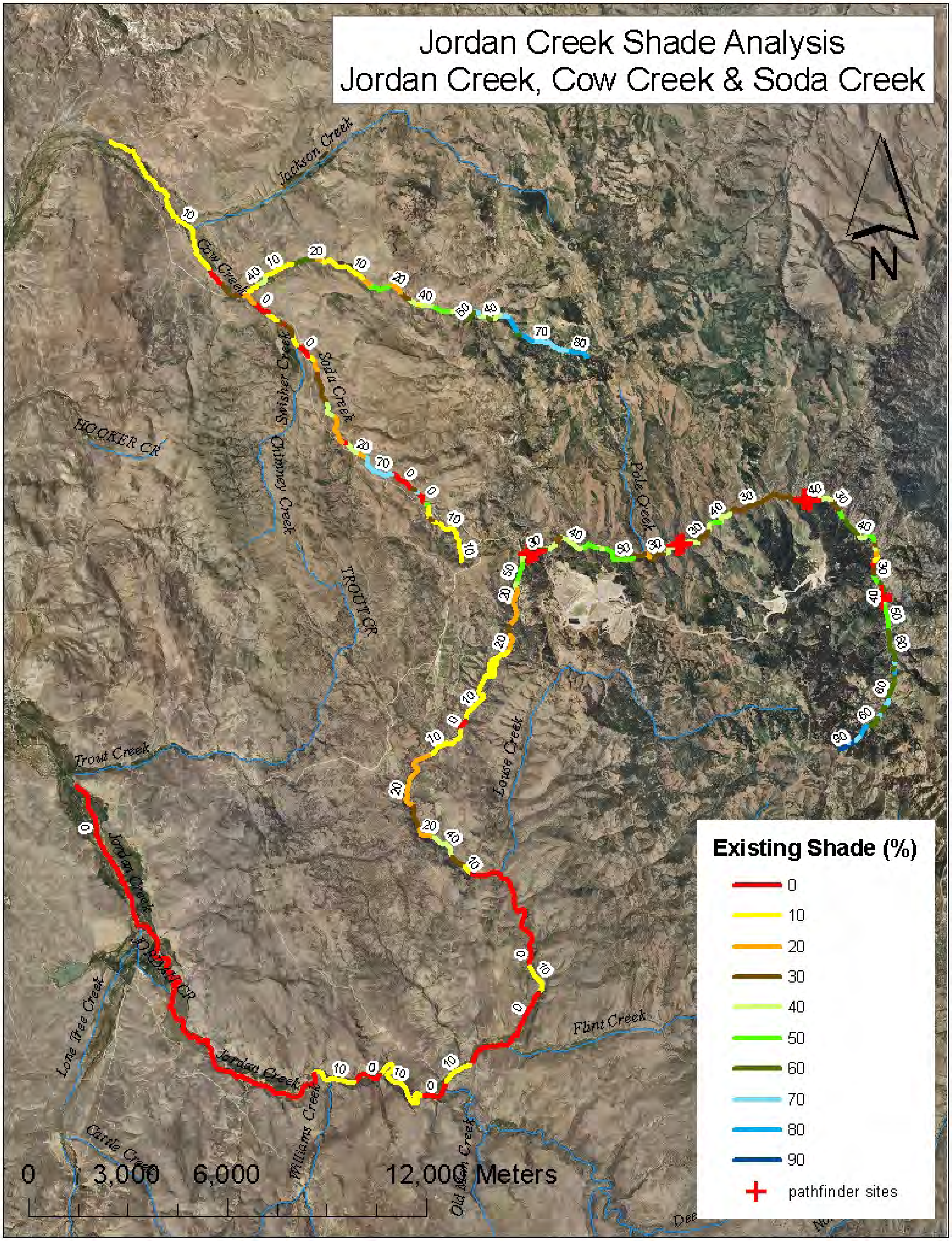


Figure 2. Existing Cover Estimated for Jordan Creek and Associated Tributaries by Aerial Photo Interpretation.

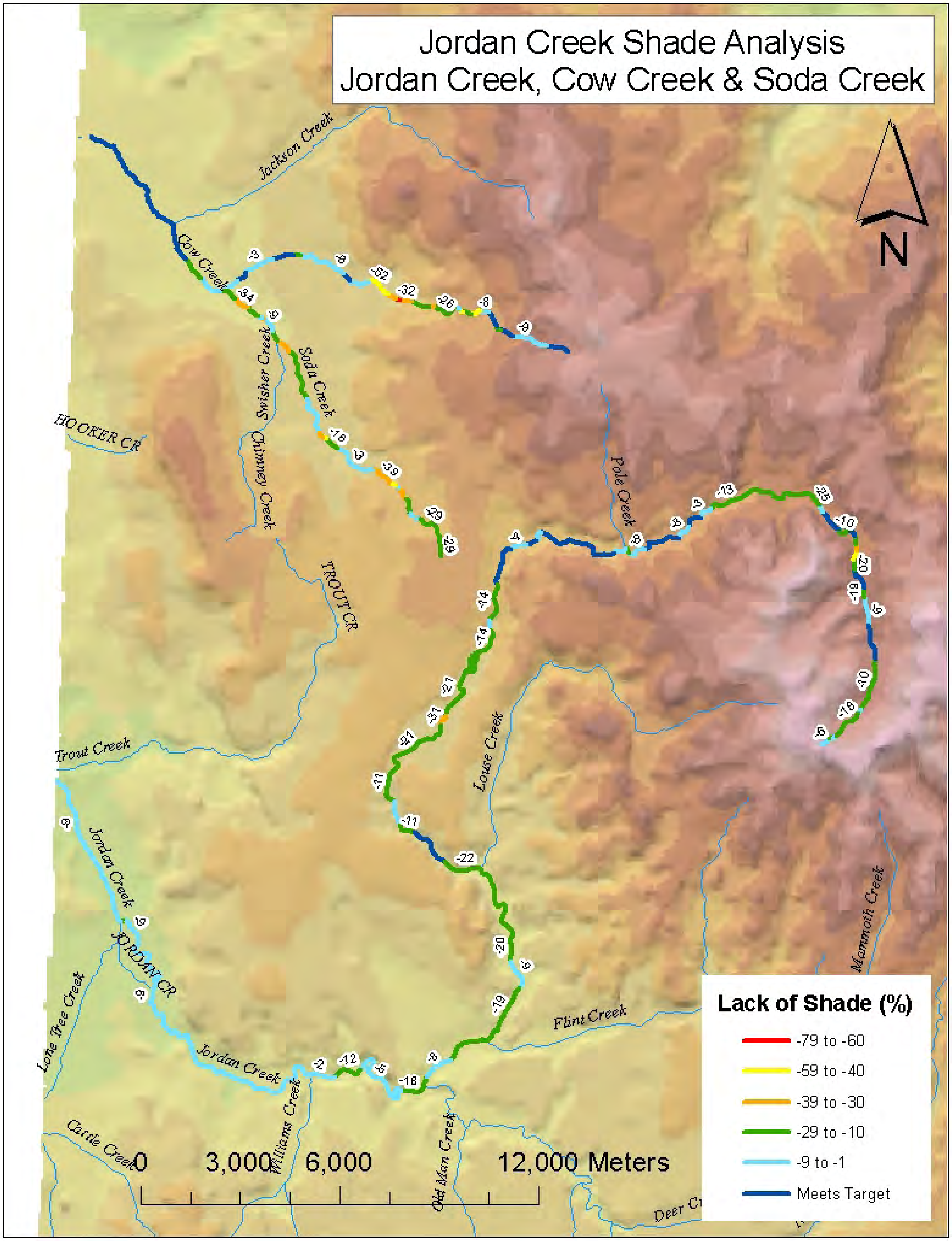


Figure 3. Lack of Shade (Difference Between Existing and Target) for Jordan Creek and Associated Tributaries.

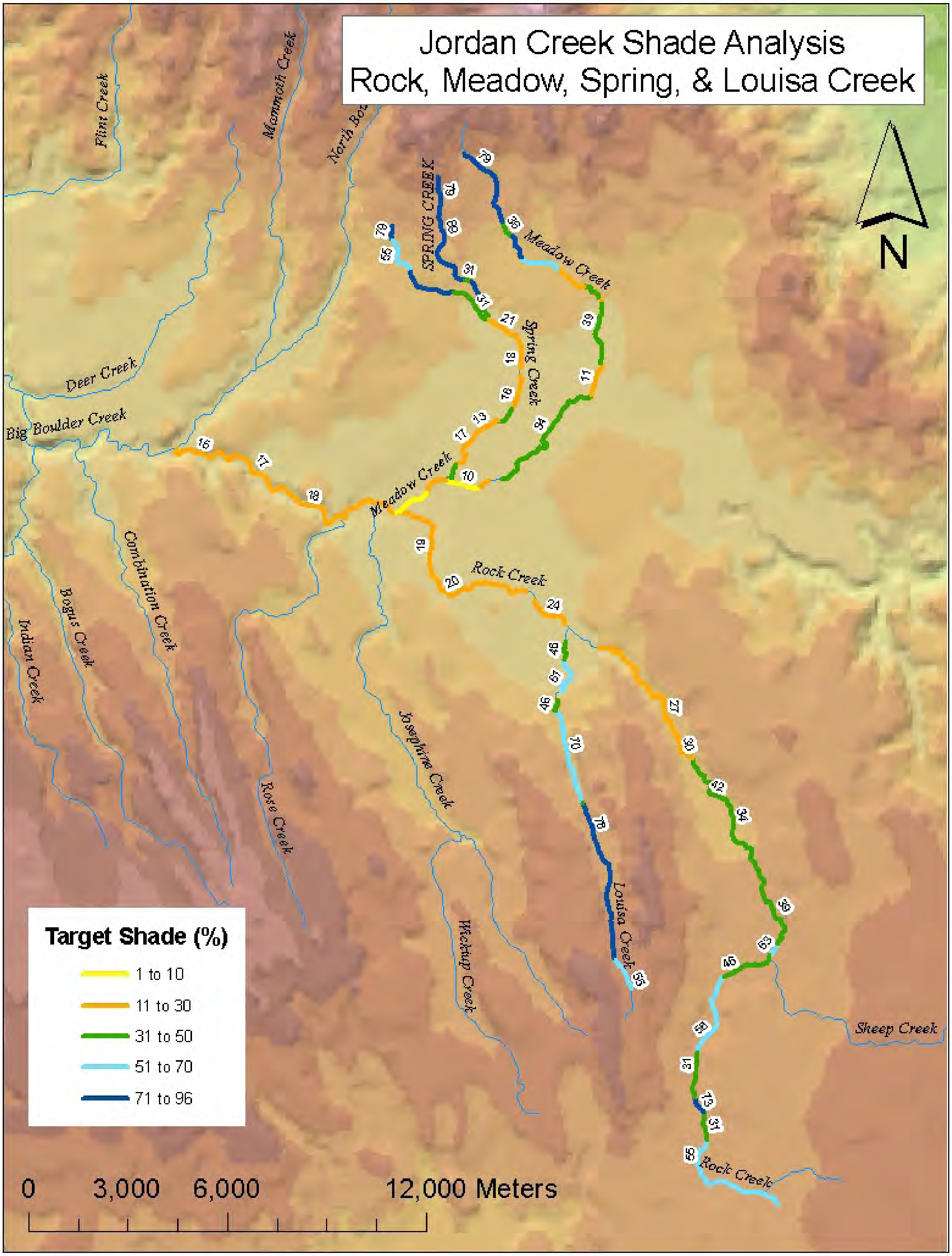


Figure 4. Target Shade for Rock Creek and Associated Tributaries.

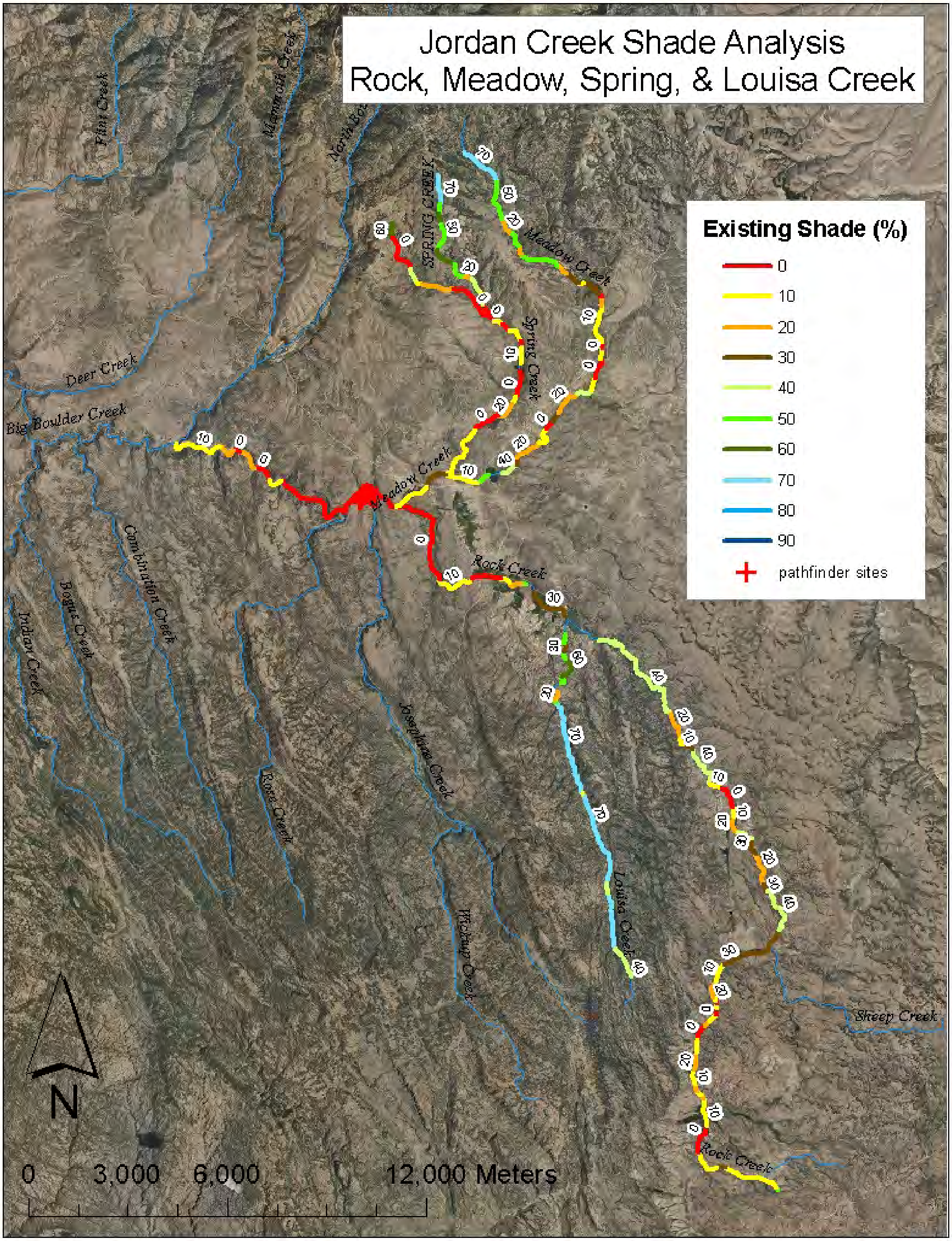


Figure 5. Existing Shade Estimated for Rock Creek and Associated Tributaries by Aerial Photo Interpretation.

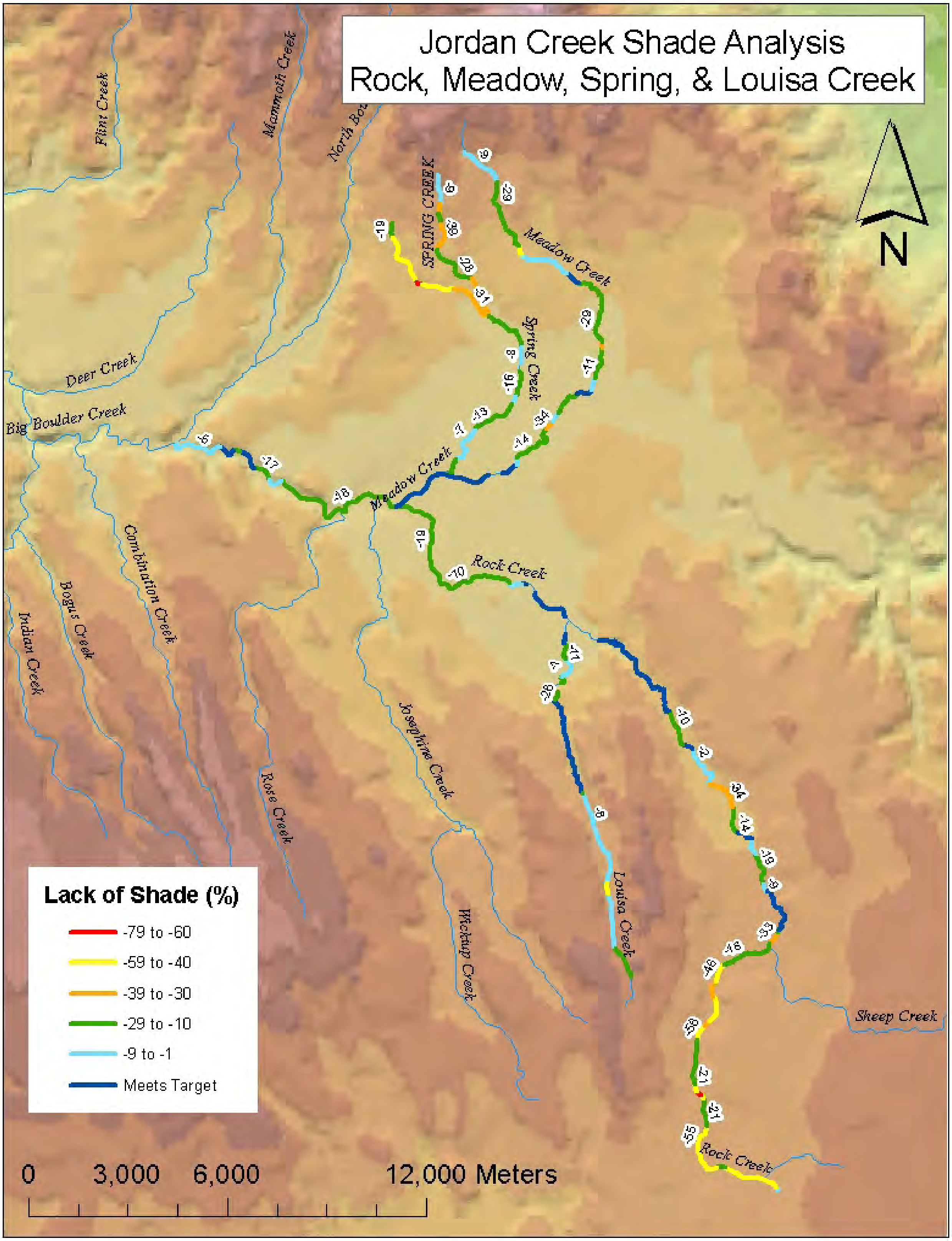


Figure 6. Lack of Shade (Difference Between Existing and Target) for Rock Creek and Associated Tributaries.

5.4 Load Allocation for Temperature

The load capacity is divided among a margin of safety (MOS), the background pollutant load allocation, the point source pollutant wasteload allocation (WLA), and the non-point pollutant load allocation (LA). The sum of these loads must equal the load capacity (LC), the total maximum daily load the water body can assimilate and still meet water quality standards.

Because this TMDL is based on potential natural vegetation, which is equivalent to background loading, the load allocation is essentially the desire to achieve background conditions. However, to reach that objective, load allocations are assigned to non point source activities that have or may affect riparian vegetation and shade as a whole. Load allocations are therefore stream reach specific and are dependent upon the target load for a given reach.

As discussed earlier, target or potential shade is converted to a potential summer load by multiplying the inverse fraction (1-shade fraction) by the average loading to a flat plate collector for the months of April through September. That is the loading capacity of the stream and it is necessary to achieve background conditions. There is no opportunity to further remove shade from the stream by any activity without exceeding its loading capacity.

Table 5 shows the excess heat load (kWh/day) experienced by each water body examined and the average difference between existing and target shade levels necessary to bring that water body back to target load levels. The size of a stream influences the size of the excess load. Large streams have higher existing and target loads by virtue of their larger channel widths as compared to smaller streams. The table lists the tributaries in order of their excess loads highest to lowest. Therefore, large tributaries tend to be listed first and small tributaries are listed last.

Jordan Creek and Rock Creek were the two largest streams examined, so they have the largest excess loads (2,965,275 and 203,933 kWh/day, respectively). Those excess loads represent 41% and 12%, respectively, of their total existing loads. Smaller streams tend to have smaller excess loads; however, Cow Creek is unique in that it is a relatively large stream with a small excess load (4% of its existing load). Spring Creek and Soda Creek had the highest excess loads relative to existing loads (25% and 26% respectively) compared to other streams. Soda Creek is largely an intermittent waterway and loss of shade in this system maybe more indicative of the lack of water rather than any other kind of disturbance. Louisa Creek and Meadow Creek had excess loads that were 15% and 12% of their respective existing loads.

Average lack of shade is the average of all the differences between existing shade and target shade for each segment of each stream. These differences are seen in the last column of the load tables. The average lack of shade value presented in Table 5 may represent a comparable level of disturbance in each system, however, individual differences between existing shade and target shade for each stream segment needs to be examined carefully for potential stream rehabilitation. These data suggest that streams in the analysis are lacking upto a quarter of their potential shade on average.

Although the table dwells on total heat loads for streams in this TMDL, it is important to note that differences between existing shade and target shade, as depicted in Figures 43 and 46 and the last column of each loading table (Table 3 through Table 5), are the key to successfully restoring these waters to achieving WQS. Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should key in on the largest differences between existing and target shade as locations to prioritize implementation efforts.

Table 5. Total Existing, Target and Excess Solar Loads and Average Lack of Shade for All Tributaries.

WATER BODY	TOTAL EXISTING LOAD (KWH/DAY)	TOTAL TARGET LOAD (KWH/DAY)	EXCESS LOAD (KWH/DAY)	AVERAGE LACK OF SHADE (%)
Jordan Creek	7,273,168	4,307,893 2,965,2	75	-10
Rock Creek	1,746,640	1,542,707 203,9	33	-23
Spring Creek	235,556	177,844	57,712	-26
Meadow Creek	418,873	369,914	48,958	-15
Soda Creek	213,092	156,756	56,336	-23
Cow Creek	521,884	499,264	22,620	-18
Louisa Creek	69,389	58,783	10,605	-13

The loading capacity for Jordan Creek is over 4.3 million kWh/day, and its existing load is about 7.3 million kWh/day (**Error! Reference source not found.**, page **Error! Bookmark not defined.**). The difference between these two values is the excess load reported in Table 5 (2,965,275 kWh/day). The excess load is 41% of the existing load, which suggests that Jordan Creek is in poor condition. However, the bulk of that excess load is coming from the last segment in the loading table, the section of stream below Williams Creek. This area has experienced excessive widening of the channel, which results in an average bankfull width that is twice its natural bankfull width. Above Williams Creek, Jordan Creek is in relatively good condition and of a lower priority than major water bodies with excess loads representing greater than 20% of their existing loads.

Triangle Reservoir, a 1200m long by 350m wide pond on Rock Creek near the confluence with Louisa Creek, was specifically excluded from the analysis. Although reservoirs obviously play a role in affecting stream temperature, it is not always clear whether that role is a benefit or a detriment to stream temperatures below the impoundment. Triangle Reservoir should be examined in the future to determine what if any influence it may have on Rock Creek water temperatures.All these data suggest that the Jordan Creek watershed is in relatively good condition with respect to shade and is not far from obtaining target conditions. The Jordan Creek watershed has made substantial improvements in riparian vegetation over the years since dredge mining and channelization occurred in the early 1900s. Landowners have demonstrated their respect for the land through maintaining riparian plant communities in many areas throughout the valley.

A certain amount of excess load is created by the method difference inherent in the loading analysis. Because existing shade is reported as a 10% class level and target shade is a unique integer, there is always a difference between them. For example, say a particular stretch of stream has a target shade of 86% based on its vegetation type and natural bankfull width. If existing shade on that stretch of stream were at target level, it would be recorded as 80% existing shade in the loading analysis because it falls into that existing shade class. There is an automatic difference of 6%, which is potentially attributable to the margin of safety.

1. Subbasin Assessment – Watershed Characterization

1.1 Physical and Biological Characteristics

Jordan Creek (Figure 1) is a diverse watershed that ranges in elevation from 8,000 feet near Silver City, Idaho to 3,500 feet near Rome, Oregon. Land uses include irrigated pasture and hay land, rangeland, and forested areas. Average precipitation ranges from a little under 21 inches in the higher elevations, to a little over 11 inches in the plateaus of eastern Oregon.

Most of the hydrology for the watershed has been modified to one extent or another. Large irrigation water storage reservoirs can be found within Oregon, while in-stream diversions make up the largest type of modifications in Idaho.

The economy is mostly agricultural, with large tracts of land under some form of irrigation in the lower elevations. Open range on federally and state managed lands, makes up the major land use in the upper elevations, and although there is also evidence of legacy mining and ore milling in the watershed, active mining is limited to one operation, the Delamar Mine, which is in the final phases of reclamation and is no longer extracting ore.

The biological characteristics, geology, and history of the watershed will be discussed in the following sections.

Climate

There is one Idaho climate monitoring station within the Jordan Creek watershed: Silver City (Station # 108412). Other stations within the watershed are located in Oregon and include Sheaville, Oregon (Station # 357736); Rocksville 5N, Oregon (Station # 357277); and Danner, Oregon (Station # 352135). Additional climate monitoring sites outside the watershed include Reynolds, Idaho (Station # 107648); Grandview 2W, Idaho (Station # 103760); Bruneau, Idaho (Station # 101195); and Owyhee Dam, Oregon (Station # 356405) (Climatic Service Center, Internet Retrieval 2004)

The Oregon stations within the watershed reflect weather conditions in the lower elevations (3670-4580 feet/1118-1395 meters), while the only climate station within Idaho shows the climatic conditions in the upper elevations (6190 feet/1900 meters).

Table 1 shows the annual average climatic summary within the watershed; Figure 2 shows the expected precipitation pattern.

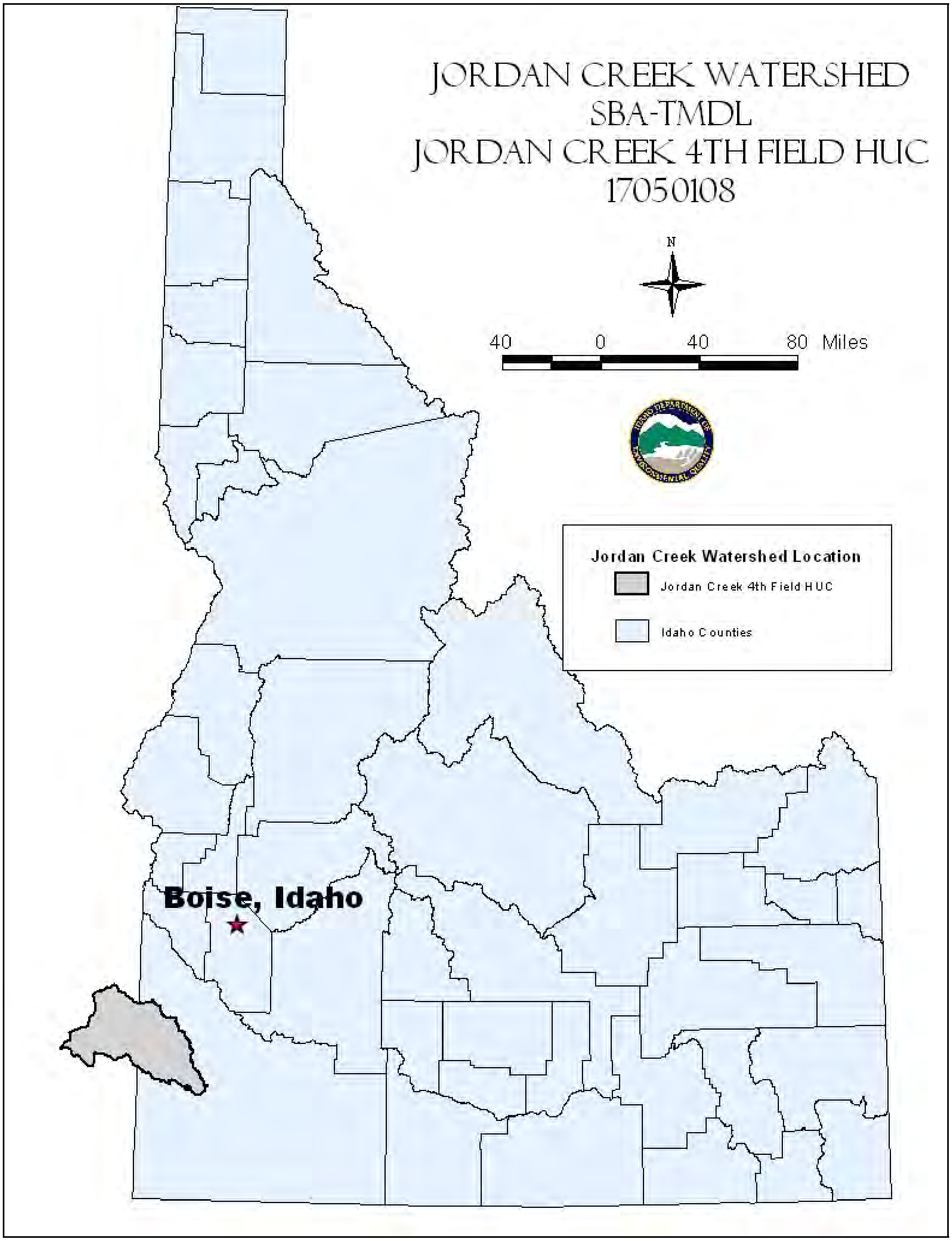


Figure 1. Jordan Creek Watershed Location.

Table 1. Climatic summary for the Jordan Creek Watershed (Western Regional Climatic Center 2004).

Station and Station Identification	Silver City, Idaho (Station # 108412)	Sheaville, Oregon (Station # 357736)	Danner, Oregon (Station # 352135)	Rocksville 5N, Oregon (Station # 357277)
Elevation meters (feet)	1877 (6160)	1396 (4580)	1320 (4330)	1146 (3760)
Max Average Temp, June-thru September (in ºF/ ºC)	55.7/13.2	60.8/16.0	83.5/28.6 62.6/17.0	
Min Average Temp, June thru September (in ºF/ ºC)	35.4/1.9 31.9/-0.1		43.0/6.1	31.3/-0.4
Average Precipitation. (inches)	20.9 13.5 11.6 11.6			
Average Snow accumulation (inches)	80.9 35.0 25.2 17.3			

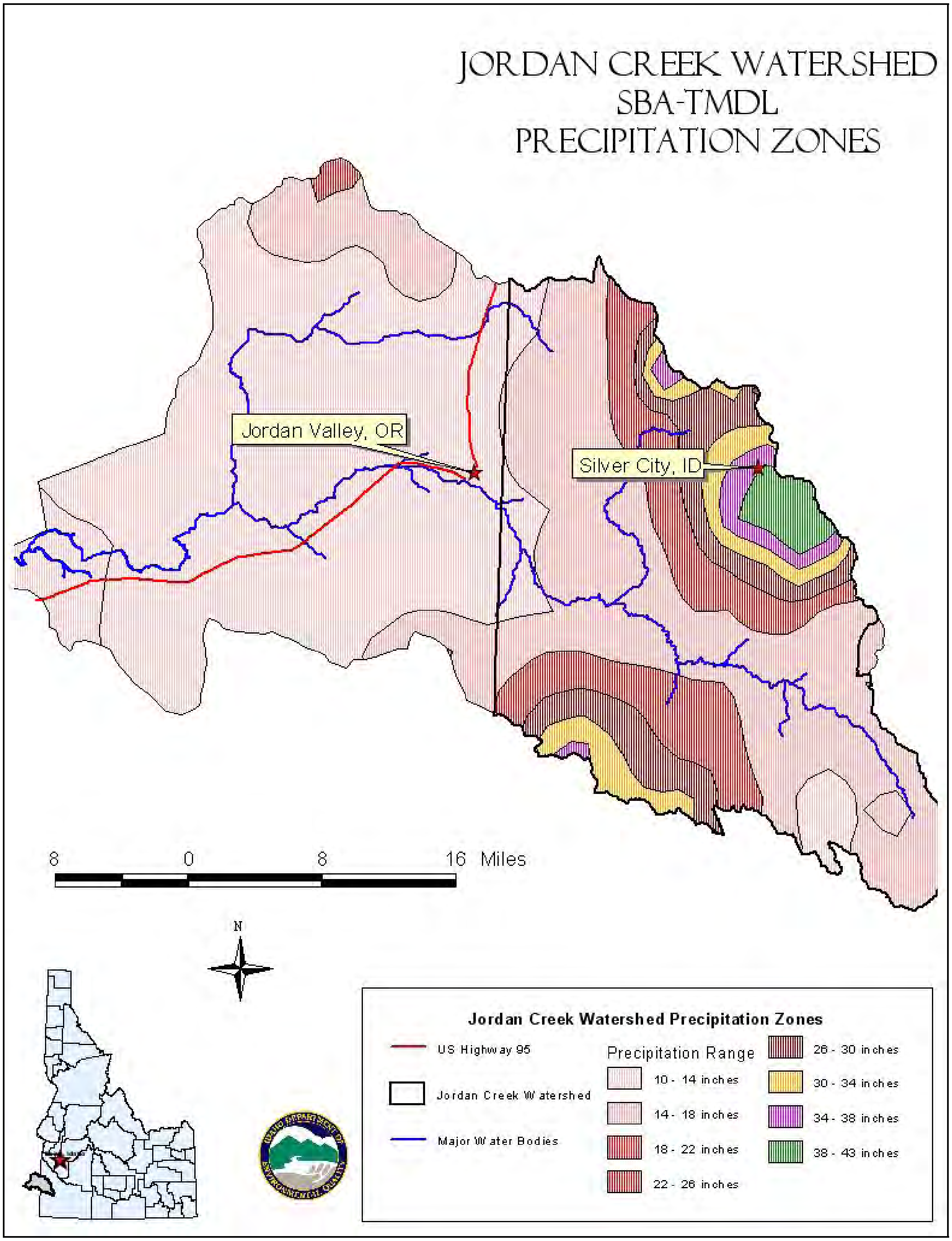


Figure 2. Precipitation ranges for Jordan Creek Watershed.

There is a sharp contrast between the amount of precipitation in the lower elevations and the upper elevations of the watershed. Silver City, located at 6,100 feet (1,900 meters) receives almost double the annual average precipitation of the stations located below 5,000 feet. These sharp changes in precipitation zones can be seen through changing vegetation patterns, which is most notable near Silver City, Idaho where isolated stands of Douglas fir (Psueudotsuga menziesii) dominate the vegetation.

Additional climate monitoring sites, in close proximity to the Jordan Creek Watershed, are listed in Table 2.

Long term climatic research on Reynolds Creek, directly north of Jordan Creek, conducted in the Reynolds Creek Experimental Watershed by the U.S. Department of Agriculture, Agricultural Research Service, exhibits many of the same physical characteristics. Hanson (2001) reported in the Reynolds Creek watershed, snowfall accounted for approximately 4% of the total precipitation at low-elevation valley sites; while in the higher elevations snowfall accounted for approximately 70% of the total precipitation. Additionally, annual precipitation increased approximately five hundred percent (500 %) from the lower elevation monitoring sites (3900 feet/1190 meters) which receive 9.2 inches compared to the higher elevation sites (7120 feet/2170 meters) which receive 44.2 inches annually.

There is one SNOTEL remote sensing station within the Jordan Creek watershed located on South Mountain (http://www.wcc.nrcs.usda.gov/snotel/snotel.pl?sitenum=774&state=id). The Silver City (Station # 108412) climate monitoring site also provides average monthly snow totals. Additional SNOTEL locations within close proximity to the Jordan Creek watershed include Mud Flat (SNOTEL #654, Station ID #16g07s) and Reynolds Creek (SNOTEL #2029, Station ID #16f08s).

Temperatures average 26-29° C (80-85° F) during summer months, but in all likelihood exceed 37 °C (100° F) on occasion during June, July and August. Overnight temperatures in the canyon areas may be affected by several factors. “Cold pooling” may result in pockets of cool air. Drainage winds may also cause mixing and create warmer air. Sheltered areas may also have areas that maintain higher temperatures from daily heating due to surrounding igneous geology.

The plateaus, South Mountain, Combination/Antelope Ridge, and the Silver City Range areas are more subject to gradient winds, daytime heating and nighttime cooling. These higher elevations are also more subject to summertime thunderstorms. Warm thermal air rises from northern Nevada and is rapidly cooled as it ascends up mountain slopes, summertime thunderstorms are the result. Danner, Oregon ambient air temperatures are probably affected by the basalt lava beds in the area where rapid daytime heating occurs due to this geological feature. It may also experience trapping of warm air during evening hours also associated with the basalt lava beds ability to retain heat and slowly radiate it out during cooler periods.

Table 2. Climatic summary, available weather information outside the Jordan Watershed (Western Regional Climatic Center 2004).

Station and Station Identification	Reynolds, Idaho (Station # 107648)	Grandview 2W, Idaho (Station # 103760)	Bruneau, Idaho (Station # 101195)	Owyhee Dam, Oregon (Station # 356405)
Elevation meters (feet)	1192 (3910)	719 (2360)	914 (3000)	731 (2400)
Max Average Temp, June-thru September (in ºF/ ºC)	61.2/16.2 67.1/19.5	66.7/19.3 65.8/18.8		
Min Average Temp, June thru September (in ºF/ ºC)	34.6/2.6 37.0/2.8	38.3/3.5 38.2/3.4		
Average Precipitation (inches)	10.6	6.9 7.4 9.3		
Average Snow accumulation (inches)	10.1	5.6 4.3 9.0		

Hydrography

The general flow characteristics of the Jordan Creek watershed are from east to west, with most of the headwaters within Idaho (Figure 3). The major topographic features include the Silver City Mountain Range to the north, South Mountain to the south and Combination/Antelope Ridges to the east. The lava beds of eastern Oregon are the most notable characteristics to the west. Jordan Creek joins the Owyhee River downstream from Rome, OR.

Within Idaho, the entire watershed could be broken into four distinctive areas associated with land use influences and/or geographical location; Cow Creek subbasin, Upper Jordan Creek subbasin, Big Boulder Creek (Triangle) subbasin and Lower Jordan Creek.

A majority of the Jordan Creek watershed, within Idaho, is within the Big Boulder Creek (Triangle) subbasin (5th Field HUCs 1705010808, 1705010809, 17050108010 and 17050108011), which includes Rock Creek, Meadow Creek, Combination Creek and Louisa Creek. Land use is mainly grazing with some irrigated areas in the Triangle area located near Triangle Reservoir. Evidence of legacy mining can be found in the South Mountain area and the higher elevations in the Silver City Range to the north.

Stream morphology in this area is influenced by parent geological material and the valley bottom type. The major geological feature is the deep canyon formed by Rock Creek and North Boulder Creek (which forms Big Boulder Creek). This canyon offers little access and no hydrological modifications from Triangle Reservoir to the confluence with Jordan Creek. Table 3 describes the location and characteristics of dams, diversions and gages. Figure 5 shows dams, diversions and discharge monitoring sites. There is no historical discharge monitoring sites in the Boulder Creek subbasin. If required, mathematical modeling will be used to determine discharge and will be discussed in Section 2.0 for the appropriate water body(s).

The upper Jordan Creek subbasin (5th Field HUCs 1705010807) includes the subbasins of Flint Creek, Louse Creek and Jordan Creek. Land use includes legacy mining, grazing and limited forest practices. This portion of the Jordan Creek watershed is probably most influenced by higher elevation snow pack and spring snow melt. Legacy mining in the area has had and may still have some influence on discharge. Past mining has “tapped” into ground water which may now be discharging into surface waters. Other practices may include the construction of tailing dams, diversion of surface water for placer mining which could be used to either increase the amount of available water for later use such as ore processing or to divert surface and/or ground water away from an activity.

The large scale removal of ore bearing material or the overburden, associated with low grade ore, alters the terrain and the overall hydrogeology/morphology, changes flow direction and paths and changes the dynamics of ground water infiltration. Further discussion of mining is located in Section 2.0.

The United States Department of Interior, U S Geological Survey (USGS) conducted discharge monitoring at one site on Jordan Creek (USGS 13177985) near Delamar from 1993 through 1996. (Figure 6 shows the average monthly discharge for this station.) Metadata for USGS Station 13177985 is located in Appendix D. If required, mathematical modeling will be used to determine discharge for the appropriate water body(s) in the smaller subbasins and will be discussed in Section 2.0.

The Cow Creek subbasin (5th Field HUC 1705010806) includes the subbasins of Soda Creek, Jackson Creek, and Cow Creek. Within Idaho, this is a small portion of the overall Jordan Creek watershed. A majority of the Cow Creek subbasin is within Oregon. Cow Creek and Jordan Creek, the two major subbasins, join southwest of Jordan Valley, Oregon near Danner, Oregon and approximately seventeen (17) miles east of the confluence with the Owyhee River at Rome, Oregon. Land use for Cow Creek subbasin, within Idaho, includes irrigated pasture and hay land, and grazing. Some mining has occurred in the watershed. However, it is not as extensive as found in the upper Jordan Creek watershed and it is not expected to influence the overall hydrology.

Lower Jordan Creek (5th Field HUCs 1705010812 and 1705010813), confluence of Big Boulder to Oregon line, includes the subbasins of Trout Creek, Williams Creek and Lone Tree Creek. This segment is the last twelve (12) miles of Jordan Creek in Idaho. Land use includes irrigated pasture and hay land, and grazing. This segment of Jordan Creek exhibits the greatest amount of modification to stream channel morphology and includes numerous in-stream water diversions.

In this segment of Jordan Creek, the natural meandering pattern has been altered to prevent extensive erosion. LANDSAT imagery of Jordan Creek shows “old” stream channel meandering patterns, which have been cutoff from the existing stream channel. Irrigation water diversions of Jordan Creek start near the confluence with Williams Creek. Five other diversions are noted from there to the Oregon state line. Lone Tree Creek also exhibits numerous diversions and is diverted or altered before reaching Jordan Creek. Just below the crossing into Oregon, Jordan Creek water is diverted into the Antelope Reservoir feeder canal. The reservoir is the main source of irrigation water for irrigated cropland throughout the lower Jordan Creek watershed (Figure 4 and Figure 5).

Irrigation water diversion occurs below the confluence of Soda and Cow Creeks. Jackson Creek enters the valley from the north and appears to be diverted into the main irrigation canal on the north side of the valley. Posey and Alkali Creeks enter the valley from the south, discharging into what once was the natural channel for Cow Creek. Diversions occur again, just prior to Cow Creek entering Oregon.

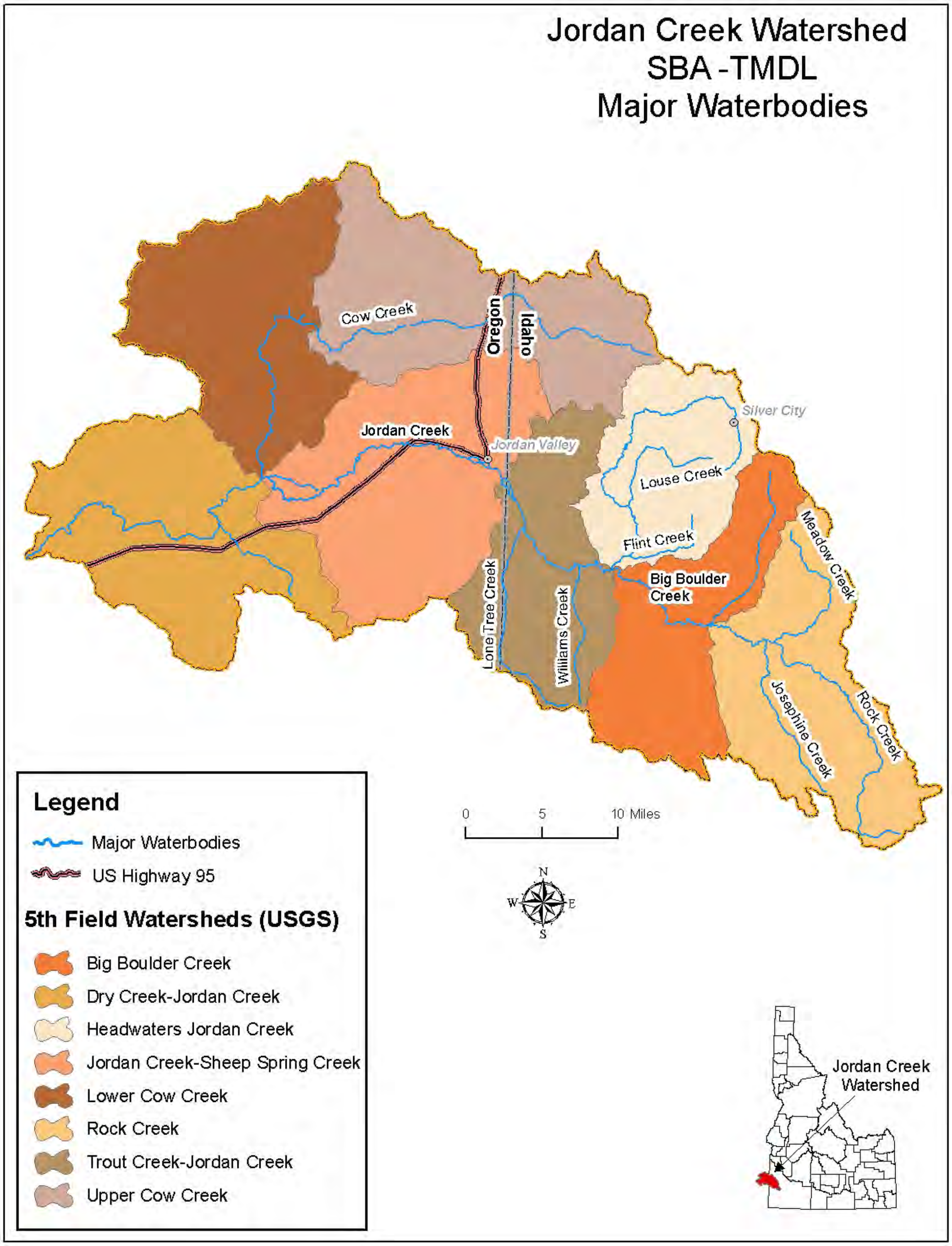


Figure 3. Jordan Creek Watershed major Water Bodies.

There is no current or historical discharge monitoring sites in the watershed, within Idaho or Oregon. If required, mathematical modeling will be used to determine discharge and will be discussed in Section 2.0 for the appropriate water body(s). However, the diversion and the use of Cow Creek for irrigation water may make an accurate discharge prediction impossible. Figure 5 shows dams, diversions and discharge monitoring sites within the Jordan Creek watershed. Table 3 describes the location and characteristics of dams, diversions and gages.

The United States Department of Interior, U S Geological Survey (USGS) conducted discharge monitoring at one site (USGS 13178000) from 1945 through 2003. Figure 6 shows the average monthly discharge for this station. USGS Station 1317800 is located downstream from the first Jordan Creek diversion and directly upstream from Lone Tree Creek. The irrigation water diversion may influence the discharge data especially during low flow periods. Metadata for USGS Station 13178000 is located in Appendix D. If required, mathematical modeling will be used to determine discharge on the other subbasins and will be discussed in Section 2.0 for the appropriate water body(s).

Most of the lower Jordan Creek watershed has some sort of hydrologic modification. These modifications are either direct diversion from the stream, small earthen structures in headwaters for stock watering, stream channel modification or disturbance to the terrain and vegetation. With these modifications in mind, it will be difficult to determine any non-anthropogenic impacts.

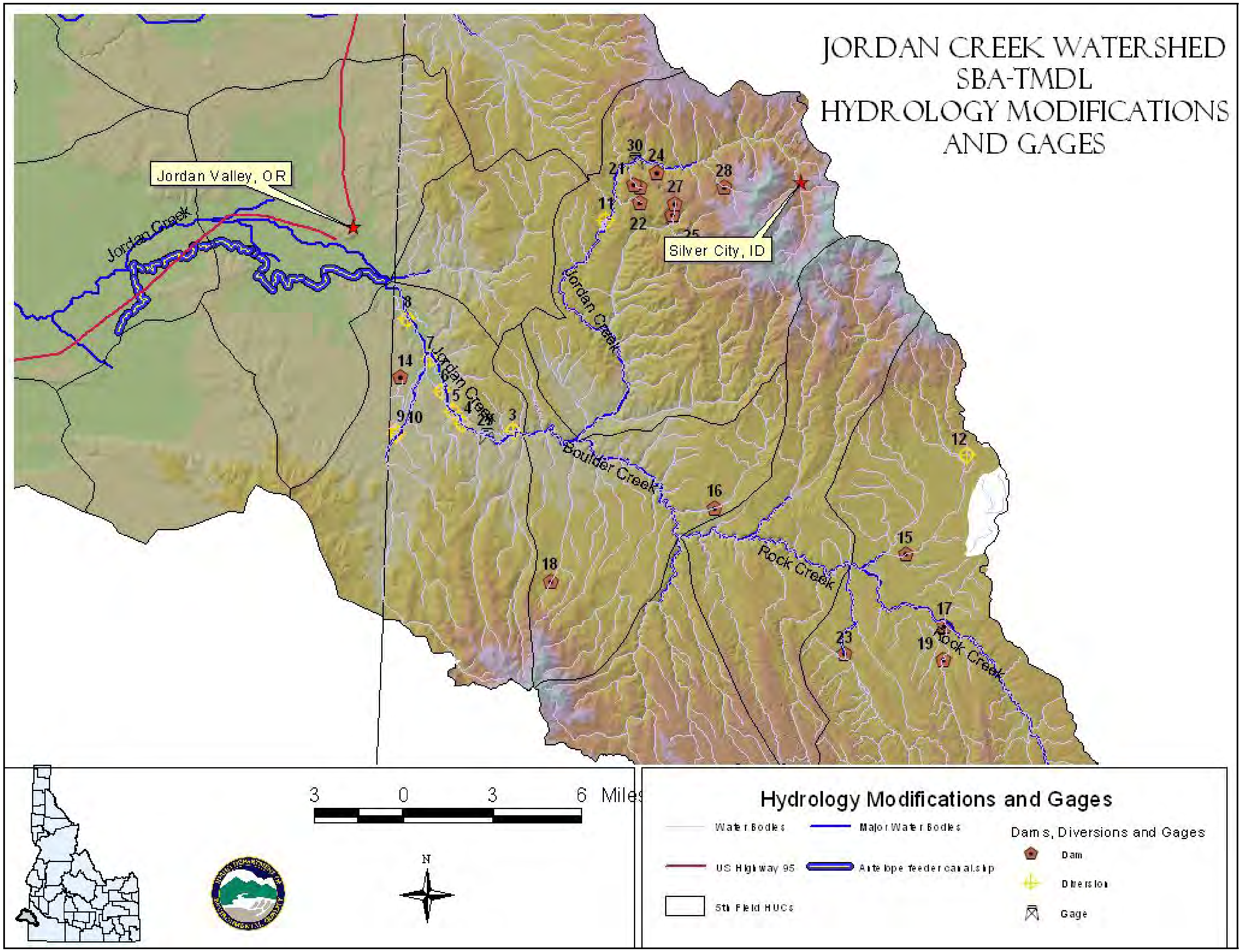


Figure 4. Jordan Creek Watershed Dams, Gages, and Diversions.

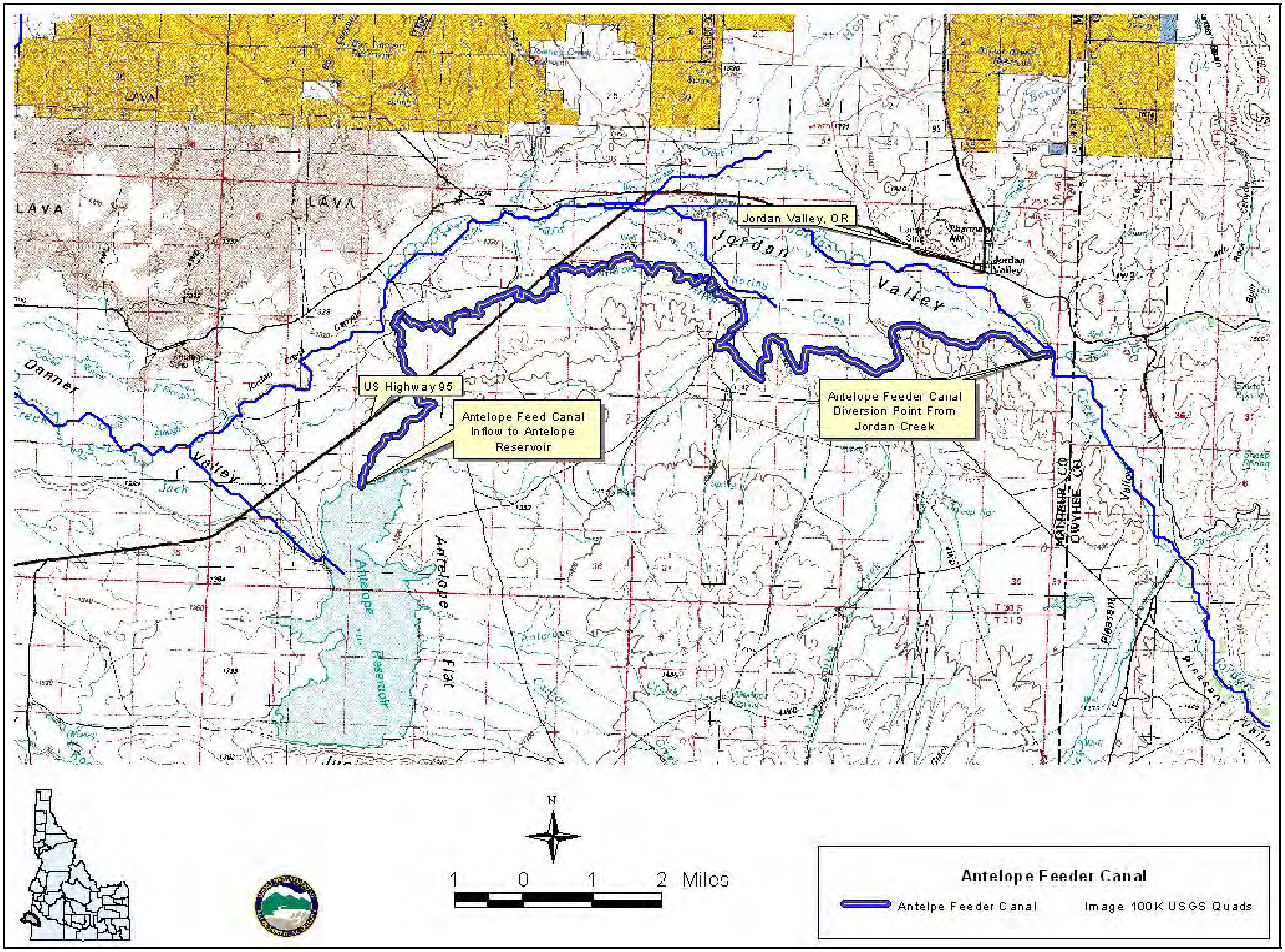
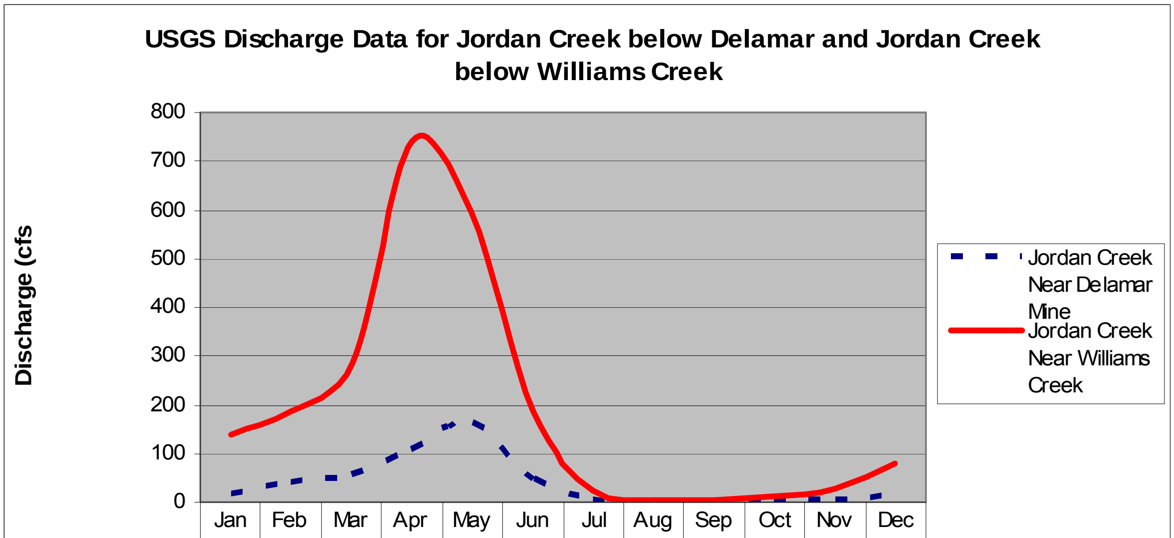


Figure 5. Antelope Reservoir Feeder Canal.

Table 3. Known diversions, dams, and discharge gage sites within Idaho.

ID Point	Type	Description/Water Body
1	Diversion	Cow Creek Diversion
2	Diversion	Jackson Creek Diversion
3	Diversion	Jordan Creek Diversion at Williams Creek
4	Diversion	Jordan Creek below Williams
5	Diversion	Jordan Creek below Williams
6	Diversion	Jordan Creek to Lone Tree Creek
7	Diversion	Jordan Creek below Lone Tree Creek
8	Diversion	Jordan Creek above Oregon State Line
9	Diversion	Lone Tree Creek Tributary Diversion
10	Diversion	Lone Tree Creek Diversion
11 Diversion		Jordan Creek Mine Tailings
12 Diversion		Spring Creek Diversion
13	Diversion	Cow Creek Diversion near Oregon State Line
14	Dam	Lone Tree Creek
15 Dam		Spencer Dam
16 Dam		Hayes Dam
17	Dam	Rock Creek Dam
18 Dam		Pershall Dam
19 Dam		Louisa Creek
20 Dam		Delamar Dam
21 Dam		Delamar Dam
22 Dam		Delamar Dam
23 Dam		Josephine Creek
24 Dam		Delamar Dam
25 Dam		Delamar Dam
26 Dam		Delamar Dam
27 Dam		Delamar Dam
28 Dam		Jacobs Gulch
29	Gage	Jordan Creek near Delamar (USGS 13177985)
30	Gage	Jordan Creek near Lone Tree Creek (USGS 13178000)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jordan Creek Near Delamar Mine	13.9	38.4	54.7	107	164	46.4	5.89	0.83	0.51	1.12	2.47	15.1
Jordan Creek Near Williams Creek	139	187	286	740	593	186	25.7	5.14	4.67	11.2	26.8	79.1

Figure 6. Discharge data, USGS discharge monitoring sites near Delamar Mine (USGS 13177985) and Jordan Creek near Williams Creek (USGS 13178000).

Geology/Soils

The Owyhee Mountains-YP Desert is composed of complex overlays of rhyolitic ash-flow tuffs, basalt flows, and intercalated sedimentary rocks. Basement rocks, consisting of Mesozoic intrusive and metamorphic units, crop out within the Owyhee Mountains, which make up the southern boundary (South Mountain) of the Jordan Creek watershed. Figure 7 shows the major lithology/geological formations within the Jordan Creek watershed.

Soils of the high plateau areas are a thin veneer of sediment from alluvial, fluvial, colluvium, ancient lakebeds, and landslide sources, generally characterized as acidic/xeric or soil moisture regime and mesic frigid soil temperature regime. Soils are classified as silt loams to clay loams and range from shallow to deep. Rock fragments can be found scattered in the soil and within the soil profile.

Stream sediment is mostly alluvial. However, in steep canyons, large boulders can be found from landslides and talus slopes. Where stream gradients lessen, sandy or sandy-loam soils exist. Depositional areas in larger streams are usually associated with flashy storm event flows or springtime flooding. Access to the historic flood plain on most larger water bodies is still occurring. However, flood control measures are noted in the lower Jordan Creek area (Pleasant Valley) to assist in protecting private property and public roads.

Smaller 3rd order stream (Cow Creek, Soda Creek, Meadow Creek) valley bottom types dictate stream morphology and near stream soils. On some low gradient water bodies, the historic presence of beaver dams would have had an influence on sediment deposition, as seen in Figure 7, where most of the valley bottom geological material is associated with alluvial material (Meadow Creek, Cow Creek, and Jordan Creek).

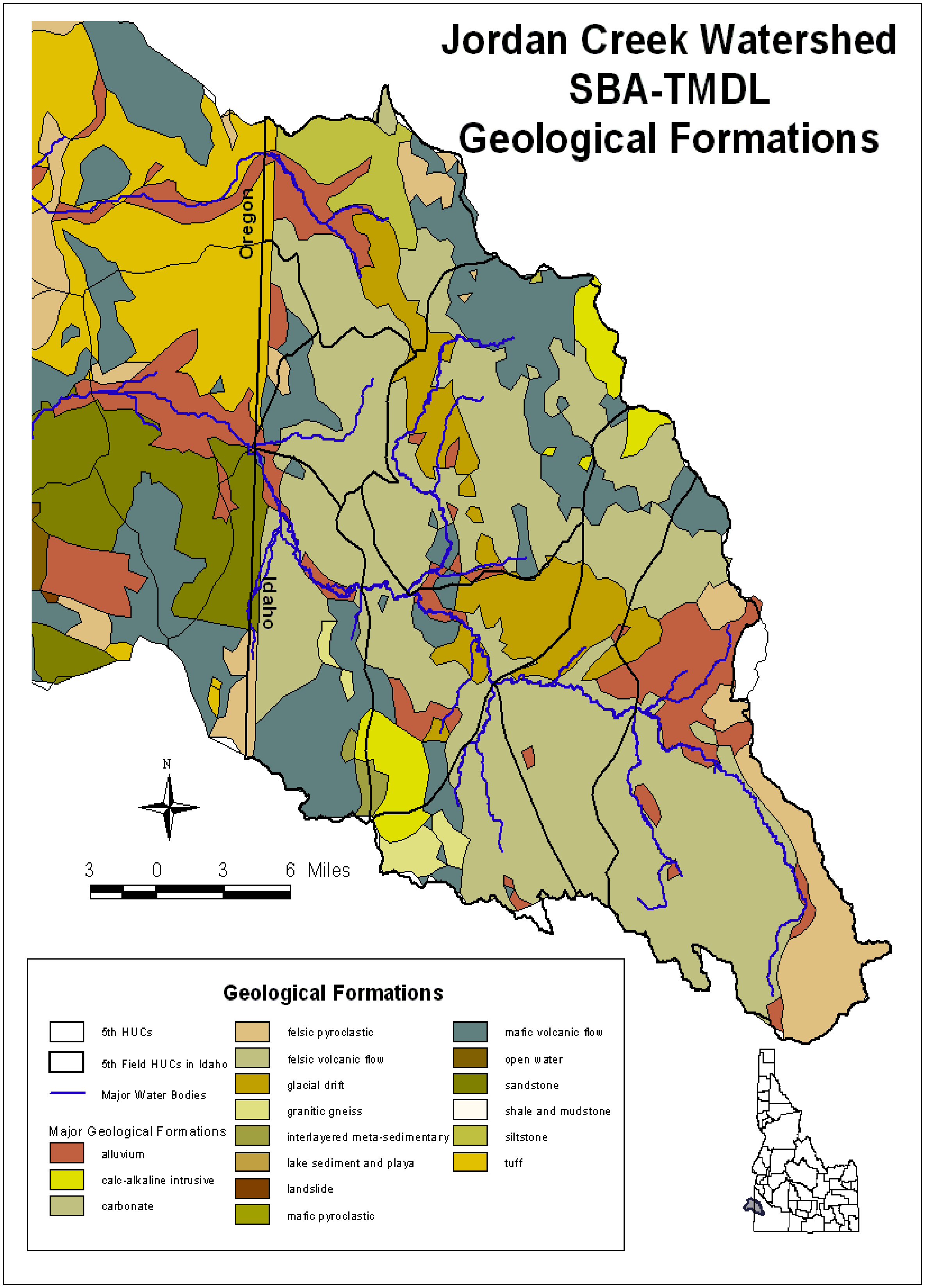


Figure 7. Jordan Creek Watershed Geological Formations.

Topography

Topographic characteristics are influenced by the parent geological formations in the Jordan Creek watershed. The relative flat terrain in eastern Oregon is mostly associated with alluvial deposits and mafic volcanic flows. Near the Idaho-Oregon state line the flat terrain gives way to rolling hills and with increased slopes associated with felsic volcanic flows. Steeper slopes are associated with the glacial drift and the intrusive formation, and other mafic and felic volcanic flows in the northern section of the watershed. Figure 8 displays contours of the watershed. (Table 6, page 26, shows a percentage breakdown of slopes encountered in the watershed.)

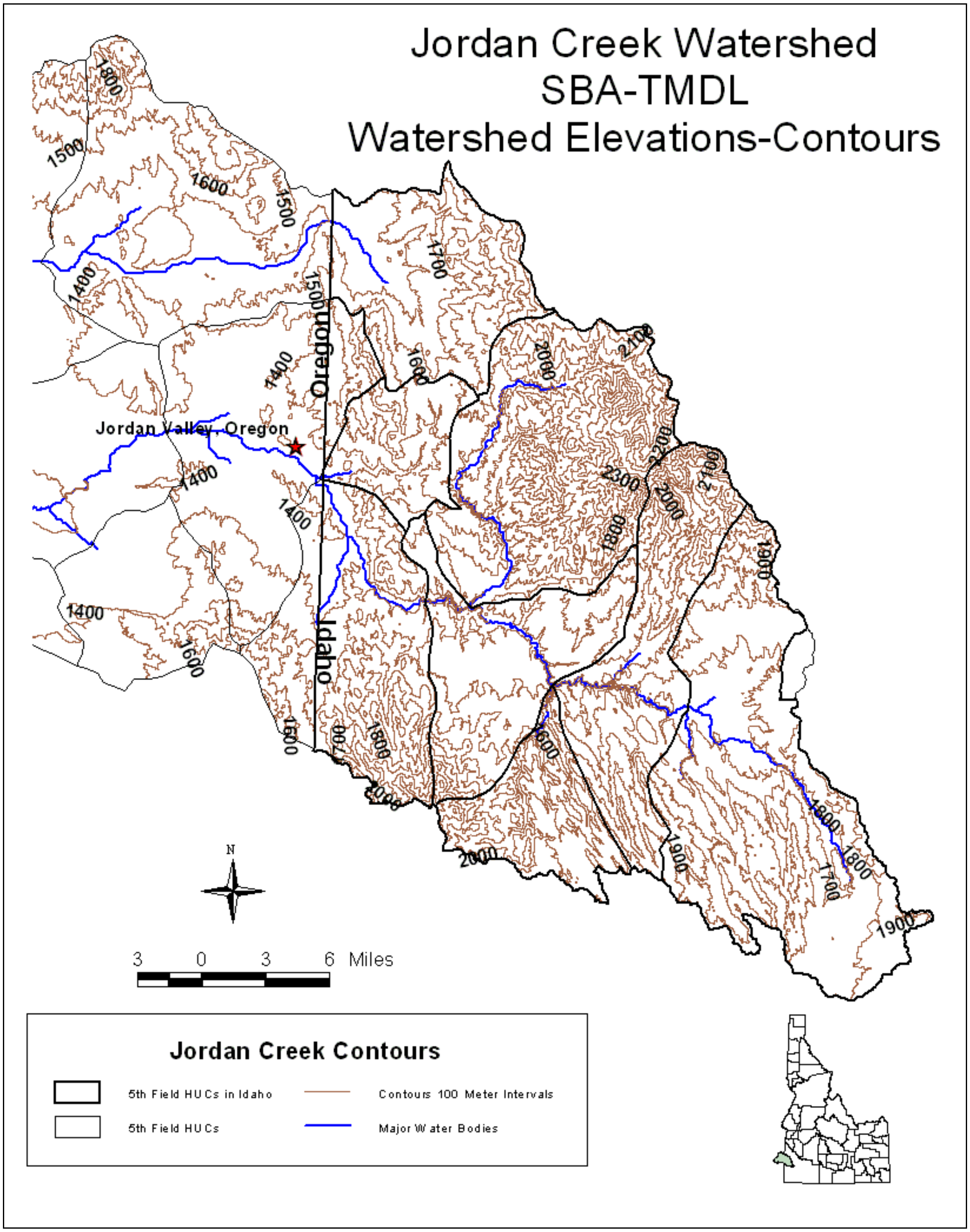


Figure 8. Elevation Contours of the Jordan Creek Watershed.

1.2 Biological Information

Endangered Species

The Owyhee Resource Management Plan and Final Environmental Impact Statement (ORMP) (BLM 1999) lists 31 species of plants that are "special status plants" and 50 animal species that are classified as "special status animal species." These plants and animals may be endangered, threatened, or candidates for listing, state endangered, state species of special concern, or BLM sensitive species.

Currently, there are no threatened or endangered plant species listed in the Jordan Creek watershed (IDFG 2004 http://fishandgame.idaho.gov/tech/CDC/t&e.cfm). For animals only the peregrine falcon (Falco mexicanus) remains listed as threatened or endangered and might be encountered in the watershed.

The Bald Eagle (Haliaeetus leuococephalus) was removed from the endangered species list in June 2007 because their populations recovered sufficiently. (www.fws.gov/migratorybirds/baldeagle/htm). This is considered one the great ESA listed species recoveries in the United States. The gray wolf (Canus lupus) was also delisted in Idaho and Montana in 2009 and is likewise considered sufficiently recovered, with numerous breeding pairs within both states.

However, there are state species of special concern including redband trout (Oncorhynchus mykiss gairdeneri), which can be found in streams in the watershed (USDI-BLM 1999). There are no federally listed endangered fish species associated with the watershed (BLM 1999).

Plant Communities

Rangeland makes up the largest portion of land use in the Jordan Creek watershed. The majority of these areas are the sagebrush steppe ecosystem, with low sagebrush (Artemisia arbuscula) communities dominating most of the lower elevations of the watershed. Most of these areas are associated with moderately sloped sage covered areas. Mountain big sagebrush (Artemisia tridentata) communities can be found in higher wetter elevations and north slopes. Understory communities are naturally assorted including Idaho fescue (Festuca idahoenis), bunchgrass and bluegrass (Poa sp.). In some areas, cheatgrass has invaded the area.

Western juniper (Juniperus occidentalis) has invaded into areas that in the past were dominated by either mountain big sagebrush or low sagebrush communities. Only a small portion of the Jordan Creek watershed would be classified as having western juniper as the potential climax species (BLM 1999). This invasion and the subsequent depletion of sage/grass lands can be associated with the current land use, frequency of fire, and possible climatic changes (Bedell et al. 1991). As stated earlier, isolated stands of Douglas fir (Psueudotsuga menziesii) dominate the woody plant community at higher elevations. Recent drought conditions have added stress to this plant community and provided an opportunity for tussock moth (Orgyia pseudotsugata) infestation in most of the area.

Riparian areas are areas of vegetation growing along stream/river corridors. Riparian areas consist of a complex vegetation structure of herbaceous or woody species, and are valuable for biodiversity. Woody species could include willow (Salix sp.), cottonwoods (Populus sp.), alders (Alnus sp.), aspen (Populus sp.), and dogwood (Cornus sp.). Herbaceous species may include rushes (Juncus sp.), sedges (Carex sp.) spiked rushes (Eleocharis sp.), and other mixed Gramineae species, both hydrophilic and hydrophobic.

Past and current land use has altered the vegetation composition of many of the riparian and upland areas. As streams down-cut and become incised there is a loss of access to historic floodplains; shallow near-stream ground water storage is also lost (Thomas et al. 1998), bringing an invasion of hydrophobic species, including western juniper, almost to the water's edge in some watersheds. In the uplands, non-native grasses, such as cheat grass, (Bromus sp.) have invaded into areas following a disturbance, such as wildfire.

In areas where stream gradients are low, some of the old wet meadow riparian areas may have been converted to irrigated pasture or hay fields. This conversion has altered the composition of native species. Introduced herbaceous species such as brome grass (Bromus sp.), Timothy grass (Phleum sp.), reed canary grass (Phalaris sp.), tall wheat grass (Agropyron sp.), orchard grass (Dactylis sp.), rye grasses (Elymus sp.) and other nonnative species may now dominate some of these areas.

Figure 9 and Figure 10 show the land cover in the Jordan Creek watershed. The former shows the entire watershed, while the latter focuses on the portion within Idaho. Table 4 shows the acreage for each identified land cover. Land cover is based on the Multi-Resolution Land Characteristics (MRLC) and is derived from LANDSAT imagery.

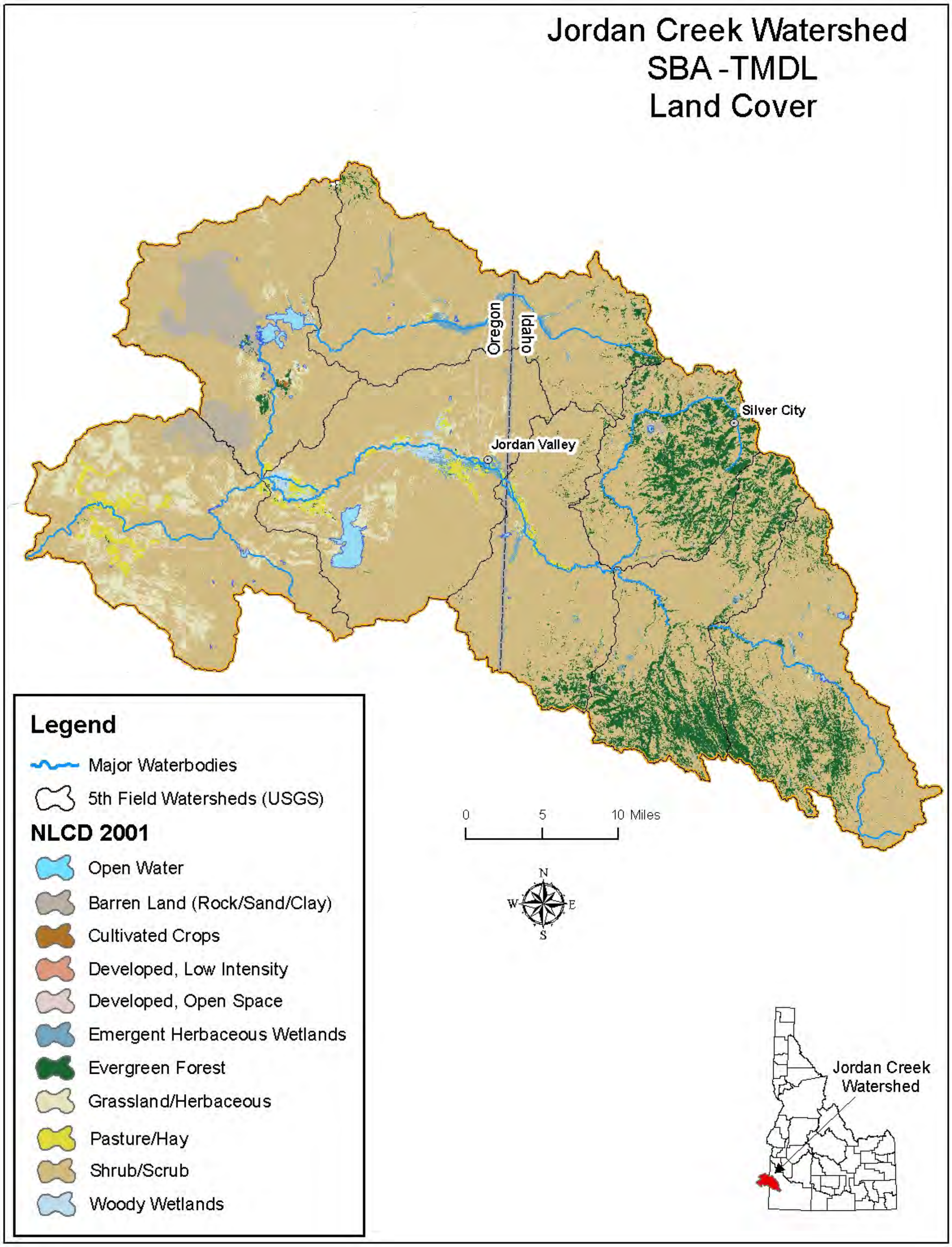


Figure 9. Land Cover in the Jordan Creek Watershed, Idaho and Oregon.

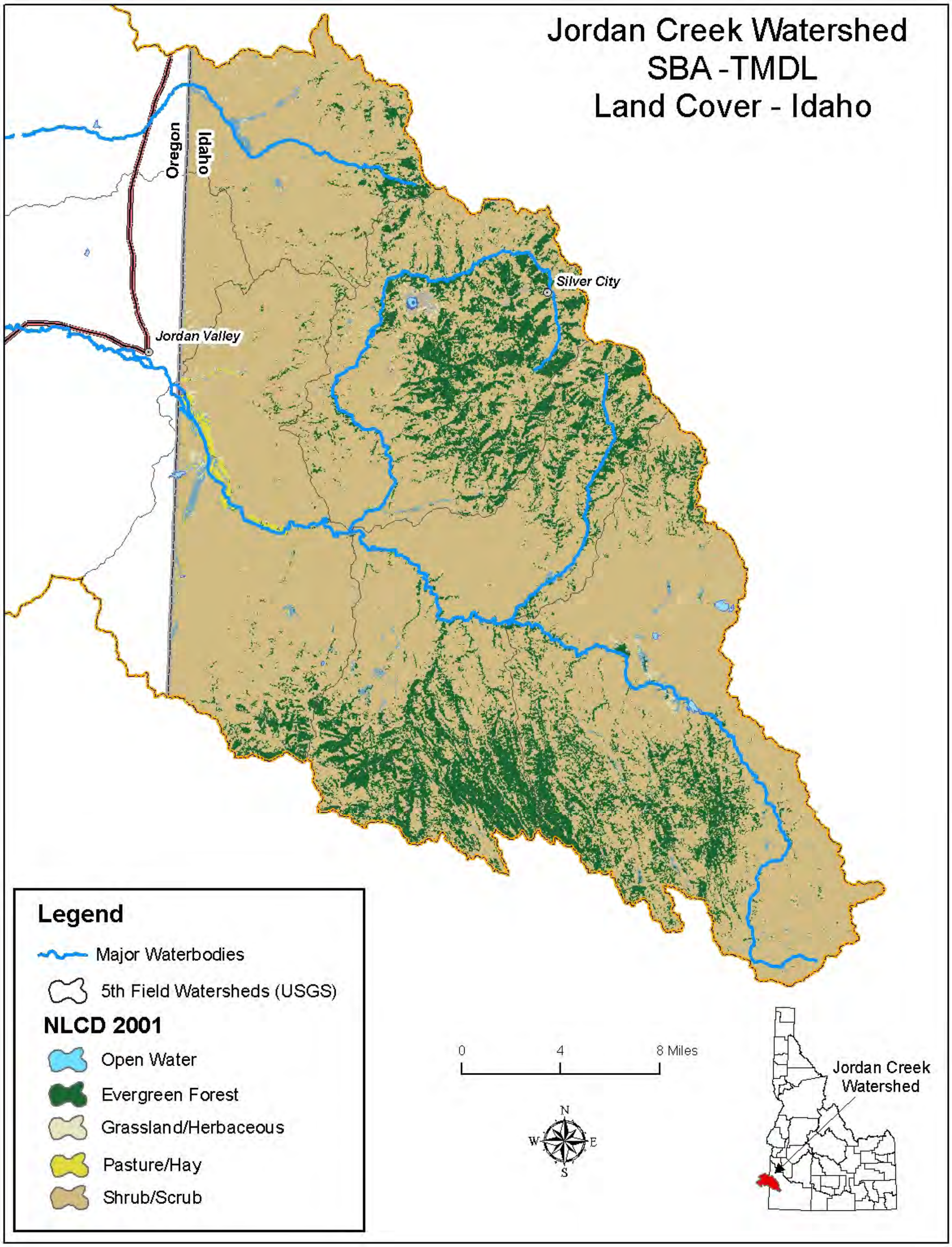


Figure 10. Land Cover in the Jordan Creek Watershed, -Idaho only.

Table 4. Land Cover Types and Extents in the Idaho Portion of the Jordan Creek Watershed.

Multi-Resolution Land Cover Description	Watershed			Idaho		
	Acres Hectar	es	% of Watershed	Acres Hectar	es	% of Watershed
Open Water	5,331	2,157	0.7%	783	317	0.2%
Perennial Ice/Snow	9	4	0.0%	9	3	0.0%
Low Intensity Residential	34	14	0.0%	NA	NA	NA
Commercial/Industrial/Transport 1,648		667	0.2%	755	306	0.2%
Bare Rock/Sand/Clay	19,919	8,061	2.6%	499	202	0.1%
Quarries/Strip Mines/Gravel Pit	26	11	0.0%	12	5	0.0%
Transitional 108		44	0.0%	108	44	0.0%
Deciduous Forest	555	225	0.1%	444	180	0.1%
Evergreen Forest	125,742	50,888	16.1%	123,363	49,925	32.0%
Mixed Forest	131	53	0.0%	73	30	0.0%
Shrub land	515,393	208,575	66.1%	235,549	95,325	61.1%
Grasslands/Herbaceous 55,970		22,653	7.2%	14,809	5,994	3.8%
Pasture/Hay 42,643		17,258	5.5%	7,841	3,173	2.0%
Row Crops	126	51	0.0%	NA	NA	NA
Small Grains	2,709	1,096	0.3%	11	4	0.0%
Urban/Recreational Grasses	1	1	0.0%	1	1	0.0%
Woody Wetlands	228	92	0.0%	35	14	0.0%
Emergent Herbaceous Wetlands	8,926	3,613	1.1%	1,712	693	0.4%
Totals 779,499		315,462	100%	385,221	155,899	100%

Fisheries

There is evidence of the prehistoric presence of anadromous fish in the entire Owyhee River watershed. (Plew 1985). During an archaeological dig near Pole Creek (Upper Owyhee River watershed), the remains of a steelhead trout were located in the Nahas Cave. This find may indicate prehistoric anadromous spawning in the smaller tributaries, such as Jordan Creek.

Anadromous fish are no longer present due to impassable barriers downstream on the Owyhee River in Oregon and other barriers on the Snake River. No endangered fish species currently inhabit water bodies in the Jordan Creek watershed. Redband trout, a species of concern as listed by the Idaho Department of Fish and Game (IDFG), are present and can be found in most of the water bodies in the watershed.

Figure 11 shows fish bearing water bodies in the Jordan Creek watershed.

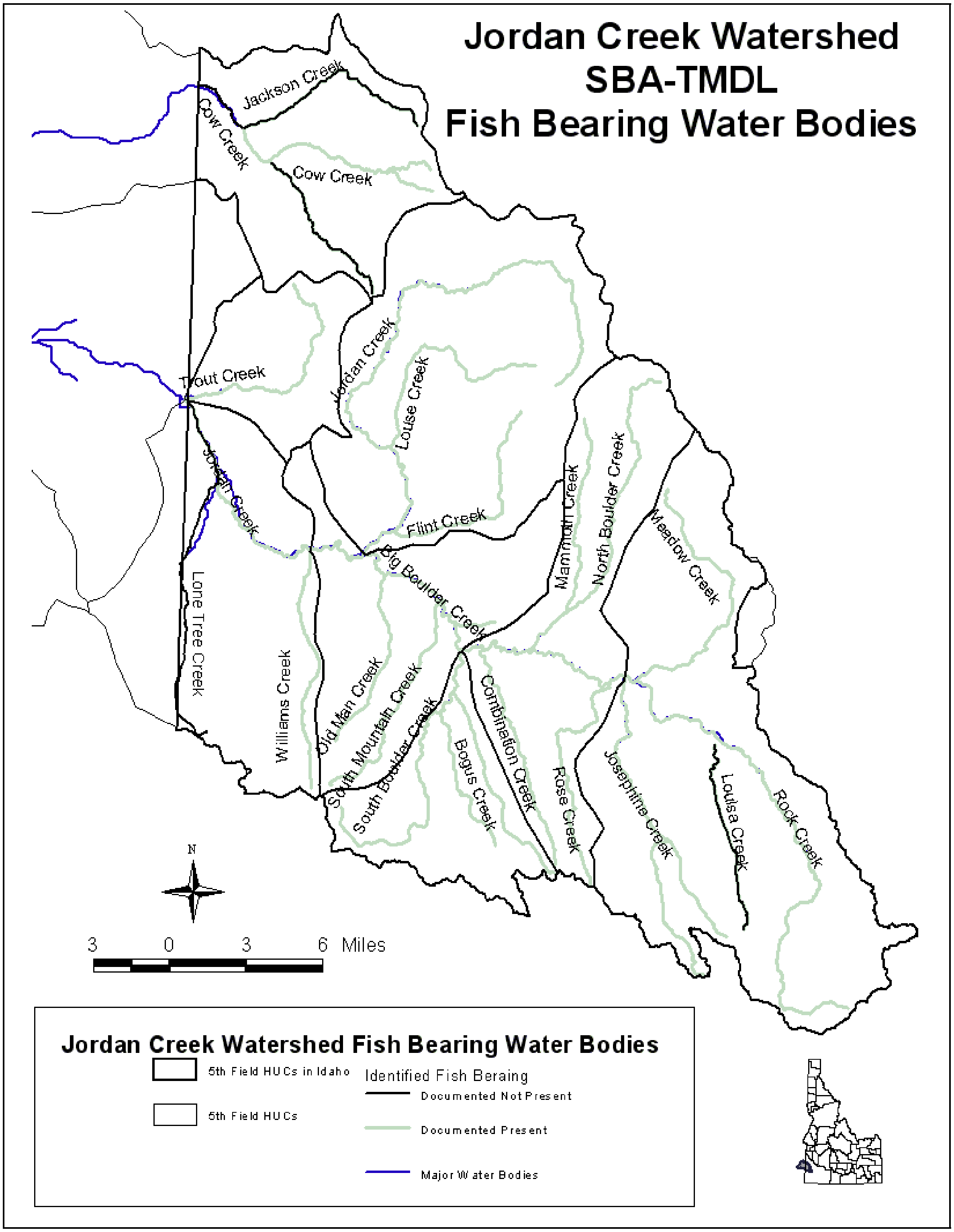


Figure 11. Fish Bearing Water Bodies in the Jordan Creek Watershed.

Although current fish data are limited, some studies have occurred in Owyhee County. Some of these studies either involved the actual capture of fish; others involved personal observations. Allen, et al. (1993, 1995, 1996, 1997 and 1998) provided documentation of the presence of a variety of species found in Owyhee County. Allen inventoried smallmouth bass (Micropterus dolomieui), sculpins (Cottus sp.), Bridgelip suckers (Catostomus columbianus), mountain sucker (Catostomun platyrhynchus), chiselmouth (Acrocheilus alutaceus), mountain whitefish (Prosopium williamsoni), redside shiners (Richardsonius balteatus), speckled dace (Rhinichthys osculus), longnose dace (Rhinichthys cataractae), northern pikeminnows (Ptychoccheilus oregonenis), largescale suckers (Catostomus macrocheilus), and redband trout (Oncorhynchus mykiss gairdeneri). Only redband trout and mountain whitefish are classified as salmonid species.

IDFG did not provide any information on recent studies completed in the Jordan Creek watershed. It is noted that the 2001-2006 IDFG Fisheries Management Plan (IDFG 2000 Volume 127, Article 3) lists all streams in Owyhee County to be managed for redband trout. However, the 2001-2006 IDFG Fisheries Management Plan does not specifically cite any water bodies in the watershed for targeted management practices addressing redband trout.

A search of the Idaho DEQ Beneficial Use Reconnaissance Program (BURP) database from 1996 through 2003 provided some additional information on fisheries. Fish collected during BURP monitoring included bridgelip suckers, redside shiners, northern pike minnows, largescale suckers, speckled dace, longnose dace, redband trout and sculpin.

Benthic (Benthos) Communities

Benthic communities are references to any living organisms that can be found on the bed (substrate) of streams, rivers and lakes or any other water body. The benthic community can consist of insects (macroinvertebrates), worms (Oligochaeta), algae (periphyton), vascular plants (macrophytes), or any other living organisms (bacteria, fungi, etc.).

The BURP sampling has focused mainly on macroinvertebrates as indicators of support of beneficial uses, mainly cold water aquatic life (CWAL). BURP data for streams in the Jordan Creek watershed showed the macroinvertebrate community consisted of the orders of Diptera (flies), Odonata (dragonflies, damselflies), Coleoptera (beetles), Trichoptera (caddisflies), Ephemeroptera (mayflies) and Oligochaeta (worms). Some studies that have either focused on the Owyhee Mountains-YP Desert area or incorporated the area into a larger statewide evaluation can be found in Clark (1978), Clark (1979) and Robinson and Minshall (1994).

Further analysis of macroinvertebrates and additional discussion of the periphyton community structure are located in Section 2.0.

1.3 Subwatershed Characteristics

Watershed size is almost equally split between Idaho and Oregon, but watershed characteristics differ greatly between the two parts.

Figure 12 shows the 5th Field HUC in Idaho and Oregon. Table 5 shows data for each 5th field HUCs.

Table 5. General Characteristics of 5th Field HUCs in the Jordan Creek Watershed.

Oregon-Idaho 5th Field HUC	**5th Field HUC Code**	**Total Acres**	**Total Hectares**	**State(s)**
Antelope Reservoir	1705010815	31,132	12,599	Oregon
Boulder Creek	1705010810	24,943	10,094	Idaho
Cow Creek	1705010804	33,335	13,490	Oregon
Cow Creek Lakes	1705010805	44,129	17,859	Oregon
Danner	1705010803	51,029	20,651	Oregon
Jordan Creek	1705010801	70,198	28,408	Oregon
Louse Creek	1705010807	71,947	29,116	Idaho
Mahogany Creek	1705010806	119,338	48,294	Oregon-Idaho
North Boulder Creek	1705010809	46,102	18,657	Idaho
Pleasant Valley	1705010812	56,984	23,061	Oregon-Idaho
Rail Creek	1705010811	40,043	16,205	Idaho
Rock Creek Reservoir	1705010802	18,200	7,365	Oregon
Sheep Spring Creek	1705010814	62,330	25,224	Oregon-Idaho
Triangle Reservoir	1705010808	92,258	37,336	Idaho
Trout Creek	1705010813	19,702	7,973	Oregon-Idaho
Total		781,670	316,332	
Percent of Watershed in Oregon				50.6%
Idaho 5th Field HUC	5th Field HUC Code	Total Acres	Total Hectares	State(s)
Boulder Creek	1705010810	24,942	10,094	Idaho
Louse Creek	1705010807	71,947	29,116	Idaho
Mahogany Creek	1705010806	43,294	17,520	Idaho
North Boulder Creek	1705010809	46,102	18,657	Idaho
Pleasant Valley	1705010812	43,106	17,444	Idaho
Rail Creek	1705010811	40,043	16,205	Idaho
Sheep Spring Creek	1705010814	6,967	2,820	Idaho
Triangle Reservoir	1705010808	89,998	36,421	Idaho
Trout Creek	1705010813	19,679	7,964	Idaho
Total		386,076	156,240	
Percent of Watershed in Idaho				49.4%

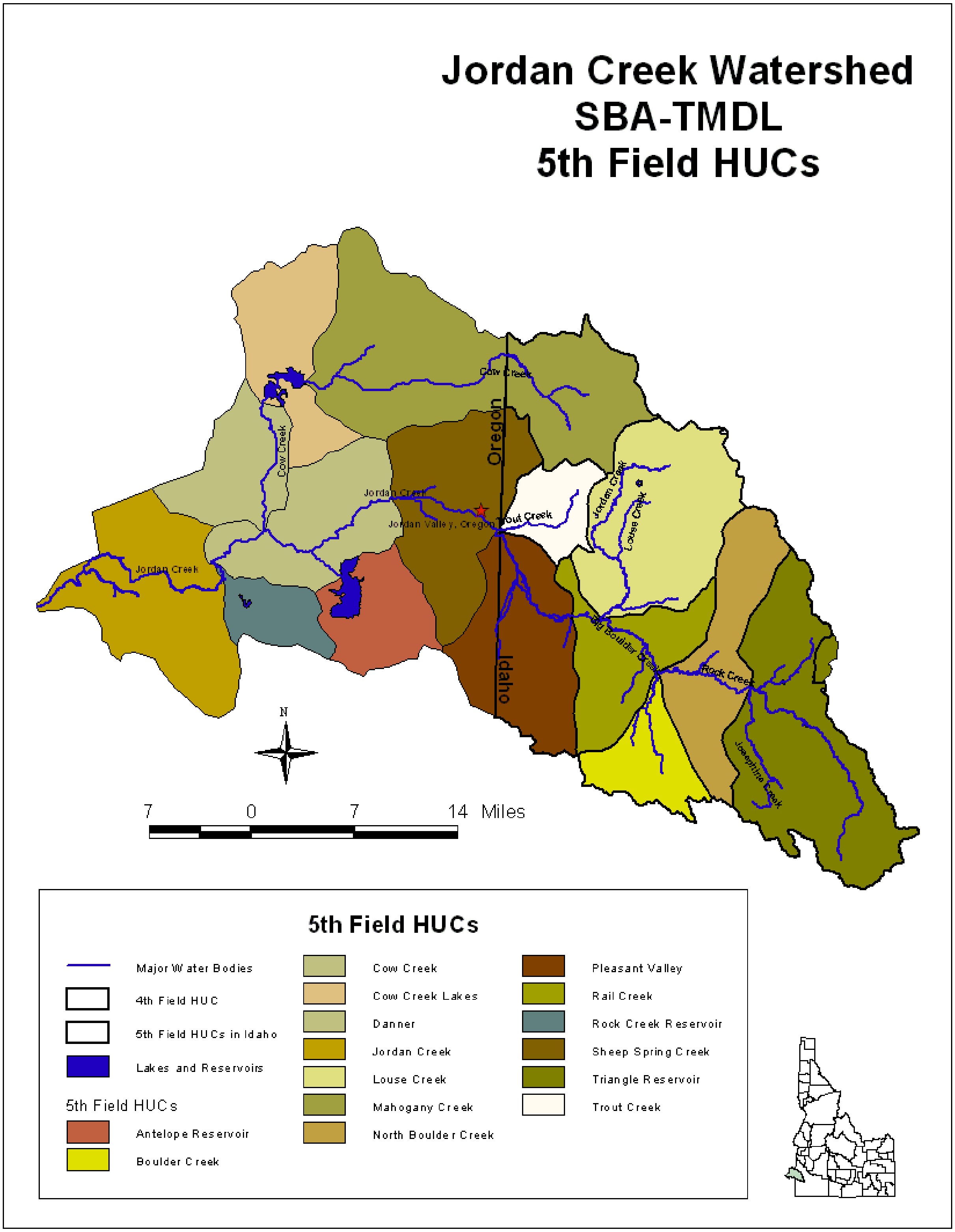


Figure 12. 5th Field HUCs of the Jordan Creek Watershed.

Slope

Watershed slope is one of the major influences in governing runoff. The greater the slope the more runoff will occur from that area. The lesser the slope, the greater the ability for runoff to be absorbed into the soil and parent geological material.

The Jordan Creek watershed is dominated by relatively flat plateaus and deep incised canyons. Most of the areas with slopes greater than 30%, amounting to only 1% of the total watershed area, are located in these canyons and the upper reaches of the Silver City Mountain Range. Of course, percentage of sub-watershed area with slopes greater than 30% will vary and will influence estimated discharge for individual sub-watersheds.

Table 6 and Table 7 show the ranges of slopes found in the watershed. Figure 13 shows the expected slope ranges found in the Jordan Creek watershed. Figure 14 illustrates the distribution of slopes found in the watershed.

Table 6. Slope, average slope, mean elevation, acres and percent of combined watershed in Idaho and Oregon.

Slope	Watershed Average Slope (%)	Watershed Mean Elevation (meters)	Watershed Total Acres	Percent of Watershed (%)
0-2% 1.3		1318	39,050	5.3%
2-5% 3.0		1347	130,166	17.6%
5-8% 6.7		1377	121,878	16.5%
8-10% 8.5		1429	42,250	5.7%
10-12% 10.9		1539	39,113	5.3%
12-15% 13.6		1551	70,974	9.6%
15-20% 17.6		1588	73,846	10.0%
20-25% 22.7		1762	95,160	12.9%
25-30% 27.4		1756	71,589	9.7%
30-35% 32.7		1855	37,809	5.1%
25-40% 37.5		1896	14,309	1.9%
>40% 45.2		1993	4,208	0.6%
Total			740,350	100%

Table 7. Slope, average slope, mean elevation, acres, and percent of watershed for Idaho.

Idaho Average Slope (%)	Idaho Mean Elevation (meters)	Idaho Total Acres	Percent of Watershed Idaho (%)	Percent in Idaho of Total (%)
1.0 1333		1,778	0.5%	5%
3.5 1362		877	0.2%	1%
6.3 1470		17,653	4.7%	14%
9.0 1566		15,823	4.2%	37%
10.8 1669		24,721	6.6%	63%
13.5 1624		59,289	15.9%	84%
17.4 1572		53,226	14.3%	72%
22.8 1721		71,983	19.3%	76%
27.4 1756		71,589	19.2%	100%
32.7 1855		37,808	10.1%	100%
37.5 1896		14,308	3.8%	100%
45.2 1993		4,208	1.1%	100%
Total		373,263	100%	

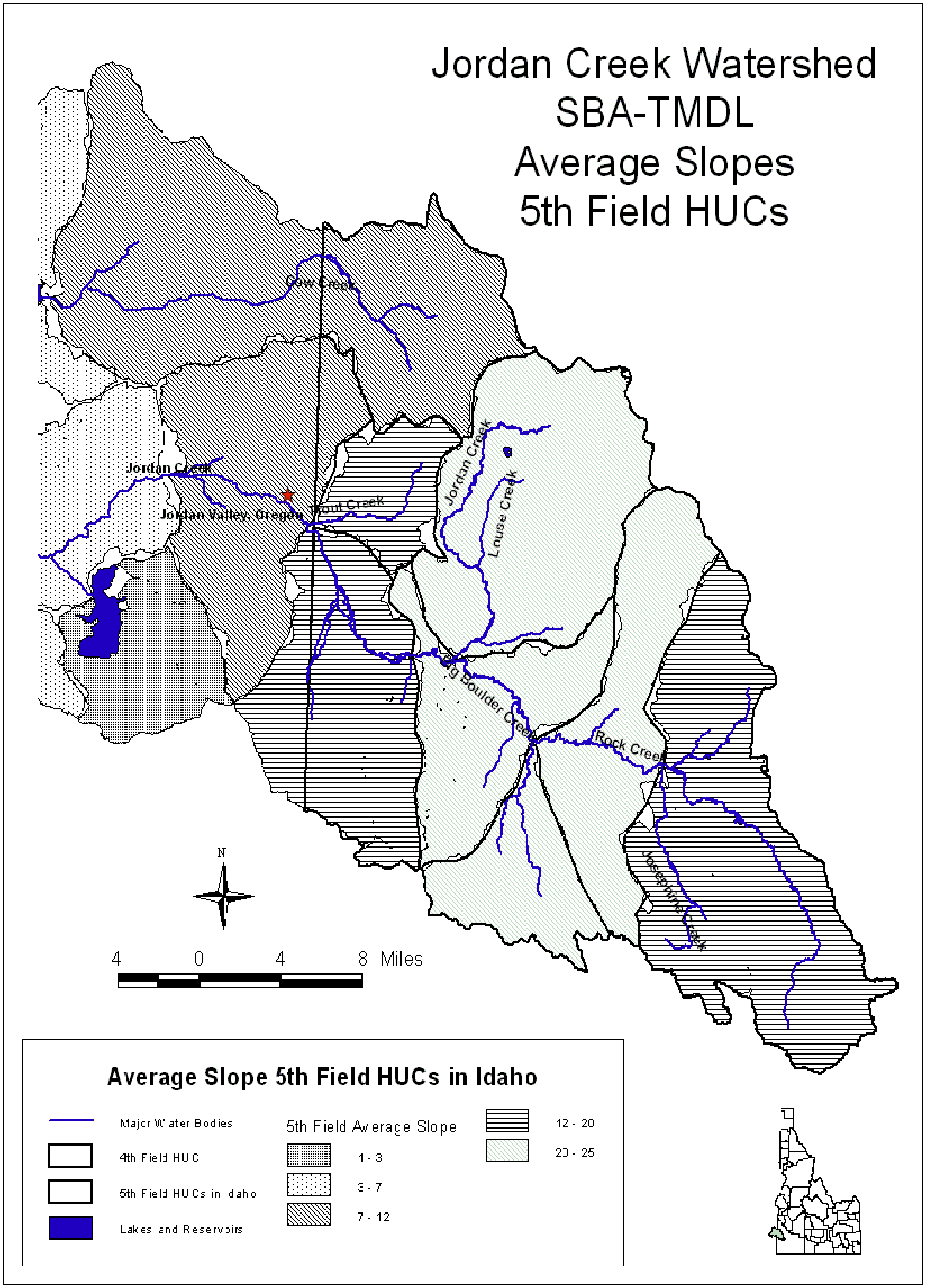


Figure 13. Average slopes (%) in the Jordan Creek Watershed.

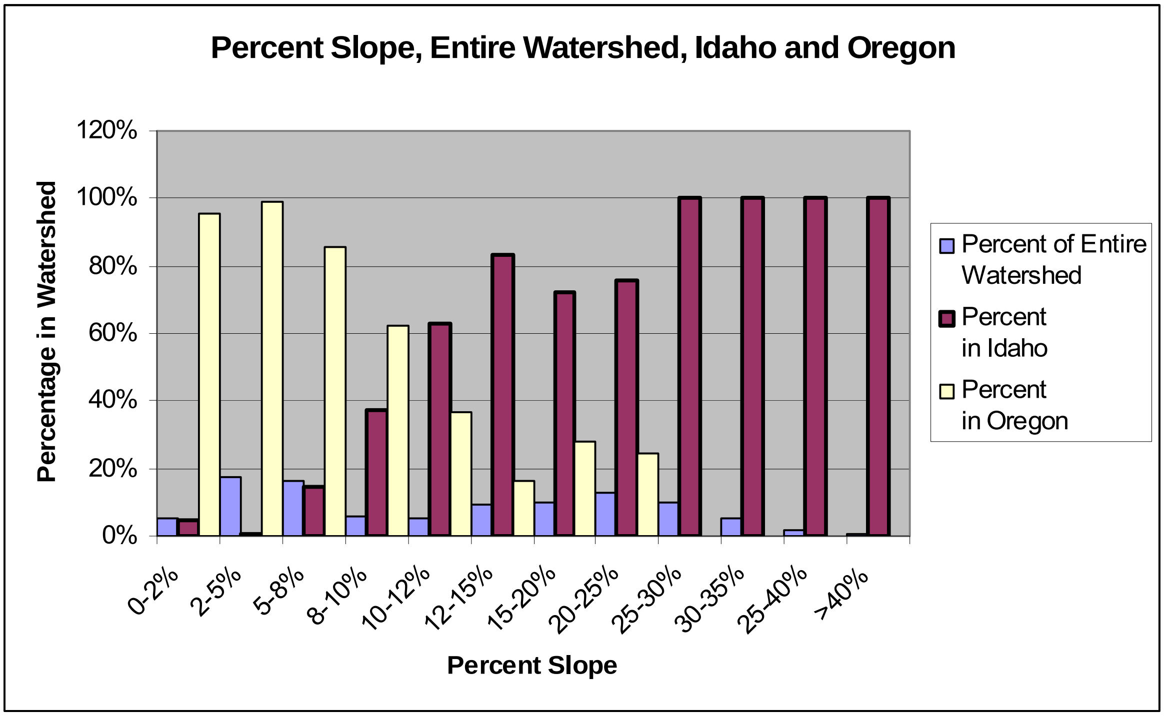


Figure 14. Slope percentage distribution in the Jordan Creek Watershed.

Stream Characteristics

Table 8 shows the average maximum and minimum elevations for each 5th field HUC, calculated maximum, minimum and average major water body's stream gradient, and average stream sinuosity (Idaho only). Figure 15 shows the location of the major water bodies identified in Table 8.

Table 8. Average maximum and minimum elevations for each 5th HUC, calculated maximum, minimum and average major water body stream gradient, and average stream sinuosity (Idaho only).

5th Field HUC Name	Maximum Elevation (meters)	Minimum Elevation (meters)	Minimum Water Body Gradient %	Maximum Water Body Gradient %	Average Water Body Gradient %	Average Water Body Sinuosity (Idaho Only)
Antelope Reservoir	1464	1316	0.00 2.05 0.84			NA
Boulder Creek	1876	1441	2.15 3.94 2.74			1.095
Cow Creek	1361	1284	0.00 1.28 0.29			NA
Cow Creek Lakes	1495	1307	0.00	1.43	0.44	NA
Danner	1400	1284	0.00 1.55 0.32			NA
Jordan Creek	1342	1024	0.00 7.38 1.38			NA
Louse Creek	1949	1393	0.59 3.37 1.43			1.130
Mahogany Creek	1700	1323	0.04 4.21 1.04			1.095
North Boulder Cr	1923	1398	0.30	3.15	1.58	1.135
Pleasant Valley	1723	1339	0.18 3.67 1.46			1.071
Rail Creek	1680	1380	0.28 3.77 1.57			1.208
Rock Creek Reservoir	1379	1229	0.00	2.39	0.76	NA
Sheep Spring Creek	1453	1311	0.10	1.29	0.47	1.070
Triangle Reservoir	1770	1524	0.37 2.85 1.23			1.101
Trout Creek	1565	1339	0.68 2.57 1.73			1.085

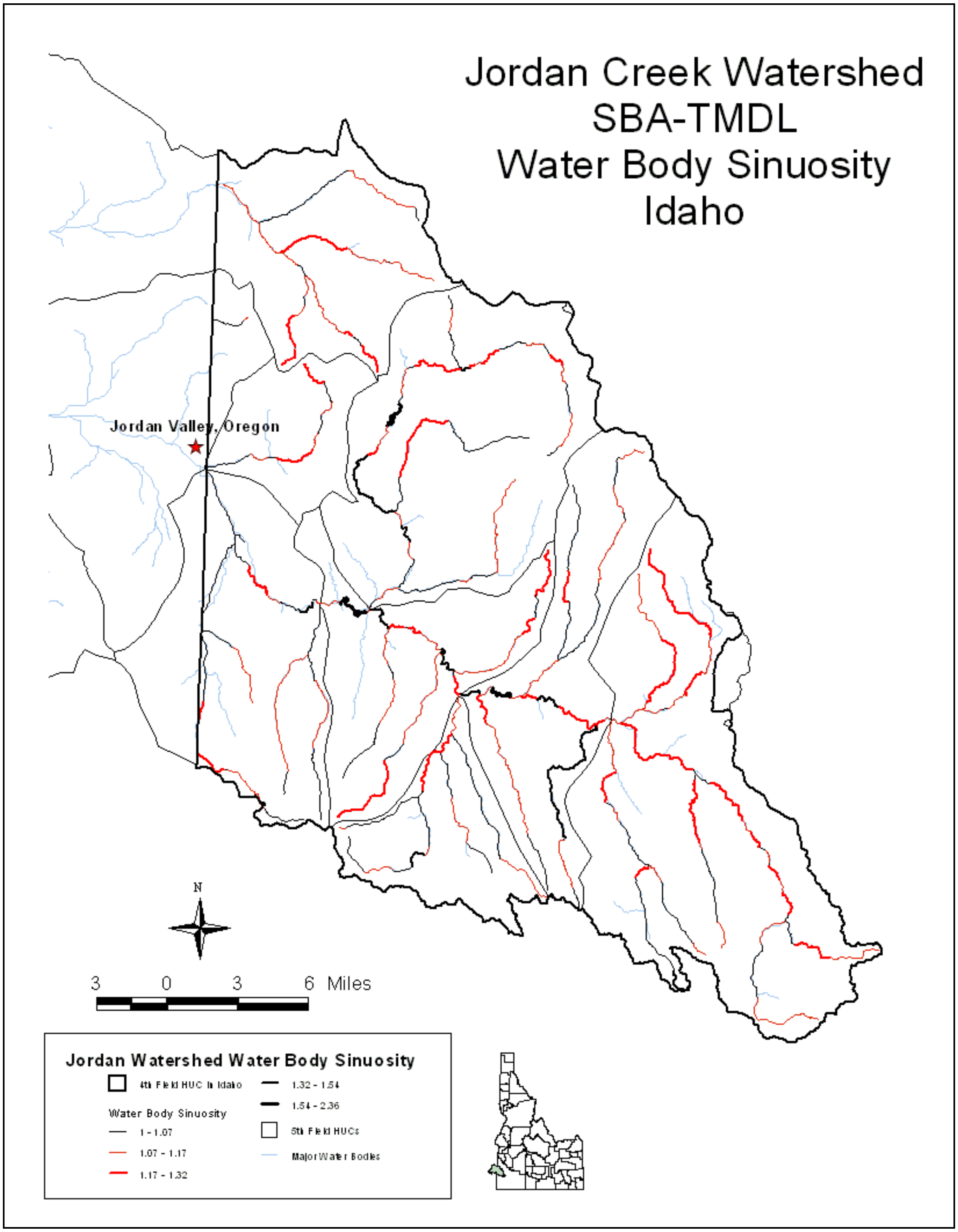


Figure 15. Water body sinuosity in the Jordan Creek Watershed.

1.4 Cultural Characteristics

Past and Current Land Use

Evidence shows the Owyhees have a long history of use by prehistoric Native Americans. Documentation by Plew (1985) indicates use by the prehistoric population was year round, with winter camps associated with the lower elevation Owyhee River Canyon. Upper elevations were used for hunting and gathering camps during summer and fall. Carbon dated material shows the area may have been inhabited over the last 6,000 years (Plew 1985).

The first historic Anglo-European presence was probably associated with the beaver trappers in the late 1700s. Although mostly a high-arid desert, the streams and rivers within the Owyhees at one time supported a viable beaver population. Past beaver activity can be noted in many of the irrigated pasture areas where fine sediment deposits have created fertile soils areas along stream corridors. Although no current trapping records are available, there appears to be sparse beaver activity currently in the Jordan Creek watershed (Personal Observation, Ingham 2005)

It was not until 1863 that a permanent presence of Anglo-Europeans is documented (Adams 1986), when mineral deposits of gold and silver were discovered in the Jordan Creek area of the Silver City Mountain Range. The first documented settlement (mining camp) was Ruby City, located on Jordan Creek. Other mining camps and new discoveries of deposits of gold and silver soon followed. This area supported numerous towns and camps throughout the late 1800s and through the early 1900s (Adams 1986). As the gold and silver deposits were mined out, many of these towns were abandoned. Silver City is the only permanent settlement remaining in the Idaho portion of Jordan Creek. The only other incorporated township in the watershed is Jordan Valley, Oregon.

Delamar Mine, located on the ridge between Jordan Creek and Louse Creek, was the only large scale operation remaining in the Silver City Mining District. In the past few years, this operation focused on the extraction of low grade ore through a cyanide heap leach process. However, the mine has now ceased mining operation and has concentrated on reclamation of disturbed areas. (Additional discussion of mining in the area is provided in the Section 2.0 discussions of the 303(d)-listed segments).

In the late 1800s, as the mining towns and camps flourished, some who could not find their riches in mining turned to supporting the mining population. Farms, along with livestock operations began to operate soon after ore deposits were discovered. These agricultural operations provided much needed food for miners, feed for horses and to some extent material for clothing.

Cattle ranching soon became a viable economic presence in the area. The availability of open range for spring-summer-fall grazing provided a potential for “cow-calf” operations. That is, calves would be born in late winter-early spring timeframe, allowed to graze on open range during the seasonal grazing period of the spring-summer-fall, then weaned and either “sold off” that year, or kept and fed for another year. The “cows” and heifers would be kept, bred, and the process repeated. However, due to the lack of acceptable areas for winter feed production, the fewer animals in the winter, the better.

Along with the spring-summer-fall open grazing, these operations needed areas for hay production for winter feed. In an area receiving approximately 10-12 inches or precipitation annually, irrigation was the only viable option. The valley bottoms and stream corridors provided these areas.

Today, land use in the Jordan Creek watershed is primarily "cow-calf" grazing in the uplands and hay production in the irrigated lowlands. Within Idaho, irrigated areas make up a small percentage of the overall land use and has probably has not expanded too much since the late 1800's. Within Oregon, the irrigated land use has greatly increased since the late 1800's due to the addition of large reservoirs and in stream water diversion. The water diversions, along with increased water storage capacity, have increased the amount of farmable lands.

Table 9 shows the breakdown of current land use practices in the watershed. Figure 16 shows a map of current land use.

Although forested areas make up 29% of the total land type in the Jordan Creek watershed, actual timber harvest for lumber is minimal. Most of the woodland areas are western juniper (Juniperus occidentalis) which has little commercial value, except for rough fencing material or firewood. More discussion of plant communities and seral conditions can be found in section 1.2.

Table 9. Land use, total acres and percent of total acres in Idaho

Land Use Description	Acres	Percent of Total
Forest 112,632.4		29.2%
Irrigated-Gravity Flow	12,345.3	3.2%
Rangeland 246,328.0		63.8%
Riparian 14,937.2		3.9%
Total 386,242.9		100.0%

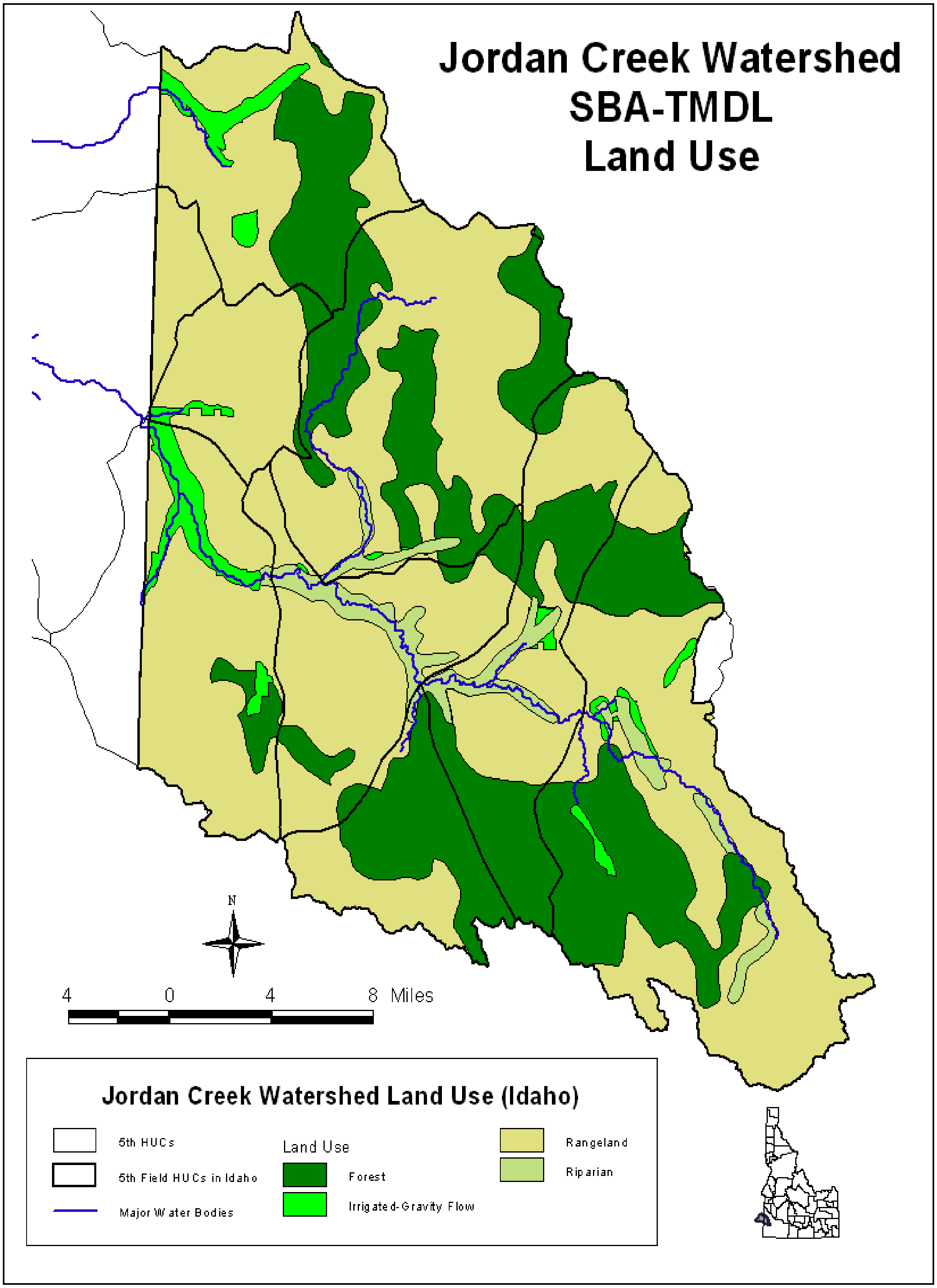


Figure 16. Land Use-in Idaho.

Land Ownership/Management

A little more than 57% (52% Idaho, 62% Oregon) of lands in the Jordan Creek watershed are managed by the BLM, and most of this land is devoted to rangeland (grazing) use. Private holdings are found mostly in the riparian and irrigated areas, and make up about 32% of all land ownership. These areas are usually the more productive areas and may or may not be irrigated.

State-managed lands for both Idaho and Oregon are primarily used as rangeland. They may or may not be managed in conjunction with federal lands, or grouped together into a single managed allotment. In the Jordan Creek watershed, private holdings are usually dependent on the use of state and/or federal lands. The privately held property (base operation) is usually too limited to support a viable cattle operation and must rely on state and/or federally managed grazing allotments. In many instances, these allotments are "financially tied" to the base operation even though they are not seen as real property. If a base operation is sold, it is usually "a given" that the grazing rights to an allotment is part of the overall "package."

Table 10 shows the breakdown of land ownership/management. Figure 17 shows the schematic of land ownership/management patterns.

Table 10. Land ownership/management, acres, and percent of total.

Ownership/ Management	**Total**		**Total Oregon**		**Total Idaho**	
	Total Acres	%	Total Acres	%	Total Acres	%
Federal 447,415		57.4%	245,316	62.3%	202,099	52.4%
Private 247,598		31.8%	132,619	33.7%	114,979	29.8%
State Lands	79,008	10.1%	10,230	2.6%	68,778	17.8%
Water 5,473		0.7%	5,290	1.3%	183	0.0%
Total 779,494		100%	393,454	100.0%	386,040	100%

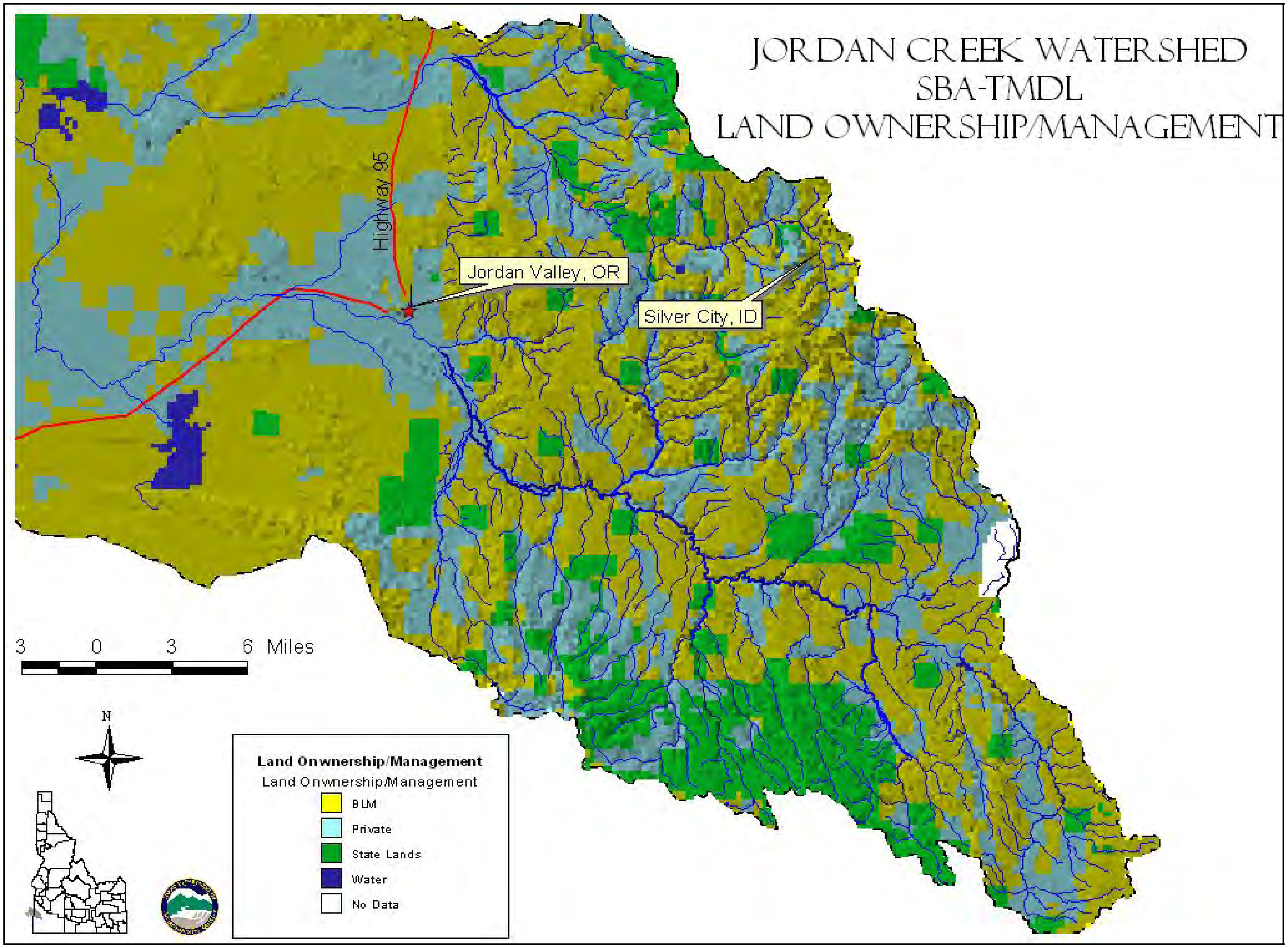


Figure 17. Land Ownership/Management.

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2. Water Quality Limited and Supporting Information

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently this list must be published every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. (In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.) This document addresses the water bodies in the Jordan Creek Subbasin that have been placed on Idaho's current §303(d) list.

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

2.1 Introduction

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

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

Background

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

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

These requirements result in a list of impaired waters, called the "§303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. An SBA and TMDL provide a summary of the water quality status and allowable TMDL for water bodies on the §303(d) list. Jordan Creek Subbasin Assessment and Total Maximum Daily Load provides this summary for the currently listed waters in the Jordan Creek Subbasin.

The SBA section of this document (Sections 2 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the Jordan Creek Subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (Water quality planning and management, 40 CFR Part 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also allocates allowable discharges of individual pollutants among the various sources discharging the pollutant.

Some conditions that impair water quality do not receive TMDLs. The EPA does consider certain unnatural conditions, such as flow alteration, human-caused lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutants as "pollution." However, TMDLs are not required for water bodies impaired by pollution, but not by specific pollutants. A TMDL is only required when a pollutant can be identified and in some way quantified.

Idaho's Role

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

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

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

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

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

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

2.2 Water Quality Limited Assessment Units Occurring in the Subbasin

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

About Assessment Units

Assessment Units (AUs) define all the waters of Idaho. These units and the methodology used to describe them can be found in the Water Body Assessment Guidance, second edition (Grafe et al. 2002d).

AUs are groups of similar streams that have similar land use practices, ownership, or land management. Stream order, however, is the main basis for determining AUs; although ownership and land use can change significantly, the AU remains the same.

Using assessment units to describe water bodies offers many benefits, the primary benefit being that all the waters of the state are now defined consistently. In addition, using AUs fulfills he fundamental requirement of EPA's 305(b) report, a component of the Clean Water Act wherein states report on the condition of all the waters of the state. Because AUs are a subset of water body identification numbers, there is now a direct tie to the water quality standards for each AU, so that beneficial uses defined in the water quality standards are clearly tied to streams on the landscape.

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

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

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

303 (d) Listed Waters & Impaired but Unlisted Waters

Table 11 shows the pollutants both listed and unlisted and the basis for listing for each §303(d) listed AU in the subbasin. Not all of the water bodies will require a TMDL, as will be discussed later. However, a thorough investigation, using the available data, was performed before this conclusion was made. This investigation, along with a presentation of the evidence of non-compliance with standards for several other tributaries, is contained in the following sections.

Table 11. 2008 §303(d) Listed Waters & Impaired but Unlisted Waters in the Jordan Creek Subbasin.

Water Body Name	Assessment Unit ID Number	Boundaries	Pollutant(s)	Listing Basis
Cow Creek	ID17050108SW021_02 ID17050108SW021_03	Headwaters to Oregon Line	Sediment and temperature	Water body carry over from 1998 303(d) list
Jordan Creek	ID17050108SW004_02	1st and 2nd Order tributaries above Williams Creek	Fecal coliform, mercury, oil/grease, unknown (pesticides) , sediment	Water body carry over from 1998 303(d) list
Jordan Creek	ID17050108SW004_03	3rd Order (Pole Creek to Louse Creek)	Fecal coliform, mercury, oil/grease, unknown, (pesticides), sediment,	Water body carry over from 1998 303(d) list
Jordan Creek	ID17050108SW004_04	4th Order	Temperature, mercury	Unlisted but impaired
Jordan Creek	ID17050108SW004_05	5th Order (Rail Creek to Williams Creek)	Fecal coliform, mercury, oil/grease, unknown (pesticides) ,sediment,	Water body carry over from 1998 303(d) list
Jordan Creek	ID17050108SW001_02	1st and 2nd Order tributaries (Williams Creek to Oregon Line)	Fecal coliform, mercury, oil/grease, unknown, (pesticides) sediment,	Water body carry over from 1998 303(d) list
Jordan Creek	ID17050108SW001_05	Williams Creek to Oregon Line	Temperature, mercury	Unlisted but impaired
Louisa Creek	ID17050108SW014_02	Headwaters to Triangle Reservoir	Sediment and temperature	Water body carry over from 1998 303(d) list
Rock Creek	ID17050108SW013_02	Headwaters to Triangle Reservoir	Sediment and temperature	Water body carry over from 1998 303(d) list
Soda Creek	ID17050108SW022_02 ID17050108SW022_03	Headwaters to Cow Creek	Sediment and temperature	Water body carry over from 1998 303(d) list Unlisted but impaired for temperature
Spring Creek and Meadow Creek	ID17050108SW015_02 ID17050108SW015_03	Headwaters to mouth	Temperature	Water body carry over from 1998 303(d) list.

2.3 Applicable Water Quality Standards

Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02); a list of the beneficial uses for §303(d) listed streams in the Jordan Creek Subbasin is provided in Table 12.

These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as briefly described in the following paragraphs. The Water Body Assessment Guidance, second edition (Grafe et al. 2002d) 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 water body on or after November 28, 1975, whether or not they are included in the water quality standards." The existing in-stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.050.02, .02.051.01, and .02.053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water that could support salmonid spawning, but salmonid spawning is not occurring due to other factors, such as dams blocking migration.

Designated Uses

Designated uses under the CWA are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained." Designated uses are simply uses officially recognized by the state. In Idaho these include uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.27 and .02.109-.02.160 in addition to citations for existing uses).

Presumed Uses

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

Table 12. Jordan Creek Subbasin beneficial uses of §303(d) listed streams.

Water Body	Description	Assessment Unit ID#	Designated Uses	IDAPA §
Jordan Creek	Williams Creek to Idaho/Oregon Stateline	ID1705108SW001_02	Cold Water Aquatic Life Salmonid Spawning Primary Contact Recreation Special Resource Water	58.01.02.140.08. SW-1
Jordan Creek	Source to Williams Creek	ID1705108SW004_02 ID1705108SW004_03 ID1705108SW004_05	Cold Water Aquatic Life Salmonid Spawning Primary Contact Recreation Special Resource Water	58.01.02.140.08. SW-4
Cow Creek	Headwaters to Oregon Line	ID1705108SW021_02 ID1705108SW021_03	No Designated Uses	58.01.02.140.08. SW-21
Rock Creek	Headwaters to Triangle Reservoir	ID1705108SW013_02	No Designated Uses	58.01.02.140.08. SW-13
Louisa Creek	Headwaters to Triangle Reservoir	ID1705108SW014_02	No Designated Uses	58.01.02.140.08. SW-14
Soda Creek	Source to Mouth	ID1705108SW022_02 ID1705108SW022_03	No Designated Uses	58.01.02.140.08. SW-22
Spring Creek (Meadow Creek)	Source to Mouth	ID1705108SW015_02 ID1705108SW015_03	No Designated Uses	58.01.02.140.08. SW-15

2.4 Beneficial Use Support Status

To determine if a water body is fully supporting the designated and/or existing uses, the process defined in IDAPA 58.01.02.053 (Figure 18) is applied to outline the measures to be taken to determine use support.

IDAPA 58.01.02.053.01 & 02 states the following:

> In determining whether a water body fully supports designated and existing beneficial uses, the Department shall determine whether all of the applicable water quality standards are being achieved, including any criteria developed pursuant to these rules, and whether a healthy, balanced biological community is present. The Department shall utilize biological and aquatic habitat parameters listed below and in the current version of the "Water Body Assessment Guidance", as published by the Idaho Department of Environmental Quality, as a guide to assist in the assessment of beneficial use status. Revisions to this guidance will be made after notice and an opportunity for public comment. These parameters are not to be considered or treated as individual water quality criteria or otherwise interpreted or applied as water quality standards.
>
> 01. Aquatic Habitat Parameters. These parameters may include, but are not limited to, stream width, stream depth, stream shade, measurements of sediment impacts, bank stability, water flows, and other physical characteristics of the stream that affect habitat for fish, macroinvertebrates or other aquatic life; and (3-20-97)
>
> 02. Biological Parameters. These parameters may include, but are not limited to, evaluation of aquatic macroinvertebrates including Ephemeroptera, Plecoptera and Trichoptera (EPT), Hilsenhoff Biotic Index, measures of functional feeding groups, and the variety and number of fish or other aquatic life to determine biological community diversity and functionality. (3-20-97)"

In IDAPA 58.01.02.053.04 natural conditions are addressed as follows:

> 03. Natural Conditions. There is no impairment of beneficial uses or violation of water quality standards where natural background conditions exceed any applicable water quality criteria as determined by the Department, and such natural background conditions shall not, alone, be the

> basis for placing a water body on the list IDAPA 58.01.054.1 of water quality limited water bodies described in Section 054. (3-15-02)

IDAPA 58.01.02.10.45 provides a definition for *intermittent waters*:

> Intermittent Waters. A stream, reach, or water body which has a period of zero (0) flow for at least one (1) week during most years. Where flow records are available, a stream with a 7Q2 hydrologically base flow of less than one-tenth (0.1) cfs is considered intermittent. Streams with natural perennial pools containing significant aquatic life uses are not intermittent."

As pertaining to beneficial uses, mainly cold water aquatic life and primary and secondary contact recreation, IDAPA 58.01.02.70.06 applies:

> 06. Application of Standards to Intermittent Waters. Numeric water quality standards only apply to intermittent waters during optimum flow periods sufficient to support the uses for which the water body is designated. For recreation, optimum flow is equal to or greater than five (5) cubic feet per second (cfs). For aquatic life uses, optimum flow is equal to or greater than one (1) cfs. (3-30-01)

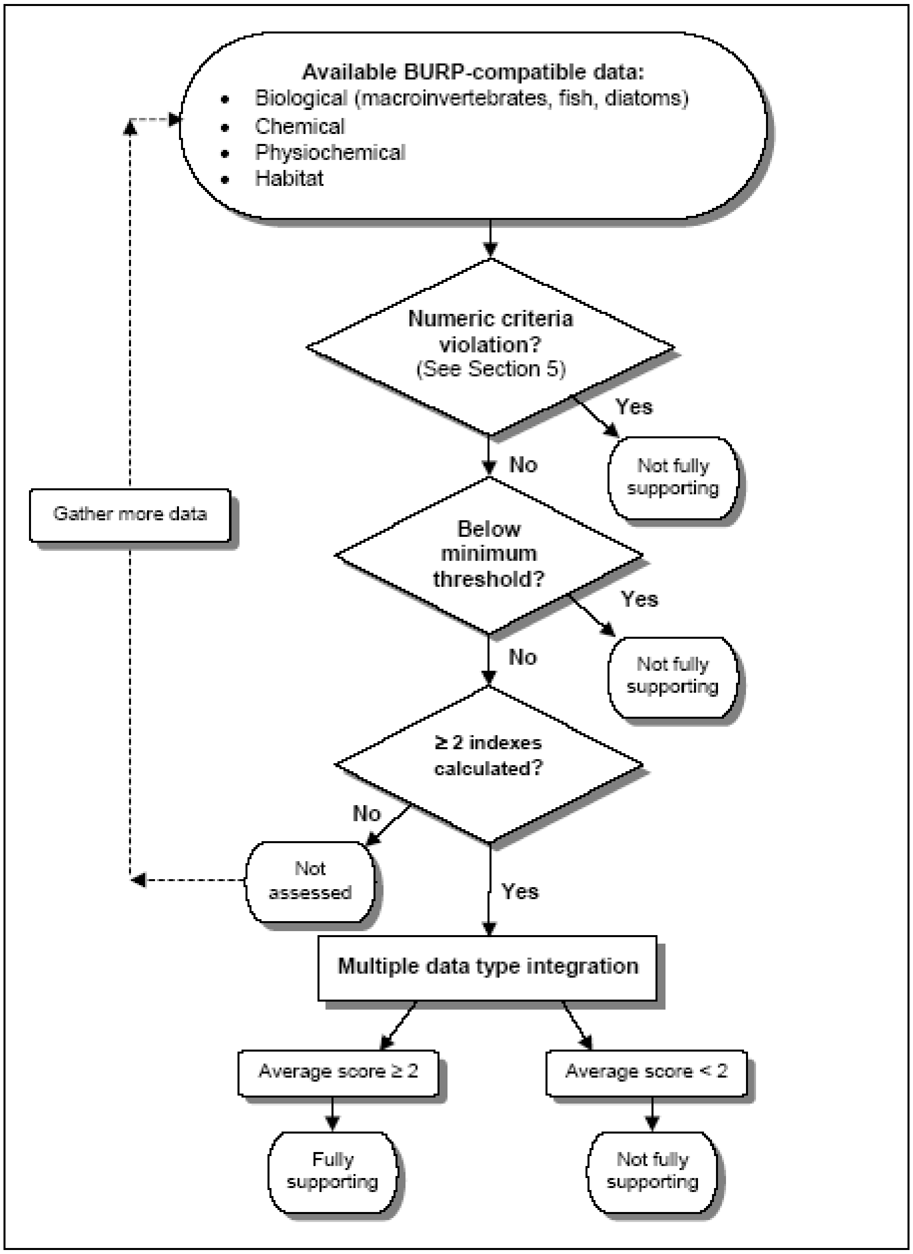


Figure 18. Process for determining support status of beneficial uses (Grafe et al. 2002d).

2.5 TMDLs and Other Appropriate Actions

If a water body is determined to be not fully supporting the designated or existing uses IDAPA 58.01.02.054.01 & 02 would apply. This standard states:

> 01. After Determining That Water Body Does Not Support Use. After determining that a water body does not fully support designated or existing beneficial uses in accordance with Section 053, the Department, in consultation with the applicable basin and watershed advisory groups, shall evaluate whether the application of required pollution controls to sources of pollution affecting the impaired water body would restore the water body to full support status. This evaluation may include the following: (3-20-97)
>
> a. Identification of significant sources of pollution affecting the water body by past and present activities; (3-20-97)

> b. Determination of whether the application of required or cost-effective interim pollution control strategies to the identified sources of pollution would restore the water body to full support status within a reasonable period of time; (3-20-97)
>
> c. Consultation with appropriate basin and watershed advisory groups, designated agencies and landowners to determine the feasibility of, and assurance that required or cost-effective interim pollution control strategies can be effectively applied to the sources of pollution to achieve full support status within a reasonable period of time; (3-20-97)
>
> d. If pollution control strategies are applied as set forth in this Section, the Department shall subsequently monitor the water body to determine whether application of such pollution controls were successful in restoring the water body to full support status. (3-20-97)
>
> 02. Water Bodies Not Fully Supporting Beneficial Uses. After following the process identified in Subsection 054.01, water bodies not fully supporting designated or existing beneficial uses and not meeting applicable water quality standards despite the application of required pollution controls shall be identified by the Department as water quality limited water bodies, and shall require the development of TMDLs or other equivalent processes, as described under Section 303(d) (1) of the Clean Water Act. A list of water quality limited water bodies shall be published periodically by the Department in accordance with Section 303(d) of the Clean Water Act and be subject to public review prior to submission to EPA for approval. Informational TMDLs may be developed for water bodies fully supporting beneficial uses as described under Section 303(d)(3) of the Clean Water Act, however, they will not be subject to the provisions of this Section. (3-20-97)

Criteria to Support Beneficial Uses

Idaho utilizes both numeric criteria and narrative targets to determine if beneficial uses are supported or not supported.

Numeric Criteria

Numeric criteria, such as temperature, metals, or pH, apply a value or range to protect beneficial uses. These criteria provide specific endpoints that are to be achieved for the full support of the uses. If the specific criteria are not being met (are exceeded), then it is determined that the use is not fully supported due to that exceedance. For instance, the Jordan Creek watershed specific numeric criteria apply to cold water aquatic life, sediments and turbidity, contact recreation beneficial uses, and mercury.

Cold Water Aquatic Life

For the protection of cold water aquatic life, numeric criteria have been adopted to protect the beneficial use. Numeric criteria for temperature and turbidty can be found in IDAPA 58.01.02.250.02:

> **02. Cold Water.** Waters designated for cold water aquatic life are not to vary from the following characteristics due to human activities: (3-15-02)
>
> …
>
> **b**. Water temperatures of twenty-two (22) degrees C or less with a maximum daily average of no greater than nineteen (19) degrees C. (8-24-94)
>
> …
>
> **e.** Turbidity, below any applicable mixing zone set by the Department, shall not exceed background turbidity by more than fifty (50) NTU instantaneously or more than twenty-five (25) NTU for more than ten (10) consecutive days. (8-24-94)

Salmonid spawning is a subcategory of cold water aquatic life. This sensitive life stage is protected by more stringent criteria for temperature, dissolved oxygen and ammonia. The applicable temperature criteria are (IDAPA 58.01.02.250.02.f.ii):

> ii. Water temperatures of thirteen (13) degrees C or less with a maximum daily average no greater than nine (9) degrees C. (8-24-94)

For the numeric temperature criteria, two exceptions can be applied. The first is in IDAPA 58.01.02.070.07:

> **07. Temperature Criteria**. In the application of temperature criteria, the Director may, at his discretion, waive or raise the temperature criteria as they pertain to a specific water body. Any such determination shall be made consistent with 40 CFR 131.11 and shall be based on a finding that the designated aquatic life use is not an existing use in such water body or would be fully supported at a higher temperature criteria. For any determination, the Director shall, prior to making a determination, provide for public notice and comment on the proposed determination. For any such proposed determination, the Director shall prepare and make available to the public a technical support document addressing the proposed modification. (4-5-00)

The second numeric exception to the temperature criteria is found in IDAPA 58.01.02.080.03:

> **03. Temperature Exemption**. Exceeding the temperature criteria in Section 250 will not be considered a water quality standard violation when the air temperature of a given day exceeds the ninetieth percentile of a yearly series of the maximum weekly maximum air temperature (MWMT) calculated over the historic record measured at the nearest weather reporting station. (3-15-02)

A natural background narrative criterion also applies to temperature and is the basis for the Jordan Creek TMDL as discussed below.

Recreation

A description of the distinction between primary and secondary contact recreation is found in IDAPA 58.01.02.100.02.a and .02.b:

> **02. Recreation.** (7-1-93)
>
> **a. Primary contact recreation (PCR**): water quality appropriate for prolonged and intimate contact by humans or for recreational activities when the ingestion of small quantities of water is likely to occur. Such activities include, but are not restricted to, those used for swimming, water skiing, or skin diving. (4-5-00)
>
> **b. Secondary contact recreation (SCR):** water quality appropriate for recreational uses on or about the water and which are not included in the primary contact category. These activities may include fishing, boating, wading, infrequent swimming, and other activities where ingestion of raw water is not likely to occur. (4-5-00)

The numeric criteria to determine if a water body is supporting either primary or secondary contact recreation are found in IDAPA 58.01.02.251.01:

> 01. E. Coli Bacteria. Waters designated for recreation are not to contain E.coli bacteria, used as indicators of human pathogens, in concentrations exceeding: (4-11-06)
>
> a. Geometric Mean Criterion. Waters designated for primary or secondary contact recreation are not to contain E. coli bacteria in concentrations exceeding a geometric mean of one hundred twenty-six (126) E. coli organisms per one hundred (100) ml based on a minimum of five (5) samples taken every three (3) to seven (7) days over a thirty (30) day period. (4-11-06)
>
> b. Use of Single Sample Values. A water sample exceeding the E. coli single sample maximums below indicates likely exceedance of the geometric mean criterion, but is not alone a violation of water quality standards. If a single sample exceeds the maximums set forth in Subsections 251.01.b.i., 251.01.b.ii., and 251.01.b.iii., then additional samples must be taken as specified in Subsection 251.01.c.: (4-11-06)

i. For waters designated as secondary contact recreation, a single sample maximum of five hundred seventy-six (576) E. coli organisms per one hundred (100) ml; or (4-11-06)

ii. For waters designated as primary contact recreation, a single sample maximum of four hundred six (406) E. coli organisms per one hundred (100) ml; or (4-11-06)

iii. For areas within waters designated for primary contact recreation that are additionally specified as public swimming beaches, a single sample maximum of two hundred thirty-five (235) E. coli organisms per one hundred (100) ml. Single sample counts above this value should be used in considering beach closures. (4-11-06)

c. Additional Sampling. When a single sample maximum, as set forth in Subsections 251.01.b.i., 251.01.b.ii., and 251.01.b.iii., is exceeded, additional samples should be taken to assess compliance with the geometric mean E. coli criteria in Subsection 251.01.a. Sufficient additional samples should be taken by the Department to calculate a geometric mean in accordance with Subsection 251.01.a. This provision does not require additional ambient monitoring responsibilites for dischargers.

Mercury

Idaho adopted a fish tissue criterion for methyl mercury in April 2005 (IDAPA 58.01.02.210) for use in place of direct measurement of mercury in water. This criterion was approved by the EPA in September 2005. The criterion is 0.3 mg methylmercury /kg wet weight of tissue. According to the Implementation Guidance for the Idaho Mercury Water Quality Criteria (DEQ 2005), the criterion applies to all waters in Idaho.

Mercury and Human Health Concerns

Methylmercury is a potent neurotoxin to which the developing human brain is especially vulnerable. Even very low levels of inorganic mercury (Hg) in water can, through the processes of methylation and then *bioaccumulation*, produce unhealthful levels of methylmercury in fish tissue. Bioaccumulation, in which living organisms take up contaminants more rapidly than they eliminate them, magnifies mercury contamination greatly. At each step or trophic level in the food chain - from water to algae, algae to aquatic insects, insects to fish, fish to other fish, and fish to humans - mercury concentrations in tissue increase, reaching multiples that can be on the order of a million times the original concentration of mercury in the water column.

Estimation of the Reference Dose

The quantitative health risk assessment for a non-carcinogen relies on a reference dose (RfD). This is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious health effects during a lifetime. To derive an RfD, toxicologists first establishes a no adverse effect level for a particular endpoint. This can be done by inspection of the available data or by using a mathematical modeling procedure to estimate the no adverse effect level. The latter approach was used for methylmercury. Next, the no adverse effect level is divided by a numerical uncertainty factor to account for areas of variability and uncertainty in the risk estimate.

Estimation of the No Adverse Effect Level

A benchmark dose analysis was chosen as the most appropriate method of quantifying the dose effect relationship. The level chosen was a benchmark dose lower limit; this was the lower 95% limit on a 5% effect level obtained by applying a K power model (K - 1) to dose-response database on mercury in cord blood. The benchmark dose lower limit was chosen as the functional equivalent of a no-adverse effect level for calculation of the RfD.

Estimation of the Lowest Observed Adverse Effect Level

This is the lowest exposure level at which there are statistically or biologically significant increases in frequency or severity of adverse effects in a comparison between an exposed population and a control group.

Estimation of the Benchmark Dose

In common parlance, this term refers to a quantitative assessment for non-cancer health effects that uses a curve-fitting procedure to determine a level functionally equivalent to a no adverse effect level. Benchmark dose is used to calculate the mean estimated dose that corresponds to a specified risk above the background risk.

Estimation of the Benchmark Dose Lower Limit

This is the lower limit on a calculated benchmark dose. In this document the 95% lower confidence limit will the benchmark dose lower limit. This will be used as the starting point for the calculation of the methylmercury RfD.

Mercury and Aquatic Life Support Status

EPA has expressed concerns that their aquatic life water column mercury criteria may not be protective of some important aquatic species in Idaho (EPA 1995). The methylmercury tissue criterion was developed by EPA (EPA 2001) to protect human health. While EPA has yet to agree, DEQ believes the fish tissue criterion of 0.3 mg methylmercury /kg, wet (fresh) weight, is more protective of aquatic life than the recommended water column criteria and adequately protects aquatic-dependent life if applied to the highest trophic level of fish. If the fish tissue criterion is translated to an equivalent water column concentration, using worst case bioaccumulation factors, dissolved mercury levels need to be an order of magnitude lower than EPA's 2002 recommended chronic criterion (see table 13). Recent data on concurrent fish tissue and water concentrations of mercury from Idaho rivers (Essig 2009) indicates fish tissue concentrations of mercury at the human health criterion are associated with water column total mercury levels of less than 2 ng/L.

The Clean Water Act requires that the most sensitive use be protected. Because application of the fish-tissue-based human health criterion will in most cases require lower water mercury levels, human health is nominally the more sensitive use than aquatic life.

When Idaho adopted the fish tissue criterion, it also removed its old aquatic life criteria from the rules and added this footnote:

> No aquatic life criterion is adopted for inorganic mercury. However, the narrative criteria for toxics in Section 200 of these rules apply. The Department believes application of the human health criterion for methylmercury will be protective of aquatic life in most situations.

Thus in addition to the protection offered by the fish tissue criterion, aquatic life is protected through application of a narrative prohibition on toxics in amounts that would impair aquatic life. DEQ's analysis is that the 0.3 mg/kg methyl mercury criterion is protective of aquatic life as well as human health.

Translation of fish tissue methylmercury to water column total mercury

The translation of fish tissue methylmercury to an equivalent water column total mercury concentration depends upon 1) bioaccumulation rate (factor) for methylmercury, and 2) proportion of methylmercury to total mercury. Although this translation will vary widely, even extremely conservative bioaccumulation factors (BAFs) applied to the 0.3 mg/kg fish tissue criterion will result in water column concentrations of total mercury protective of aquatic life in the vast majority (upwards of 95%) of Idaho waters. The following analysis illustrates this point.

Three conservative assumptions can be applied to determine a near worst-case scenario for translation of a fish tissue concentration of methylmercury (MeHg) to a corresponding water column concentration of total mercury:

- Application to Trophic Level 4 vs. Trophic Level 3 species;
- Application of 5th percentile BAFs (95% of waters are higher) vs. geometric mean BAFs for the choosen trophic level; and
- Application of low fraction of methylmercury to total mercury in the water column.

Table 13 compares each of these assumptions and shows the resulting water column concentration of total Hg that would be necessary to meet the fish tissue criterion.

Table 13. Bioaccumulation Factors and Estimated Corresponding Methyl Mercury-Total Mercury Concentrations.

Fish Tissue Criterion	**Bioaccumulation Factor[a]**			**Equivalent Water Column Methylmercury Concentration**	**Equivalent Water Column Total Inorganic Mercury Concentration**	
MeHg					@ 1.4% MeHg:THg[b]	@ 5% MeHg:THg
(mg/kg) Trophic	level		(l/kg)	(ng[c]/l MeHg)	(µg[d]/l T Hg)	(µg/l T Hg)
0.3	TL3	5th %tile	74,000	4.0	0.29	0.081
0.3	TL4	5th %tile	250,000	1.2	0.09	0.024
0.3 TL3		Median	680,000	0.44	0.03	0.009
0.3 TL4		Median	2,700,000	0.11	0.01	0.002

a These national default BAFs are from Appendix A of EPA's "Water Quality Criterion Human Health: Methylmercury" criterion document, EPA-823-R-01-001, January 2001

b Ratio of methyl mercury to total mercury in water. 1.4% is the grand median from rivers stated in comments of James Hurley, reviewer of Appendix A of EPA's 2001 methylmercury criterion document. 5% is the midpoint of the range of 2-8% for sediments and water from NAWQA basin in the western US as reported by D. Krabenhoft of the USGS in a March 2003 briefing to Congress.

c Nanogram (10^{-9} gram)

d. Microgram (10^{-6} gram)

When EPA's 5th percentile draft national BAF of 74,000 for trophic level 3 fish is applied, water column concentrations of methylmercury would have to be about 4.0 ng/L to produce 0.3 mg/Kg in fish tissue. If methylmercury is as low as 1.4 % of the total mercury (2-8% is more typical), this would in turn correspond to a total mercury concentration of 0.29 µg/L. A concentration of 0.29 µg/L total mercury is more than three times lower than EPA's currently recommended, albeit self-questioned, chronic criterion of 0.91 µg/L. It is also lower than the estimated chronic toxicity value of 0.37 µg/L for Coho salmon, which caused EPA to question the protectiveness of their 0.91 µg/L recommended chronic criterion.

This above is a highly unlikely, near worst case. Any greater trophic level, higher BAF, or larger fraction of methylmercury to total Hg would correspond to an even lower total Hg concentration in the water.

Idaho's rules also require that:

> In waters inhabited by species listed as threatened or endangered under the Endangered Species Act or designated as their critical habitat, the Department will apply the human health fish tissue residue criterion for methylmercury to the highest trophic level available for sampling and analysis.

Combining the more typical values of 5% Me-Hg, a median BAF and applying it to trophic level 4 as required by Idaho's rules results in an equivalent total Hg in water of 0.002 μg/L (2 ng/L). This example is shown in last row in Table 13 and corresponds well with the recent findings of Essig (2009) that a fish tissue mercury level at the human health criterion of 0.3 mg/Kg correlates to a total Hg in water of less than 2 ng/L. This more typical translated concentration of 2 ng/L is well below the 12 ng/l aquatic life criterion Idaho abandoned.

DEQ recognizes there may be situations in which very low BAFs occur, and thus cannot claim the methylmercury criterion is always protective of all aquatic life. However, because of the aforementioned conservative application and resulting safety factors, these odd situations can be expected much less than 5% of the time. On the other hand we expect the fish tissue criterion will provide better protection in other waters because as the proportion of methylmercury to total mercury rises, use of a static water column total mercury criterion becomes increasingly less effective in limiting the tissue burden of the more toxic methylmercury in higher trophic levels of fish, as well as humans.

Narrative Criteria

Narrative criteria apply a general condition or status, such as sediment, to determine compliance. The general surface water quality criteria at IDAPA 58.01.02.200 address sediment and natural background with narrative statements.

Sediment Criteria

The general surface water quality criterion for sediment is found in IDAPA 58.01.02.200.08:

> 08. Sediment. Sediment shall not exceed quantities specified in Sections 250 and 252, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Section 350. (4-5-00)

This narrative criterion requires that impairment to the beneficial uses must be demonstrated before a violation or an exceedance is occurring. The primary use protected by this narrative is cold water aquatic life.

Impairment to aquatic life is usually associated with two forms of sediment: bedload and suspended sediment:

- Bedload sediment is the sediment transported along the substrate. This transport is associated with the rolling or short-term suspension of sediment. Bedload sediment transport is a direct result of stream velocity, substrate roughness, and available energy.

Available energy is usually determined by the amount of sediment already in suspension or bedload being moved through the system. This is not to say that sediment at one time suspended cannot become bedload. As stream velocity decreases and/or available energy decreases for one reason or another, suspended sediment will "drop" from the water column and may continue to be transported as bedload sediment.

Fishery biologists appear to consider sediments less than 6mm in diameter as fine, since it can cause impairment of uses in a variety of ways. Bedload sediment can fill in gravels associated with salmonid spawning, cover redds reducing intergravel dissolved levels, encase fry, fill in interstitial spaces required for fry development and salmonid food sources, reduce pool volume required for salmonid refugia areas, and cover substrate required for primary food (periphyton) production areas. However, DEQ uses a 2.5mm cutoff for "fine sediment" in our BURP process. Most reference literature indicate that when >30% of the substrate is composed of fine sediment (<2.5mm), the benthic community begins to shift to more sediment tolerant macroinvertebrates, algae and fish species.

Unfortunately, there is no bedload data available for the Jordan Creek watershed. This lack of data is due, in part, to the difficulty in monitoring this parameter, especially on a large river system where the high velocity associated with peak flows prevents such monitoring. However, surrogate measures may be implemented that can assist in determining a bedload sediment load. These surrogate measures can include substrate evaluation, pool filling, riffle-pool ratio, and number of or ratio of pools in a given segment.

- Suspended sediment (SS), or total suspended solids (TSS), is usually associated with that fraction of the sediment load suspended within the water column. Suspended sediment and TSS, as with bedload sediment, is directly related to stream velocity and the available energy for sediment transport. The transport of suspended sediment can also vary depending on the size of the sediment and/or buoyancy of the particle being transported. That is, some sediment may be colloidal (made of clay particles) in nature, have high surface tension, and/or be highly buoyant and remain suspended even in a stagnant water column such as a lake or reservoir.

Sediment impairment may also be exacerbated by lack of suitable habitat for cold water aquatic life (e.g., pools, riffles).

Sediment Literature Values and Research

There are a variety of studies to determine the effects of sediment and turbidity on salmonid species. Sigler, Bjorn, and Forest (1984) determined that turbidity levels as low as 25 NTUs can cause a reduction in fish growth, and levels between 100-300 NTUs will cause fish to die or seek refuge in other channels. Lloyd (1987) suggested that a moderate level protection of salmonid species is provided by limiting turbidity levels to 23 NTUs. For a high level of protection, Lloyd (1987) suggested limiting turbidity levels to 7 NTUs. Nevada has set a numeric turbidity standard of less than or equal to 25 NTUs for the protection of aquatic life, water supply, and recreational use in Lake Mead on the Nevada-Arizona border (State of Nevada NAC §445A.195).

Most studies have demonstrated that turbidity levels exceeding 25-30 NTUs will impair aquatic life use by causing reduced fish growth, reduced survival, reduced abundance, respiratory stress, and increased ventilation (Bash, Berman, and Bolton 2001). General avoidance, reduced energy intake, and displacement can occur at turbidity levels of 22 to greater than 200 NTUs.

Suspended sediment concentrations at levels of 100 mg/L have shown reduced survival of juvenile rainbow trout (Herbert and Merkens 1961). The covering of spawning gravels has shown to decrease the survivability during incubation and emergence (Bash, Berman, and Bolton 2001). Chronic turbidity during emergence and rearing of young anadromous salmonid could affect the quantity and quality of fish produced (Sigler, Bjorn, and Forest 1984). Sediment may also alter the hyporheic conditions, reducing ground water flows and increasing water temperature (Poole and Berman 2001).

Surface fines can impair benthic species and fisheries by limiting the interstitial space for protection and suitable substrate for nest or redd construction. Certain primary food sources for fish (Ephemeroptera, Plecoptera, and Tricoptera species [EPT]) respond positively to a gravel to cobble substrate (Waters 1995). Substrate surface fine targets are difficult to establish. However, as described by Relyea, Minshall, and Danehy (2000), macroinvertebrates (Plecoptera) intolerant to sediment are mostly found where substrate cover (<6mm) is less than 30%. More sediment tolerant macroinvertebrates are found where the substrate cover (<6mm) is greater than 30%.

Most studies have focused on smaller streams, A, B, and C channel types (Rosgen 1996). Studies conducted on Rock Creek (Twin Falls County, Idaho) and Bear Valley Creek (Valley County, Idaho) found percent fines above 30% begin to impair embryo survival (Idaho DEQ 1990). Overton et al. (1995) found natural accumulation of percent fines were about 34% in C channel types. Most C channel types exhibit similar gradient as F channel types, <2.0% (Rosgen 1996).

The smallmouth bass species (Micropeterus dolomieui), found throughout the Owyhee River watershed, require adequate substrate for nest building. This substrate could be sand or gravel (Simpson and Wallace 1982). The sucker species found in the area (Catostomus macrohelus) prefer gravel to rocky substrate. The northern pike minnow (Ptychocheilus oregonensis) uses streams and rivers for spawning, but is more of a broadcast spawner than nest builder (Simpson and Wallace 1982). Sculpin (Cottus baird) are also known to inhabit waters in the watershed and prefer clean water and clean gravel for habitat.

Salmonid species, mainly redband trout, require clean, well-oxygenated gravels for spawning, incubation, and emergence. Intergravel space is required for fry development, location of primary food sources, and refuge. Pools are required for mature fish development and provide areas of refugia during high water temperature and for prey protection (Burton 1991).

A general overview of literature referenced material pertaining to appropriate sediment targets are presented in Table 14.

Table 14. Water quality standards, criteria, and literature reviews.

Applicable Criteria	Citation
Narrative Criteria	
Sediment shall not exceed quantities specified in Sections	IDAPA 58.01.02.200.08

250 and 252, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Section 350	
Suspended Sediment-TSS Targets	
100 mg/L[a] Suspended Sediment	Herbert and Merkens (1961)
25 mg/L TSS Water Body Specific Criteria (e.g. East Fork Owyhee River)	State of Nevada NAC §445A.223
50 mg/L suspended sediment concentrations not to exceed 60 days and 80 mg/L suspended sediment concentrations not to exceed 14 days	Boise River SBA-TMDL (DEQ 1999b)
50 mg/L (Average) TSS not to exceed 28 day period	Rowe, Essig and Jessup (2003)
Turbidity-Substrate Targets	
25 NTUs[b] Site Specific Criteria for Lake Mead, Nevada	State of Nevada NAC §445A.195
25-30 NTUs	Bash, Berman, and Bolton (2001)
23 NTUs	Lloyd (1987)
25 NTUs	Sigler, Bjorn, and Forest (1984)
Substrate < 30% at 6.0 mm[c]	Rock Creek, Twin Falls County (Idaho DEQ 1990)
Substrate < 34% at 6.0 mm	Overton (1995)
Substrate < 30% at 6.0 mm	Relyea, Minshall, and Danehy (2000)

a milligrams per liter
b nephelometric turbidity units
c millimeter

If it is determined a TMDL is required to address sediment, target selection will be discussed in individual water body assessment and in Section 5.0. The discussion above is to provide information of the use recommended criteria, regulatory criteria, and comparable criteria in the region and indicator targets.

Natural Background

There can be situations in which natural conditions are not optimal for support of beneficial uses and result in exceedance of numeric criteria. Idaho's water quality standards recognize this and allow for this with a natural conditions narrative at IDAPA 58.01.02.200.09:

> **09. Natural Background Conditions as Criteria**. When natural background conditions exceed any applicable water quality criteria set forth in Sections 210, 250, 251, 252, or 253, the applicable water quality criteria shall not apply; instead, there shall be no lowering of water quality from natural background conditions. Provided, however, that temperature may be increased above natural background conditions when allowed under Section 401. (3-30-07)

This narrative applies to any pollutant that may be naturally adverse, e.g. temperature, sediment, dissolved oxygen, and metals. A Potential Natural Vegetation Temperature TMDL was developed for the Jordan Creek watershed based on this provision of the rules. To address the solar heat loading, a surrogate measurement of percent shade is utilized.

Temperature

Heat exchange between water and the environment can be affected by a variety of factors, including physical and atmospheric attributes. These factors influence the overall heat gain or loss in the water, as illustrated in Figure 19.

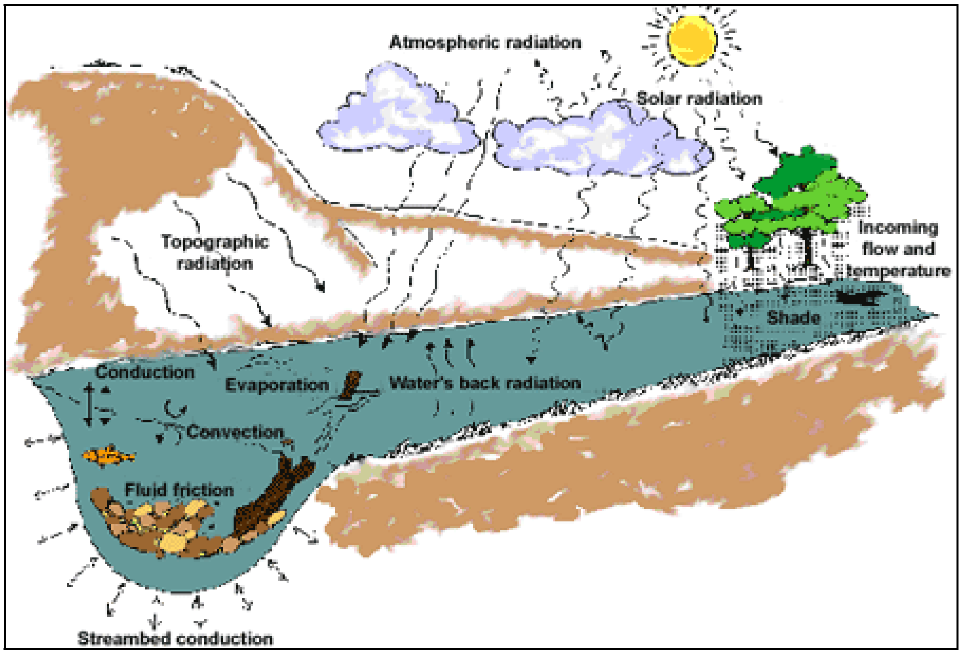


Figure 19. Heat sources (Source: Bartholow 1999).

As the amount of shade increases, the solar heat load to the water body decreases. Many variables determine what effect an increase in vegetation may have on stream temperature; these include channel width, channel length, air temperature, relative humidity, wind speed, and other physical/climatic. Streams may receive more than enough solar load even in their natural condition of shade to exceed Idaho numeric temperature criteria.

Design and Approach of the Subbasin Assessment

There are two steps in determining the support status and applicable WQS and criterion that apply to the water bodies in the Jordan Creek watershed.

Step 1: Classifying Flow Regime

The first step was to examine the flow regime of the different water bodies. If a water body exhibited zero discharge for more than seven days at a time, it was classified as intermittent and the appropriate WQS were applied.

Since most of the water bodies in the watershed do not have existing or historic discharge data, discharge was estimated using a model developed by Hortness and Berenbrock (2001). If the estimated daily average discharge was less than one (1) cfs and other available data or information indicated that the water body tends to go dry, the water body was classified as intermittent.

Appendix D provides the data used in the model and the results. The additional information for the Jordan Creek watershed was usually obtained from data collected during BURP monitoring. Although a water body may be determined to be intermittent and numeric criteria are not applicable, other available data are discussed in the assessment.

If a water body was determined to have adequate flow (> 1 cfs), available biological and habitat data were evaluated and appropriate metrics and indices applied. Indices used included the Stream Macroinvertebrate Index (SMI) and the Stream Habitat Index (SHI). A description of these indices and metrics can be found in the *Idaho Small Stream Ecological Assessment Framework: An Integrated Approach* (Grafe, 2002b). The Stream Fish Index (SFI) is also used if data are available. Once an index score and the final "condition rating" are calculated those values are compared to the range of index scores to determine use support status as found in the *Idaho Water Body Assessment Guidance, second edition* (Grafe et al. 2002d).

Step 2: Determining Numeric Criteria Exceedance

The second step involves a determination if numeric criteria are exceeded. These numeric criteria are set values that have been established to protect beneficial uses, which include aquatic life uses, recreational uses, and drinking water supply (IDAPA 58.01.02.210).

As seen in the flow chart of Figure 18 (page 44), if the final "condition rating," using at least two indices, is less than two (<2) the beneficial use for the water body are not full supported; if the "condition rating" is greater than or equal to two (≥2) the water body is full supported.

If it is determined that beneficial use of the water body is not full supported due to its final "condition rating," an evaluation of the biological composition and structure is made. With the use of established and accepted stress indicators, a link can be made between impairment and a pollutant(s), the cause and affect.

Step 3: Determining Narrative Criteria Exceedance

Since Idaho utilizes a narrative criterion for nutrients and sediment, it must be demonstrated these pollutants are impairing the designated uses. As an example, if a stream was listed for sediment and the biological community structure is mainly composed of sediment tolerant species, a link would be established between the pollutant of concern and the biological indicators.

Determination of a TMDL

If a beneficial use is determined to be not full supported due to an exceedance of a numeric criteria and/or the final "condition rating" is below the value established in the Idaho *Water Body Assessment Guidance* (Grafe et al. 2002d), the water body is placed in § 5 of Idaho's Integrated Report. This signifies the water body is impaired and according to the CleanWater Act a TMDL must be developed for that water body to reduce the pollutants causing the impairment.

The TMDL is described as the maximum load of a pollutant(s) that is required to meet numeric criteria or a surrogate target. The components of a TMDL are:

LC = MOS + NB + LA + WLA = TMDL

Where:

Load capacity (LC) is described as the acceptable total load of a pollutant(s) to obtain a numeric criteria or target.

Margin of safety (MOS) is described as a portion of the load capacity that provides a buffer to offset uncertainty of available data.

Natural background (NB) is described as a portion of the LC associated with natural, non-anthropogenic conditions in a watershed.

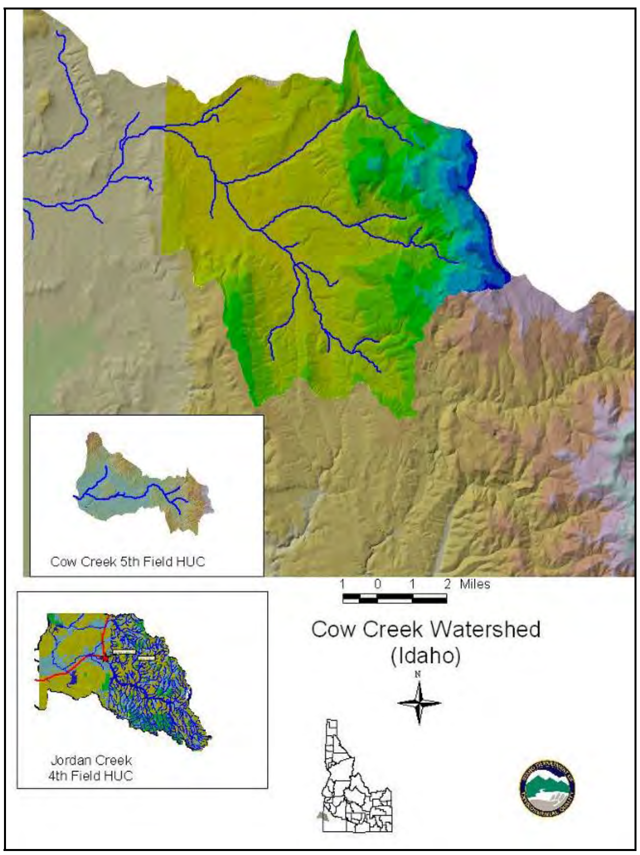
Load allocation (LA), is described as portion of the LC associated with non-point sources, which are usually associated with land use in the watershed (i.e. agriculture, timber, roads….etc).

Waste load allocation (WLA), is described as the portion of the LC associated with a point source discharge and/or a NPDES permitted activity.

2.6 Beneficial Use Support Assessments

Beneficial use support for each of the listed water bodies is discussed in the following.

Cow Creek



Water Body	Cow Creek Headwaters to Jordan Creek
5th Field HUC	1705010806
Miles of impaired water body	58.54 miles
Assessment Units	ID1705108SW021_02 ID1705108SW021_03
Total Acres	50,599
Listed pollutant(s)	Flow Modification, Sediment and Temperature
Impaired designated uses	Presumed Cold Water Aquatic Life
TMDL/Allocations goals	No Numeric WQS Allocations, Potential Natural Vegetation temperature TMDL will be developed
Further listing recommendations	Water body is intermittent; delist for sediment
Potential sources	Overland flow, streambank erosion, irrigation water return

Discharge (Flow) Characteristics

There are no current or historic state or federal discharge monitoring stations in the Cow Creek watershed. Discharge measurement occurred in June 1998 during BURP monitoring on Cow Creek (1998SBOIB013). The BURP site is located below the confluence with Soda Creek.

The June 18, 1998 instantaneous discharge was 26.6 cfs, which is a considerable discharge for this size watershed. However, high flows in 1998 were common. The USGS discharge monitoring gage (USGS 13181000) on the Owyhee River near Rome, Oregon showed a discharge of 1520 cfs, which is almost twice the mean average discharge for that date. The recorded daily discharges for June 1998 remained about twice the average for the entire month. In all likelihood, these high flows were caused by late season snow melt or a cool wet spring and were not associated with a brief localized storm event.

Watershed characteristics were applied to the statewide discharge estimate model developed by Hortness and Berenbrock (2001). The model showed the estimated annual average discharge for the Cow Creek watershed is 0.05 cfs. The model does not factor in the diversion of Cow Creek for irrigation water. This model also indicated the 26.6 cfs recorded on June 18, 1998 would exceed the Q20 discharge event, i.e., a discharge that can be expected to be exceeded less than 20% of the time.

Factoring in the western aspect, parent geology (volcanic flow and alluvium deposits), native vegetation (shrub-grassland), cover and irrigation water withdrawal, it is highly probable, as with other water bodies in the watershed, that Cow Creek is dry for a good portion of the summer months. The USGS 7.5 Minute Quad Map shows Cow Creek as an intermittent water body as well. This is further validated with continuous water temperature results provided by the BLM.

Examination of 24K topographic maps and 1999 2.5-meter SPOT satellite imagery indicate that there are flow modification structures in Cow Creek and in its tributary Jackson Creek. From the confluence of Jackson Creek and Cow Creek, Cow Creek exhibits an incised channel characteristic with little to no access to the historic floodplain. Land use is mostly irrigated pastures/hay fields, which are located on both sides of Cow and Jackson Creeks.

Biological and Other Data

Macroinvertebrates

Macroinvertebrate samples were obtained from Cow Creek in June 1998. Water Body Assessment Guidance, second edition describes macroinvertebrate data collected prior to July 1 as non-compatible BURP data that is not used in the WBAG process. Although not used in the WBAG process, the final analysis of the macroinvertebrates assemblages may be helpful. The macroinvertebrate sample showed an overall Stream Macroinvertebrate Index score of 57.0 (Grafe et al. 2002). With this score, the condition rating would be a “3”, indicating that the expected macroinvertebrate community structure is present.

Macroinvertebrate information can provide information on possible cause and effect of pollutant(s) for the stream. As an example, the 1998 macroinvertebrate data showed one cold water indicator species, which made up less than 1% of the total number of individuals. Percent dominance by single taxa, or a small group of taxa, may indicate a low diversity.

In Cow Creek, 70% of the macroinvertebrate assemblage was dominated by five taxa. Using a sediment tolerant-intolerant species indicator, or the fine sediment bioassessment index (FSBI) developed by Relyea, Minshall and Danehy (2000), a majority (80%) of the species have an assigned FSBI value which indicates the macroinvertebrate assemblage is moderately intolerant to fine sediment.

Periphyton

Periphyton was also collected as part of the 1998 BURP monitoring. The Siltation Index (based on percent total Navicula, Nitzschia and Surirella present) scored 20.2. This index score is slightly above the higher end of the index (0-20), which still indicates good water quality and no apparent impairment.

The number of taxa reported, 98 taxa in all, also indicates good diversity at the Cow Creek site. The low percentage of a single dominant taxa, 9.2%, is another indicator of good water quality and species diversity.

However, the presence of species commonly found in eutrophic environments indicate some organic enrichment. This could be associated with decaying biomass from previous benthic algal growth. See Appendix D for additional information on periphyton.

Fisheries

No fisheries data are available.

Water Column

The BLM collected water column samples from Cow Creek in 1977. None of these samples exceeded any Idaho numeric water quality standards.

Sediment

The BLM also collected samples for total suspended solids (TSS) and total solids (TS) in 1977. Neither sample showed concentrations that would indicate a water quality concern for sediments.

Temperature

The BLM provided continuous temperature monitoring data for 2000 and 2003. Although it is not clear exactly where the temperature loggers were located, the data does verify that Cow Creek is intermittent. The 2000 data shows an unusual temperature increase around August 18th (Figure 20). This increase is likely due to exposure of the temperature logger to ambient air.

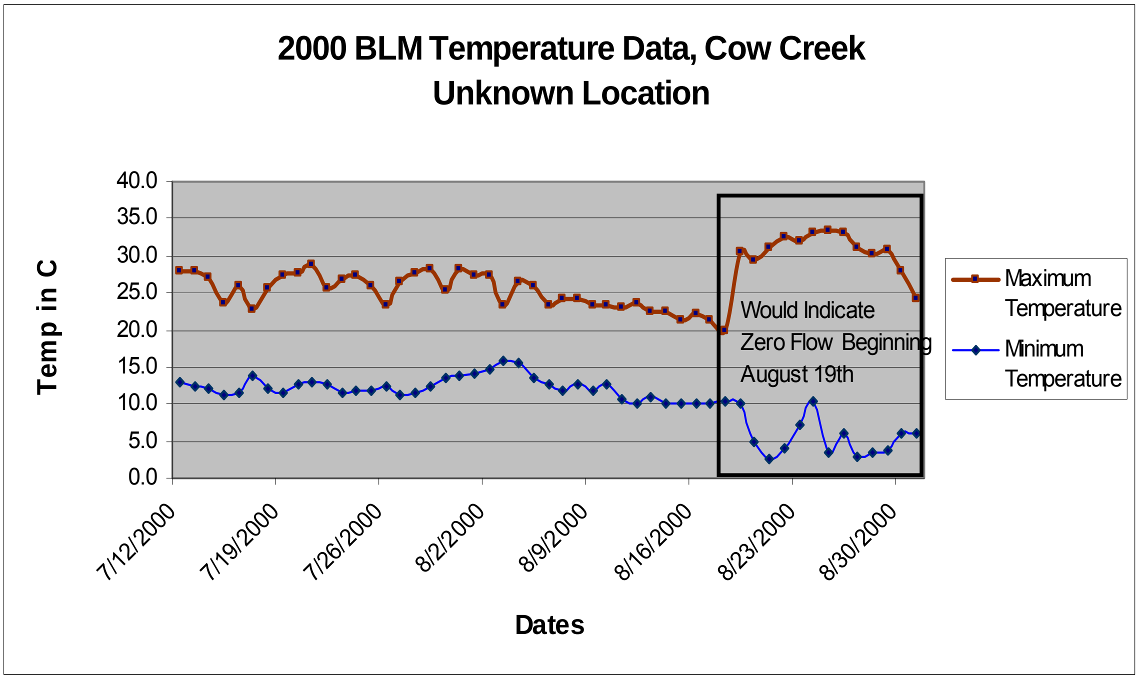


Figure 20. Continuous water temperature data for Cow Creek, BLM 2000.

Additional temperature data are available for 2003 at three Cow Creek sites, but the exact locations of these sites are also unknown:

Figure 21 indicates that Cow Creek, at the measured location, becomes dry around July 15th.

For the Cow Creek site in Figure 22, there were no exceedances of either the maximum daily maximum temperature (MDMT) of 22 °C or the maximum daily average temperature (MDAT) of 19 °C. For the site in Figure 23, the maximum daily maximum temperature criteria (22 °C) was exceeded on approximately 22% of the dates, but after exempting dates when the ambient air 95th percentile standard is applied, only 7% of the dates exceeded the 22 °C MDMT criterion, and only 1% of the dates exceeded the 19 °C MDAT criterion. Since neither criterion was exceeded over 10% of the time, there is not a violation of WQS.

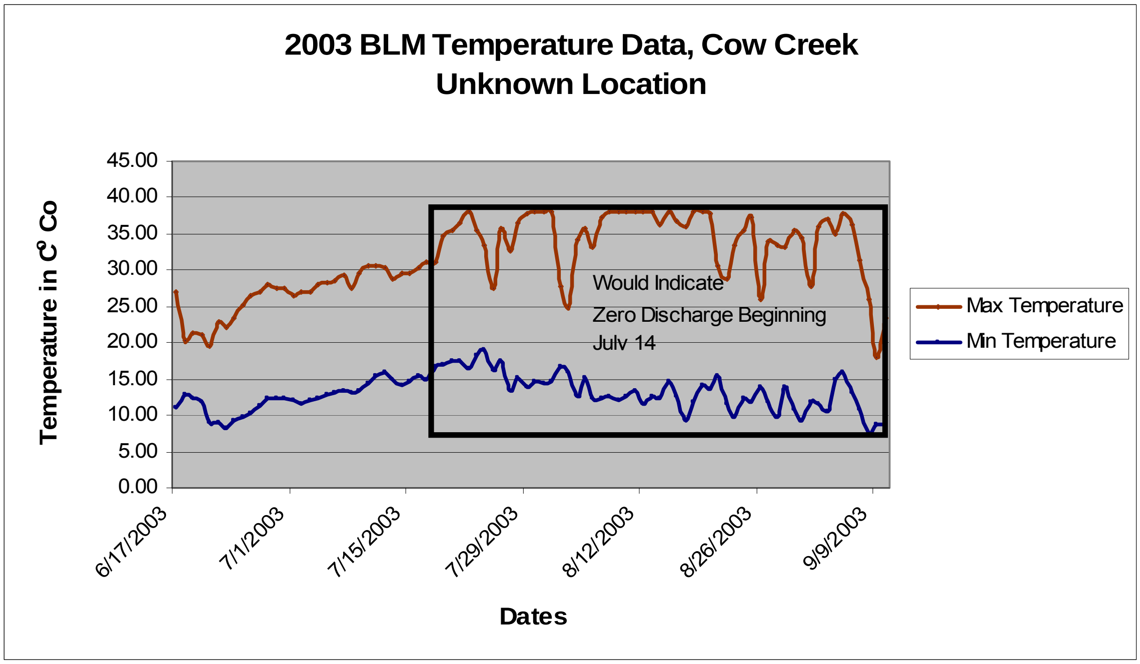


Figure 21. Continuous temperature data for Cow Creek, BLM 2003.

However, since no discharge data was provided for these sites, and the discharge model applied to Cow Creek calculated an annual discharge of < 1.0 cfs, it is assumed that that no temperature exceedances occurred during the "optimum flow" outlined in the Idaho WQS.

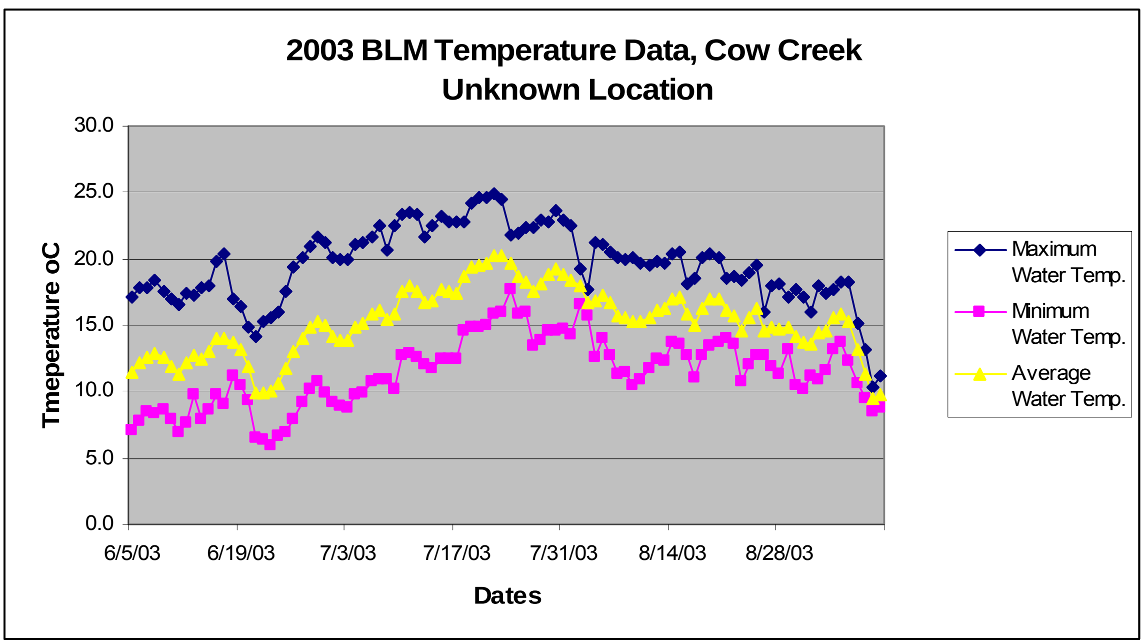


Figure 22. Continuous temperature data for Cow Creek, BLM 2003.

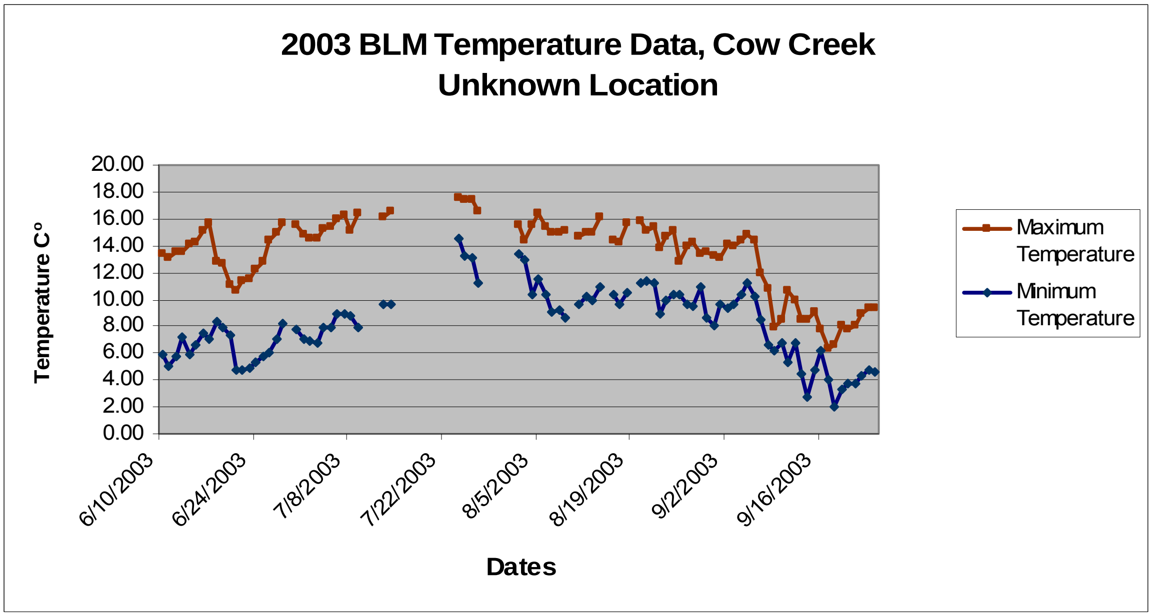


Figure 23. Continuous temperature data for Cow Creek, BLM 2003.

Despite the fact that Cow Creek does not appear to violate temperature standards, a Potential Natural Vegetation Temperature TMDL was developed.

Bacteria

Bacteria are not a listed pollutant for Cow Creek and are not evaluated. It is assumed that primary and secondary contact recreation is fully supported during optimum flow conditions, as outlined in the Idaho WQS.

Physical Attributes

Substrate

In 1998, percent fines were calculated from the Wolman pebble count (Wolman 1954) collected during BURP monitoring. This method involves the random collection and measurement of a water bodies' substrate. Those fines less than or equal to 2.5 mm in size have been determined to have the greatest influence on the substrate as far as condition of embeddedness and filling of intergravel spaces. Particles of this size are also easily suspended and transported during even mild (low velocity) discharge events.

The terminology of percent fines (% fines) means the percentage of those fines less than or equal to 2.5 mm measurement of the substrate at a given site under DEQ's BURP protocols. The % fines found in the 1998 sample from Cow Creek are below levels that would normally indicate impairment (>30 %.) Table 15 shows the results from the 1998 Cow Creek site.

Table 15. Percent fines ≤ 2.5 mm for Cow Creek.

BURP Site ID	Transect #1	Transect #2	Transect #3	Average Percent Fines ≤2.5 mm of Substrate
1998SBOIB013 10.9%		18.6%	12.1%	13.9%

Canopy Cover

At the BURP monitoring site in 1998 canopy cover was calculated to be approximately 27%. This would not be unusual for an intermittent water body, where the availability of year-round water would govern vegetation growth, especially woody species.

Streambanks

BURP monitoring in 1998 at the Cow Creek site indicate approximately 90% of the streambank was in a stable and covered condition. 10% of the streambank was un-vegetated and at risk of being eroded.

Habitat

The Stream Habitat Index score from the 1998 Cow Creek BURP site was 58.0. This is a condition rating of "3."

Status of Beneficial Uses

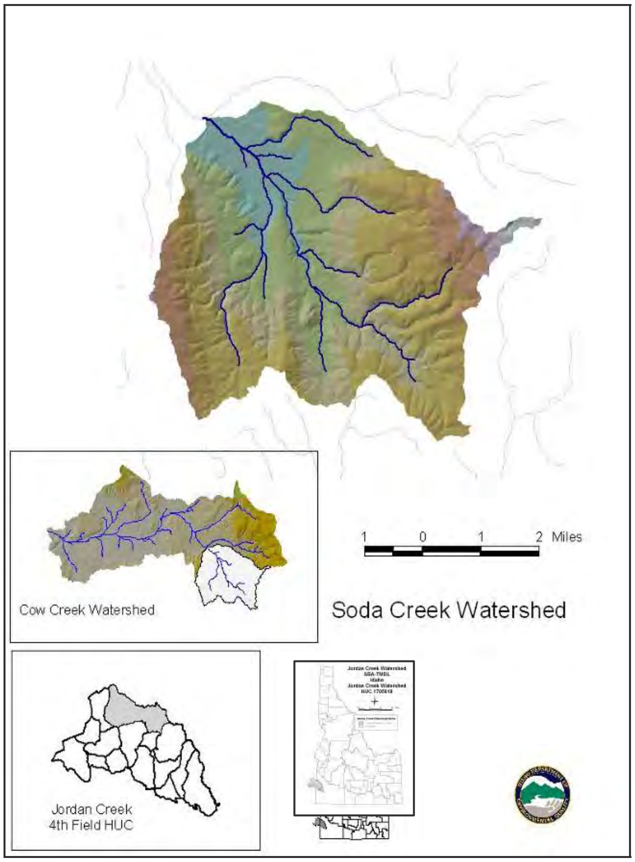
The available biological data indicate Cow Creek is not impaired for sediment.

The interpretation of the community structure and diversity for both periphyton and macroinvertebrates indicate some impact from sediment and organic enrichment, but no impairment.

Using the Hortness and Berenbrock (2001) model for estimating discharge and in accordance with Water Body Assessment Guidance, second edition, the flow (0.05 cfs) is below the criteria for applying numeric WQS criteria.

Water temperature data supplied by the BLM during two different monitoring years verifies Cow Creek is dry for a minimum duration of at least seven days.

Soda Creek



Water Body	Soda Creek Headwaters to Cow Creek
5th Field HUC	1705010802 (Smaller watershed 6th-7th Field HUCs not established)
Assessment Units	ID17050108SW022_02 ID17050108SW022_03
Miles of impaired water body	40.0 miles
Total acres	14,387
Listed pollutants	Sediment[a]
Unlisted pollutants Impaired designated/existing uses	Temperature Presumed Cold Water Aquatic Life
TMDL/Allocations goals	Sediment Targets; 50 mg/l and 80 mg/l, Potential Natural Vegetation Temperature TMDL
Further listing recommendations	Intermittent water body
Potential sources	Overland flow, riparian-streambank erosion

Discharge (Flow) Characteristics

There are no state or federal discharge monitoring stations in the Soda Creek watershed. In 2003, DEQ attempted to conduct BURP monitoring on Soda Creek, but the water body was dry, so no discharge measurements were obtained for that year.

BURP monitoring was conducted on Soda Creek in June 1996. Data collected prior to July 1 is considered incompatible with WBAGII Guidance. However the data can be analyzed and inform final determinations of impairment in a TMDL process. At the lower site, an instantaneous discharge measurement recorded a flow of 0.8 cfs (1996SWIROB007), and at the second location, approximately 2 miles upstream, the instantaneous discharge measurement recorded was 0.08 cfs (1996SWIROB008).

Watershed characteristics were applied to the statewide discharge model developed by Hortness and Berenbrock (2001). The model showed the estimated annual average discharge for the Soda Creek watershed is 0.02 cfs. Factoring in the western aspect, parent geology (volcanic flow, glacial drift, and alluvium deposits), native vegetation (shrub-grassland), and cover, Soda Creek is dry for most of the summer.

Examination of 24K topographic maps and 1999 2.5-meter SPOT satellite imagery indicate no flow modification structures in Soda Creek. A small, unnamed tributary appears to be diverted for possible pasture irrigation near the confluence with Cow Creek. The current operative condition of this diversion is unknown.

Biological, Chemical and Physical Data

Periphyton

No periphyton data are available.

Macroinvertebrates

Macroinvertebrate samples were obtained from Soda Creek in 1996 from the two sites. These samples were collected prior to July 1st and should not be used to determine support status using the assessment process described in Water Body Assessment Guidance (Water Body Assessment Guidance, second edition). When BURP monitoring was attempted after July 1st, as described in the Water Body Assessment Guidance, second edition (DEQ 2002), Soda Creek was dry and no macroinvertebrate samples were collected (BURP ID 2003SBOIA008 and 2003SBOIA009).

Currently, there is no guidance for determining the support status of intermittent water bodies in Idaho. Biological communities in intermittent water bodies may be different from those found in perennial systems, where long-lived species may be better indicators of water quality and physical conditions.

However, the macroinvertebrate information can provide information on possible impairment issues for the water body. As an example, the 1996 macroinvertebrate data showed no cold water indicator species at either of the Soda Creek BURP sites. The skewed number of trophic species and the low number of different taxa would indicate a low diversity with 80-90% of all taxa groups dominated by 5 taxa.

Using a sediment tolerant-intolerant species indicator, or the fine sediment bioassessment index (FSBI) developed by Relyea, Minshall and Danehy (2000), most of the species that have an assigned FSBI value at the two Soda Creek sites for 1996 are tolerant to fine sediment. This could indicate that fine sediments (< 2mm) associated with the substrate and/or suspended in the water column is impairing the macroinvertebrate community structure and favoring tolerant species.

Fish

No fish data are available.

Water Column

There is no water quality data available.

Physical Attributes

In 1996, habitat parameters were assessed through the BURP monitoring process. These parameters are usually incorporated into the calculation of the Stream Habitat Index (SHI) as described in *Water Body Assessment Guidance, second edition* (Grafe et al., 2002d. Further description of the methods used in the SHI can be located in *Idaho Small Stream Ecological Assessment Framework:* An *Integrated Approach* assessment document (Grafe, 2002b). The

SHI, SMI and the Stream Fish Index (SFI) are the indices used to determine the support status of a water body through the use of BURP data and the WBAG assessment process.

Substrate

In 1996, percent fines were calculated using the Wolman pebble count method (Wolman 1954). Table 16 shows the results for the two Soda Creek sites evaluated in 1996.

Table 16. Percent fines ≤ 2.5 mm for Soda Creek.

BURP Site ID	Transect #1	Transect #2	Transect #3	Average Percent Fines ≤2.5 mm of Substrate
1996SWIROB07	14.5%	20.0%	44.4%	26.3%
1996SWIROB08	18.1%	21.2%	18.9%	19.4%

Canopy Cover

At the two BURP monitoring sites in 1996, canopy cover was basically non-existent. This would not be unusual for an intermittent water body where the availability of year-round water would govern vegetation growth, especial woody species.

Streambanks

BURP monitoring in 1996, at the upper Soda Creek, site indicate that approximately 39% of the streambank was unstable and mostly in an uncovered condition. At the lower BURP site in 1996, approximately 48% of the streambanks were determined unstable and mostly uncovered.

Habitat

Assessment of both BURP sites from 1996 indicates poor habitat conditions. Few pools along with marginal streambank, canopy cover, and other attributes contributed to a low habitat rating.

Status of Beneficial Uses

Soda Creek is not designated in the WQS. Therefore, cold water aquatic life and contact recreation (primary and/or secondary contact recreation) are presumed uses (IDAPA 58.01.02.101.01.a). However, since Soda Creek is intermittent, WQS for intermittent water bodies would apply.

It is recognized that aquatic life will occupy intermittent water bodies during periods when it is physically possible (adequate flow and habitat). These water bodies could be utilized for spawning and refuge from high flows, predators, or turbid conditions. Usually, the presence of aquatic life is short term and their long term survival is not reliant on those intermittent water bodies.

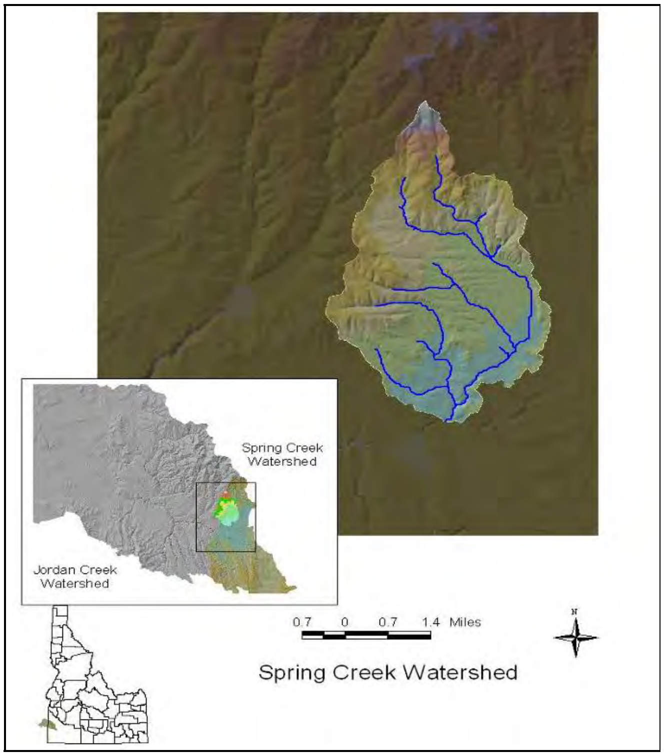
Numeric criteria will not be applied to Soda Creek. However, the WQS state that the general surface water criteria will apply to all water bodies, including intermittent water bodies, such as Soda Creek (IDAPA 58.01.02.200).

The biological data indicate the community structure is populated with those species tolerant to fine sediments.

It appears substrate percent fines less than or equal to 2.5 mm are not a factor for impairing uses, since the data presented in Table 16 would indicate percent fines ≤ 2.5 mm cover less than 30% of the substrate. Therefore, an in-stream water column target may be the most appropriate criterion. It is therefore proposed that water column targets be established during the optimum flow period, when impairment to the presumed uses can occur. These periods would occur during the critical periods when Soda Creek exceeds 1 cfs.

The targets would consist of two criteria: a geometric mean of 50 mg/L suspended sediment for no longer than 60 consecutive days and a geometric mean of 80 mg/L suspended sediment for no longer than 14 consecutive days.

Spring Creek



Water Body	Spring Creek Headwaters to Rock Creek
8th Field HUC	1705010807
Assessment Units	ID17050108SW015_02 ID17050108SW015_03
Miles of impaired water body	48.8 (miles)
Total Acres	8429 acres
Listed pollutant(s)	Temperature, flow modification
Impaired designated uses	Unknown, presumed Cold Water Aquatic Life
TMDL/Allocations goals	A Potential Natural Vegetation Temperature TMDL was developed.
Further listing recommendations	Water body is intermittent
Potential sources	Overland flow, riparian-stream bank erosion

Discharge (Flow) Characteristics

There are no state or federal discharge monitoring stations in the Spring Creek watershed. Watershed characteristics were applied to the statewide discharge estimate model developed by Hortness and Berenbrock (2001). The model showed the estimated annual average discharge for the Spring Creek watershed is 0.09 cfs.

Spring Creek's general stream morphology for the lower segment is low gradient, 1.1%. Valley bottom type is a wide valley for 3-4 miles upstream until reaching the moderately steeper slopes of the Silver City Mountain Range and Quicksilver Mountain. The bottom sections soils range from mostly loose gravel to sandy alluvial deposits. Parent geology is volcanic flow, pyroclastic flows, and alluvium deposits. Native vegetation is mostly a shrub-grassland community.

Close examination of 24K topographic maps and 2001-2002 2.5-meter SPOT satellite imagery does not indicate major flow modification structures in Spring Creek except for a small one-acre in-stream stock pond.

Through personal, documented observations (SCC and DEQ, 2005), along with the modeling of possible discharge, there is a strong indication Spring Creek is intermittent from headwaters to the confluence with Rock Creek. Sections of flowing waters and isolated pools may be present in areas where ground water inflow is the predominant influence.

Biological and Other Data

There are no biological data for Spring Creek to evaluate.

Water Column

There are no water quality data for the Spring Creek watershed.

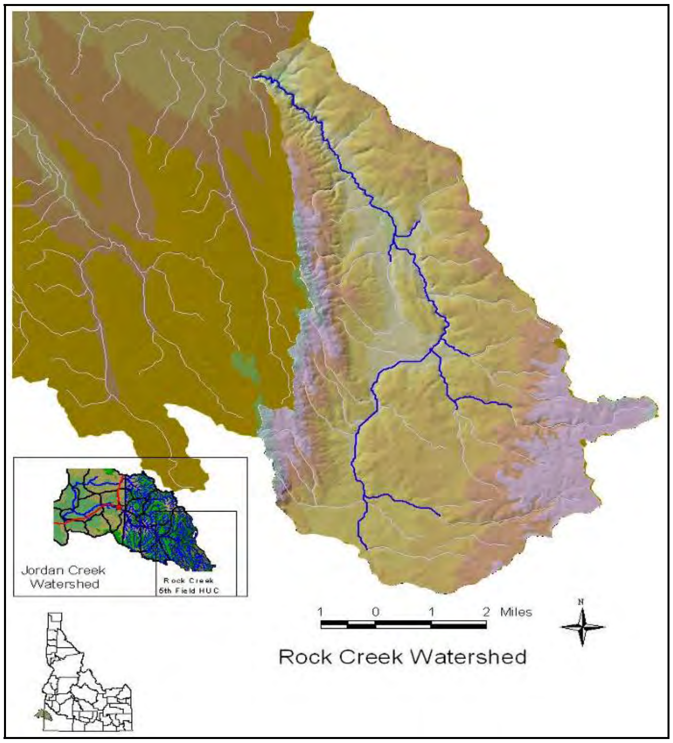
Physical Attributes

There are no data for the Spring Creek watershed.

Status of Beneficial Uses

Based on hydrologic modeling, Spring Creek appears to be intermittent or the optimum flow conditions are not present for at least 7 days during a calendar year. IDAPA 58.01.02.070.07 Application of Standards to Intermittent Waters applies to Spring Creek. A potential natural vegetation temperature TMDL was developed to address any applicable temperature issues.

Rock Creek



Water Body	Rock Creek Headwaters to Triangle Reservoir
8th Field HUC	17050108
Assessment Units	ID1705108SW013_02
Miles of impaired water body	20.3 miles
Total Acres	28359 acres
Listed pollutant(s)	Flow Modification, Sediment and Temperature
Impaired designated uses	Unknown, presumed Cold Water Aquatic Life
TMDL/Allocations goals	A Potential Natural Vegetation temperature TMDL was developed.
Further listing recommendations	Water body is intermittent. Remove sediment as pollutant of concern
Potential sources	Overland flow, riparian-stream bank erosion

Discharge (Flow) Characteristics

There are no state or federal discharge monitoring stations in the Rock Creek watershed, but there are three instantaneous discharge measurements available for Rock Creek:

- One occurred on June 17, 1998, during BURP monitoring (1998SBOIB011), approximately ½ mile above Triangle Reservoir. The instantaneous discharge was 20.9 cfs.
- An additional 1998 BURP site (1998SBOIB012) is located further upstream in the headwaters. At this site, the discharge was 4.1 cfs.
- Additional BURP monitoring was conducted on July 17, 2003 (2003SBOIA010). At this site, the discharge was 0.1 cfs.

Watershed characteristics were applied to the statewide discharge estimate model developed by Hortness and Berenbrock (2001). The model showed the estimated daily average discharge for the Rock Creek watershed is 0.6 cfs. Utilizing the estimated discharge model, the 1998 discharge data almost is equal to the calculated Q80 for the month of June (23.5 cfs).

The lower segment of Rock Creek is low gradient (1.0%). The valley bottom type is a narrow canyon for approximately one mile near Triangle Reservoir, but it opens up to a wide valley for one-two miles upstream, until reaching another incised canyon and the steeper slopes of Combination-Antelope Ridge.

Parent geology is volcanic flow, pyroclastic flows, and alluvial deposits. Native vegetation is mostly shrub-grassland and Juniper communities.

Neither the 24K topographic maps nor 2001-2002 2.5-meter SPOT satellite imagery indicate any flow modification structures in Rock Creek up-stream from Triangle Reservoir. There are two main tributaries: Long Tom Creek and Sheep Creek. No in-stream diversions are seen in the 24K Quad maps for either stream.

Through the modeling of estimated discharge, there is a strong indication Rock Creek is intermittent. Sections of flowing waters and isolated pools may be present in areas where ground water inflow is the predominate influence.

Biological and Other Data

Periphyton

In 2003, periphyton samples were collected on two sites on Rock Creek. One sample was collected on Rock Creek upstream of Triangle Reservoir. Samples were identified and evaluated by Loren Bahls, PhD, of Hannea, Inc. Dr. Bahls' assessment of the Rock Creek periphyton indicated minor stress associated with siltation and possibly metals. However, both indicators were at lower levels of the individual indices.

One index evaluated by Dr. Bahls was the metal toxicity index, which is evaluated by the percent of abnormal cells present. However, the final index score still indicated only minor stress.

Final results of Dr. Bahls' periphyton evaluation are presented in Table 17. The overall bio-criteria scoring used by Dr. Bahls is located in Appendix D.

Table 17. Rock Creek periphyton evaluation and indices bio-criteria.

Index Used in Evaluation	Primary Sample Index Bio-Criteria Score	Split Sample Index Bio-Criteria Score
Number of Species Counted	60	71
Shannon Species Diversity	4.38	4.78
Pollution Index	2.65	2.57
Siltation Index	23.89	29.16
Disturbance Index	0.70	0.61
Percent Dominant Species	25.64	17.01
Percent Abnormal Cells	0.12	0.00

Macroinvertebrates

Macroinvertebrate samples collected in 1998 were collected prior to July 1st. Water Body Assessment Guidance, second edition (Grafe et al, 2002) describes macroinvertebrate data collected prior to July 1 as non-compatible BURP data that is not used in the WBAG process.

The 2003 macroinvertebrate samples were collected after the July 1st date and were analyzed by EcoAnalysts, Inc. The results provided were applied to the SMI scoring criteria as described by Grafe (2001).

The results of the SMI evaluation are shown in Table 18. The SMI "Condition Rating" for Rock Creek is "3." The overall bio-criteria scoring used in the SMI calculation is located in Grafe (2001).

None of the macroinvertebrates collected in 2003 are “cold water” indicators. The taxa richness and percent EPT richness all indicate good diversity and community structure.

Table 18. Rock Creek Stream macroinvertebrate index evaluation and indices bio-criteria.

Index Used in Evaluation	Sample Results	Final SMI Value
Taxa Richness	48.00 100.00	
Ephemeroptera Richness	4.00 44.44	
Plecoptera Richness	2.00 33.33	
Trichoptera Richness	4.00 57.14	
% Plecoptera	1.88 9.40	
Hilsenhoff Biotic Index (HBI)	5.92 55.89	
% 5 Dominate	51.78 100.00	
Scraper Taxa Richness	4.0 50.00	
Clinger Taxa Richness	21.0 100.00	
Final SMI Score		61.13
Final SMI Condition Rating		“3”

Fish

There are no fish data to evaluate.

Water Column

BLM collected water samples on several occasions beginning in 1976 as well as 1991, 1993, 1995, and 1997. Bacteria samples were collected in the latter two years and was not exceeding water quality standards.

Sediment

There are no significant sediment data for the Rock Creek watershed.

Temperature

The BLM provided continuous temperature monitoring for the 303(d) listed segment of Rock Creek. In 2004, 32% of the dates from June 5 to September 31 exceeded the 22 °C MDMT criteria, and 22% exceeded the 19 °C MDAT criteria (Figure 24).

If the temperature exemption from the state water quality standards (IDAPA 58.01.02.080.04) are used to remove the dates when the 90th percentile ambient air temperature exceeds the 34.9 °C milepost established in WBAG (DEQ, 2002); 26% of the dates in 2004 from June 5 to September 31 exceeded the 22 °C MDMT criterion and 16% exceeded the 19 °C MDAT criteria.

The BLM temperature logger was placed on lands managed by the agency, in the incised canyon approximately 2 miles upstream from Triangle Reservoir. No discharge data were provided with the temperature data to assist in determining if exceedances of numeric criteria are occurring during “optimum flow” conditions.

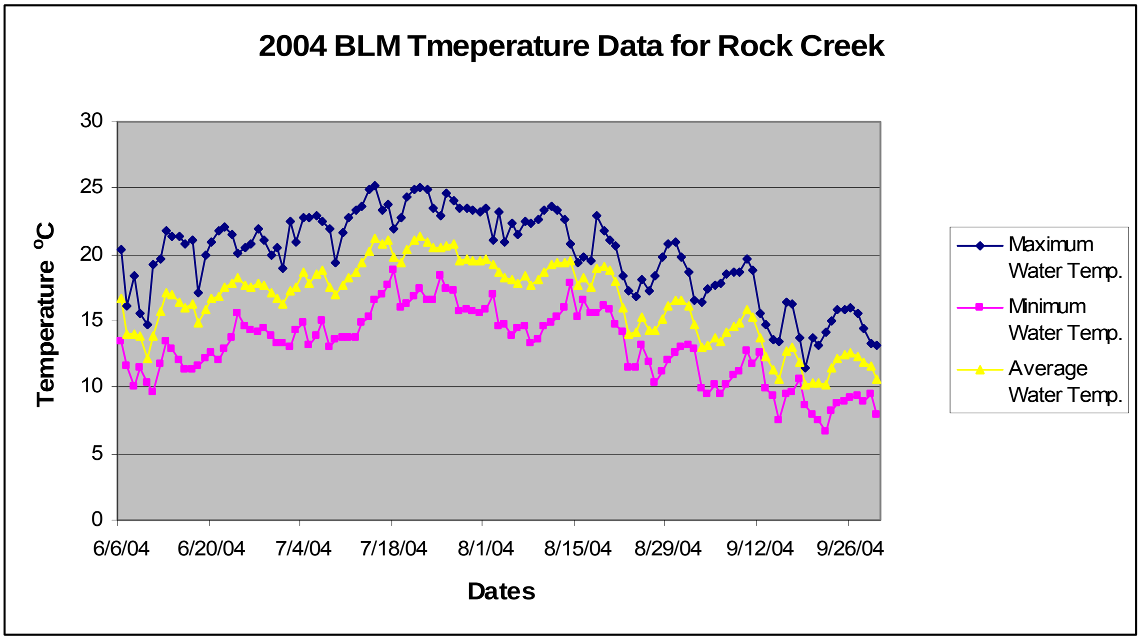


Figure 24. Continuous temperature data for Rock Creek, BLM 2004.

Bacteria

Rock Creek is not listed for bacteria. Bacteria samples collected by BLM showed that the bacteria criterion for Fecal coliform was not exceeded. There were no bacteria samples collected by DEQ during the BURP monitoring in 1998. The BURP monitoring in 2003 collected samples for E. coli analysis, and the results (63 cfu/100 ml) were below the numeric criteria established in the WQS (IDAPA 58.01.02.080.03 and 58.01.02.251.01 & .02).

Physical Attributes

Substrate

The percent fines recorded in 2003 (BURP ID 2003SBOIA010) showed 27% of the substrate consisted of material less than or equally to 2.5mm in size. As described in Section 2.2, most impairment is noted when percent fines of this size are greater than 30%.

Canopy Cover

Canopy cover at the 2003 BURP site was approximately 15%. The limited amount of canopy cover is far below any potential canopy cover or potential natural vegetation and may indicate over utilization of woody species on this water body. More woody vegetation and increased canopy cover would assist in reducing solar radiation on the water body.

Streambanks

Stream bank stability appears excellent, with 90% of the stream bank rated as covered and stable in 2003. Five percent of the stream bank was rated as uncovered and unstable.

Habitat

The 2003 BURP monitoring showed the overall stream habitat index score was a “37.0”, or a condition rating of “1”.

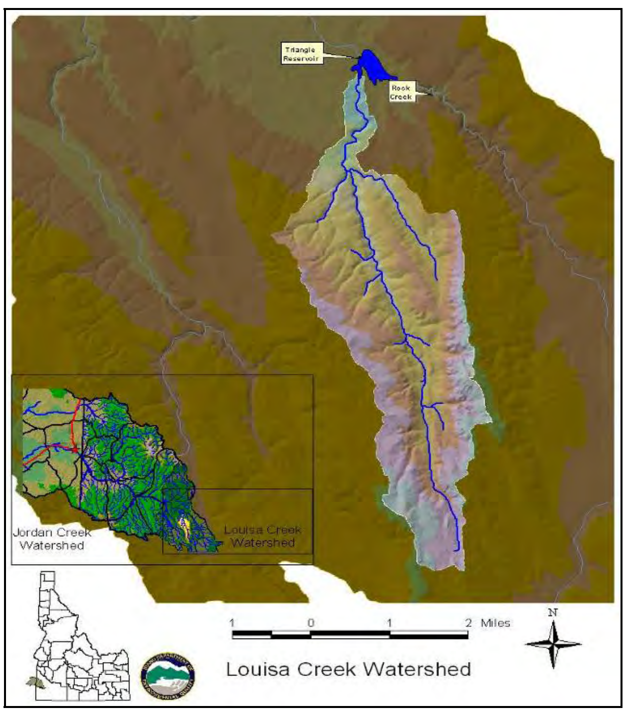
Status of Beneficial Uses

In accordance with Water Body Assessment Guidance, second edition, Rock Creek has a Condition Rating of “2” and is full support. The support status is determined by averaging at least two indices; in this case the SMI and SHI scores. Scores greater than or equal to “2” are considered full support.

Based on hydrologic modeling and actual discharge measurements, the water body appears to be intermittent or the optimum flow conditions are not present for at least 7 days during a calendar year. IDAPA 58.01.02.070.07, Application of Standards to Intermittent Waters, applies to Rock Creek.

A potential natural vegetation TMDL was developed to address any applicable temperature issues. Sediment does not appear to be impairing beneficial uses and should be removed as a pollutant of concern.

Louisa Creek



Water Body	Louisa Creek Headwaters to Triangle Reservoir
8th Field HUC	1705010808
Assessment Units	ID17050108SW018_02
Miles of impaired water body	8.0 miles
Total Acres	5,591 acres
Listed pollutant(s)	Flow Modification, Sediment and Temperature
Impaired designated uses	Unknown, presumed Cold Water Aquatic Life
TMDL/Allocations goals	A Potential Natural Vegetation temperature TMDL was developed.
Further listing recommendations	Water body is intermittent
Potential sources	Overland flow, riparian-stream bank erosion

Discharge (Flow) Characteristics

There are no current or historic state or federal discharge monitoring stations in the Louisa Creek watershed. Watershed characteristics were applied to the statewide discharge estimate model developed by Hortness and Berenbrock (2001). The model showed the estimated annual discharge for the Louisa Creek watershed is 0.06 cfs.

On closer examination of 24K USGS Quad Maps, there is a 10-acre reservoir located approximately two miles upstream from Triangle Reservoir. There does not appear to be any indication of in-stream diversion below this reservoir, which would indicate this reservoir's primary purpose is for irrigation water storage. Additional discussion with land management agencies and/or private landowners will need to occur to determine the primary use of this reservoir.

Biological and Other Data

There are no biological data to evaluate.

Water Column

Sediment

There are no sediment data to evaluate.

Temperature

For Louisa Creek, the BLM provided water temperature data for the year 2001. The data consists of 32 data points from July 19 through August 19. Of the 32 dates, 12 dates exceeded the MDMT criterion of 22 °C, but no dates exceeded the MDAT criterion of 19 °C.

One reading on July 30 shows an abnormality with a sudden decrease in maximum temperature down to 13 °C, which may indicate either a hardware-software malfunction, that the temperature logger placement was altered, or a sudden exposure to ambient air temperature.

Figure 25 shows the results of the 2001 temperature monitoring.

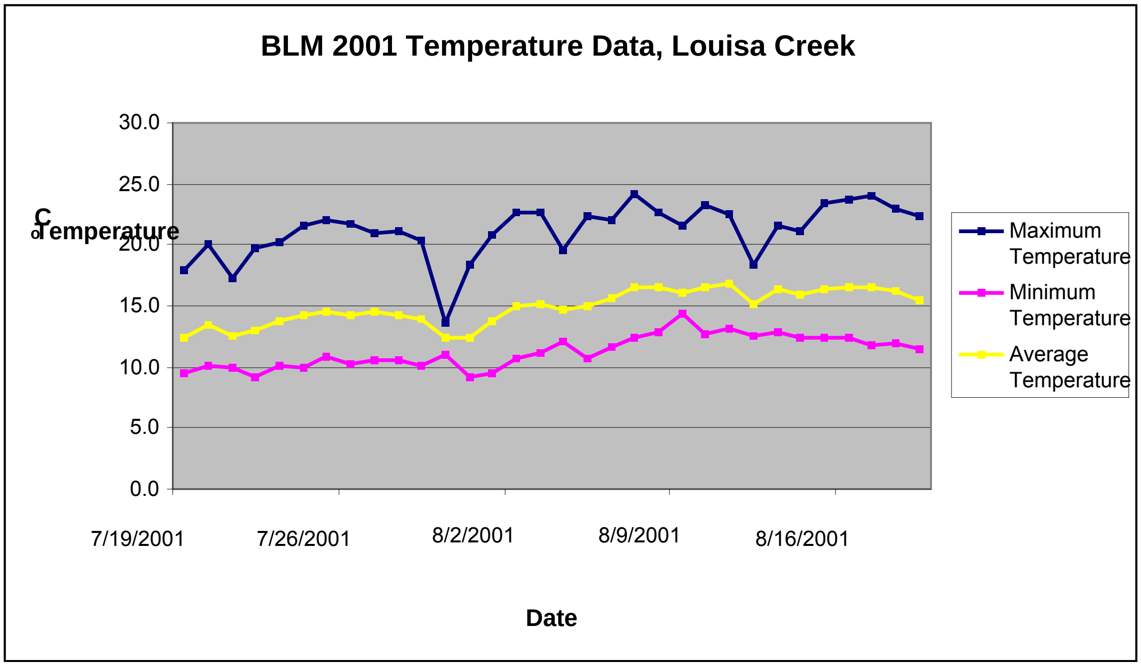


Figure 25. Temperature data for Louisa Creek, BLM 2001.

Bacteria

There is no bacteria data to evaluate.

Physical Attributes

Substrate

There are no substrate data to evaluate.

Canopy Cover

There are no canopy cover data to evaluate.

Streambanks

There are no stream bank data to evaluate.

Habitat

There are no habitat data to evaluate.

Status of Beneficial Uses

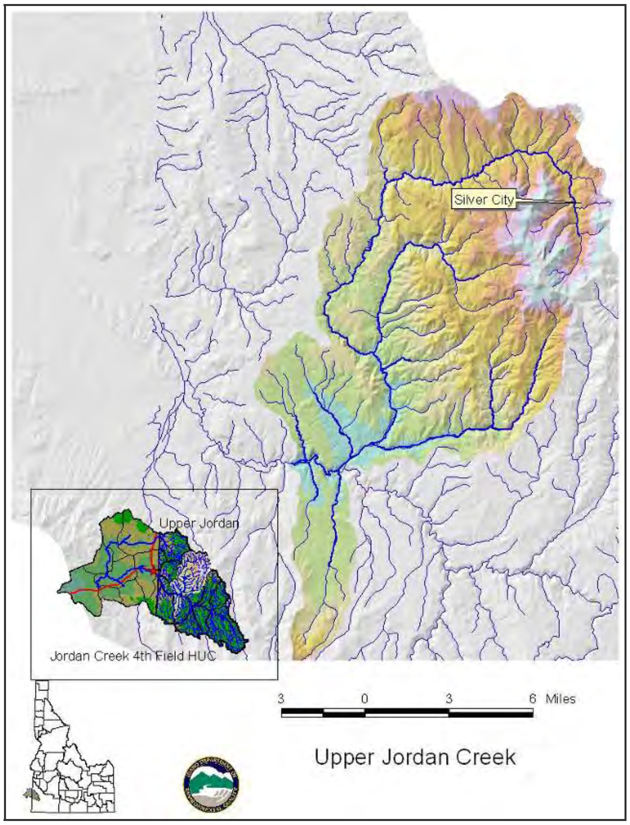
Except for the 2001 BLM temperature data, there are no other data to evaluate; it is not known how Louisa Creek was placed on the 2002 §303(d) list. DEQ believes this was a database error.

It is proposed that the listing and impairment classification be verified and further data collected prior to the development of a sediment TMDL for Louisa Creek, should it be determined the 2002 listing was warranted.

To date, DEQ has not been able to access Louisa Creek, which is only accessible through private land where a gate blocks entry to the watershed.

A potential natural vegetation TMDL was developed to address any applicable temperature issues.

Upper Jordan Creek



Water Body	Jordan Creek Headwaters to Williams Creek
8th Field HUC	17050108
Assessment Units	ID17050108SW004_02 ID17050108SW004_03 ID17050108SW004_04 - unlisted ID17050108SW004_05
Miles of impaired water body	125.28
Total Acres	81,903
Listed pollutant(s)	Sediment, Mercury, Oil and Grease, unknown, and fecal coliform
Impaired designated uses	Cold Water Aquatic Life, Contact Recreation
TMDL/Allocations goals	A Potential Natural Vegetation temperature TMDL and mercury TMDL were developed.
Further listing recommendations	Remove oil and grease, sediment, and decal coliform as pollutants of concern
Potential sources	Overland flow, riparian-stream bank erosion, legacy mining activity

Discharge (Flow) Characteristics

As mentioned in Section 1.0, the USGS operated a discharge measurement gage in the upper Jordan Creek watershed from 1993 through 1996 (USGS 13177985). Data for this period demonstrate how “flashy” Jordan Creek can be. Monthly averages for the period included “zero” discharge for two months in 1994 and peak flows exceeding 200 cfs in May 1995 and 1996, but they also demonstrate a low discharge of less than 50 cfs for the same month in 1994.

Watershed characteristics were applied to the statewide discharge estimate model developed by Hortness and Berenbrock (2001). The model showed the estimated annual average daily discharge for the Upper Jordan Creek watershed (USGS Gage upstream) at 3.4 cfs. Besides obtaining the average daily discharge, upper Jordan Creek is modeled to obtain the Q80, Q50 and Q20 estimated daily average discharge on a monthly bases.

The upper Jordan Creek section mentioned above encompasses only a third of the watershed for 17050108SW004_02 through 05 Jordan Creek Headwaters to Williams Creek. The entire watershed encompasses about 130 square miles, without the Boulder Creek watershed added. Below the USGS gage site, two 3rd order water bodies provide additional inflow (Louse and Flint Creeks). When the entire watershed is modeled, the estimated average daily discharge only increases to 3.8 cfs. In addition, the model shows an overall decreased peak discharge compared to the results for the upper sections of the watershed. These abnormalities are probably attributed to the differing variables, percent forested, precipitation amount, slope greater than 30% and mean basin slope that are applied to the model. The estimated daily average discharge for upper Jordan Creek above Boulder Creek is displayed in Figure 26.

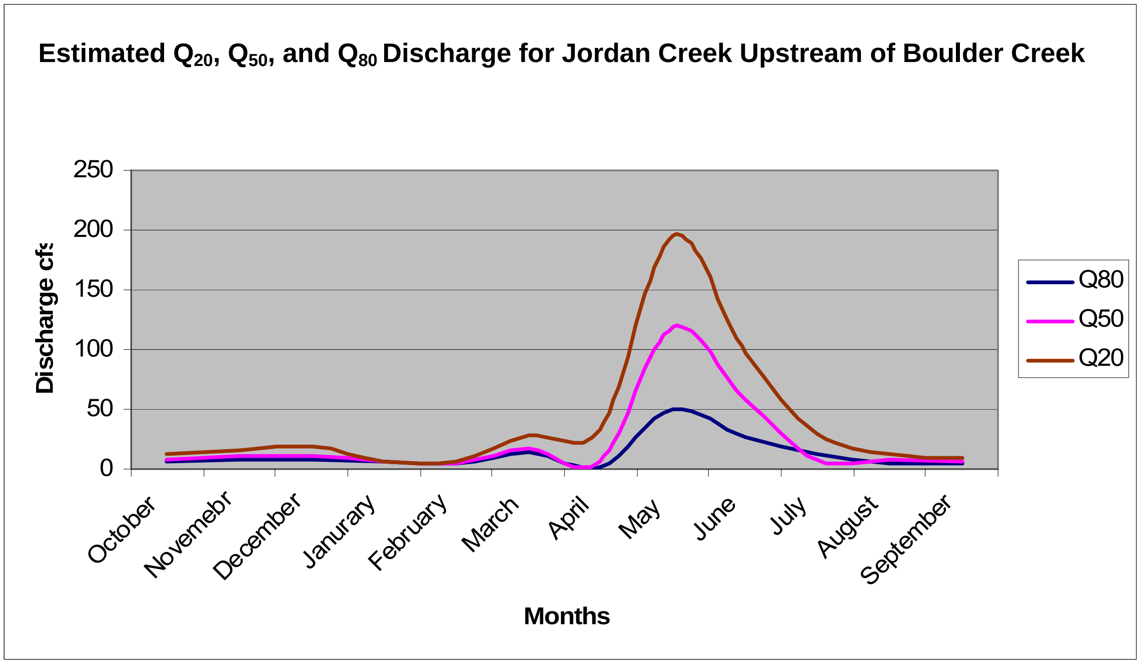


Figure 26. Estimated Q20, Q50, and Q80, in Upper Jordan Creek (upstream of Boulder Creek).

The estimated discharge and the average discharge recorded for the same months at the USGS gage are displayed in Figure 27.

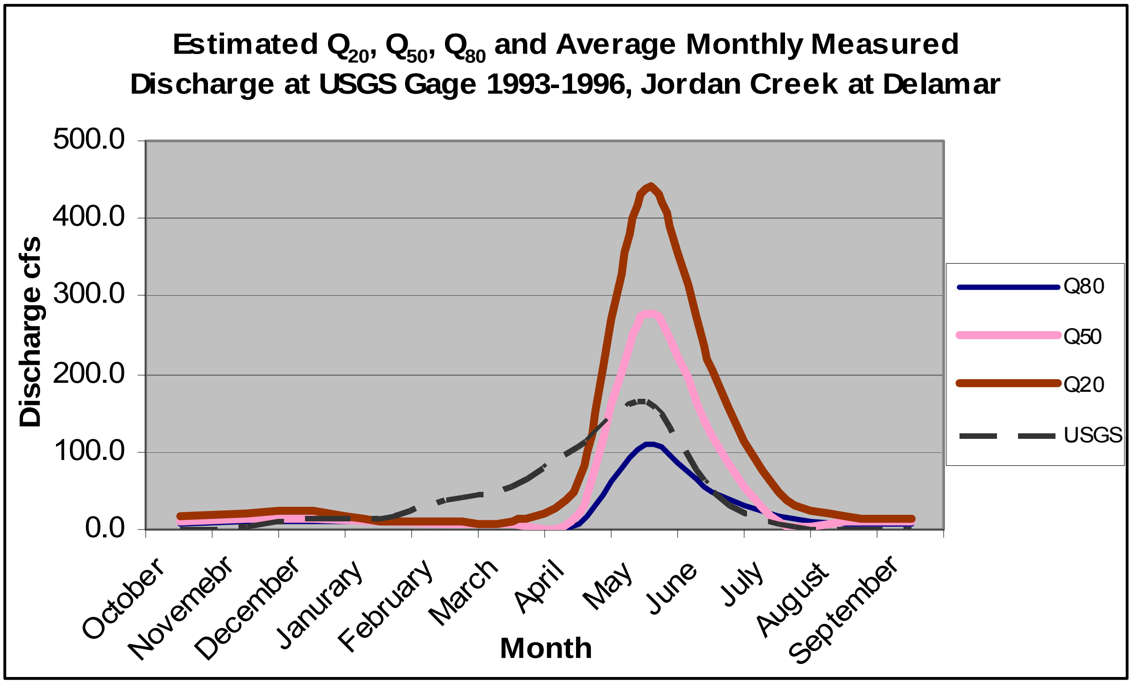


Figure 27. Estimated Q20, Q50, Q80, and average monthly measured discharge for Upper Jordan Creek, (upstream of USGS gage).

Instantaneous discharge data and other predictive discharge models for upper Jordan Creek are numerous and are well documented from 1988 through the present. The most comprehensive information is found in the Stone Cabin Mine, Final Environmental Impact Statement (EIS) (CH2M Hill 1994). The EIS presents data from 1988 through 1992.

With the availability of historic discharge information, the use of instantaneous discharge measurements will be limited to discussion of the biological, physical and/or chemical assessment.

Biological and Other Data

Periphyton

Periphyton samples were collected in 2003 at two locations in upper Jordan Creek. One site is near an area of historic mining (below Jacob Gulch) (BURP ID 2003BOIA045) and the other site is below all current and historic mining (upstream of Louse Creek) (BURP ID 2003BOIA039). By applying the periphyton results to analytical indices and community diversity, stress indicators can be determined. Some of the major indices and interpretation (employed by numerous federal and state agencies) are shown in Table 19, along with results from the 2003 upper Jordan Creek samples.

Table 19. Periphyton indices for Jordan Creek below Jacob Gulch and above Louse Creek, DEQ 2003.

Indices	Indicator	Jordan Creek below Jacob Gulch	Jordan Creek above Louse Creek	Interpretation
Siltation Index	% Motile or % Tolerant of Sediment/Silt	40.6% 30.0%		Moderate to Minor stress from sediment/silt
# of Taxa Present	Specie Diversity 48		66	Good biodiversity

Pollution Tolerance Class	Indices Developed by Lange-Bertalot 1979	2.10 2.29		Mostly pollution intolerant to moderately intolerant taxa present
% Dominate Species	Species Diversity	17.4%	19.1%	Low dominance by a single or a group of taxa
Deformed Valves	Metal Toxicity	1.99%	0%	Moderate toxicity to no toxicity

The indices, community structure and the predicted response (index value increases or decreases in response to pollutant(s)) are useful tools for identifying possible stressors. Further information on determining index predicted response can be found in Idaho River Ecological Assessment Framework (Grafe, 2002a. Additional information concerning referenced material for the individual indices can be found in Appendix D).

Periphyton community structure and indicators were examined by Loren Bahls (Bahls 2004). Dr. Bahls determined the samples collected below Blue Gulch showed moderate stress due to sediments and possible toxic metals, and the aquatic life is moderately impaired. The lower site showed only minor stress due to possible organic loading and sediments, but did not appear to be impaired.

Most of the information provided in Table 19 demonstrates the periphyton community structure have some minor to moderate stressors for metals and sediments.

Macroinvertebrates

Macroinvertebrates were collected by DEQ in 2003 at two sites in upper Jordan Creek. Kinross Delamar Mining Company (KDMC) conducted macroinvertebrate sampling at various sites. Figure 28 shows the DEQ and KDMC macroinvertebrate monitoring sites for 1998 and 2003. Appendix D contains KDMC macroinvertebrate data for 1999. Additional macroinvertebrate data was collected by KDMC but was not available in published form at the time of TMDL development. Those documents are identified in Appendix D.

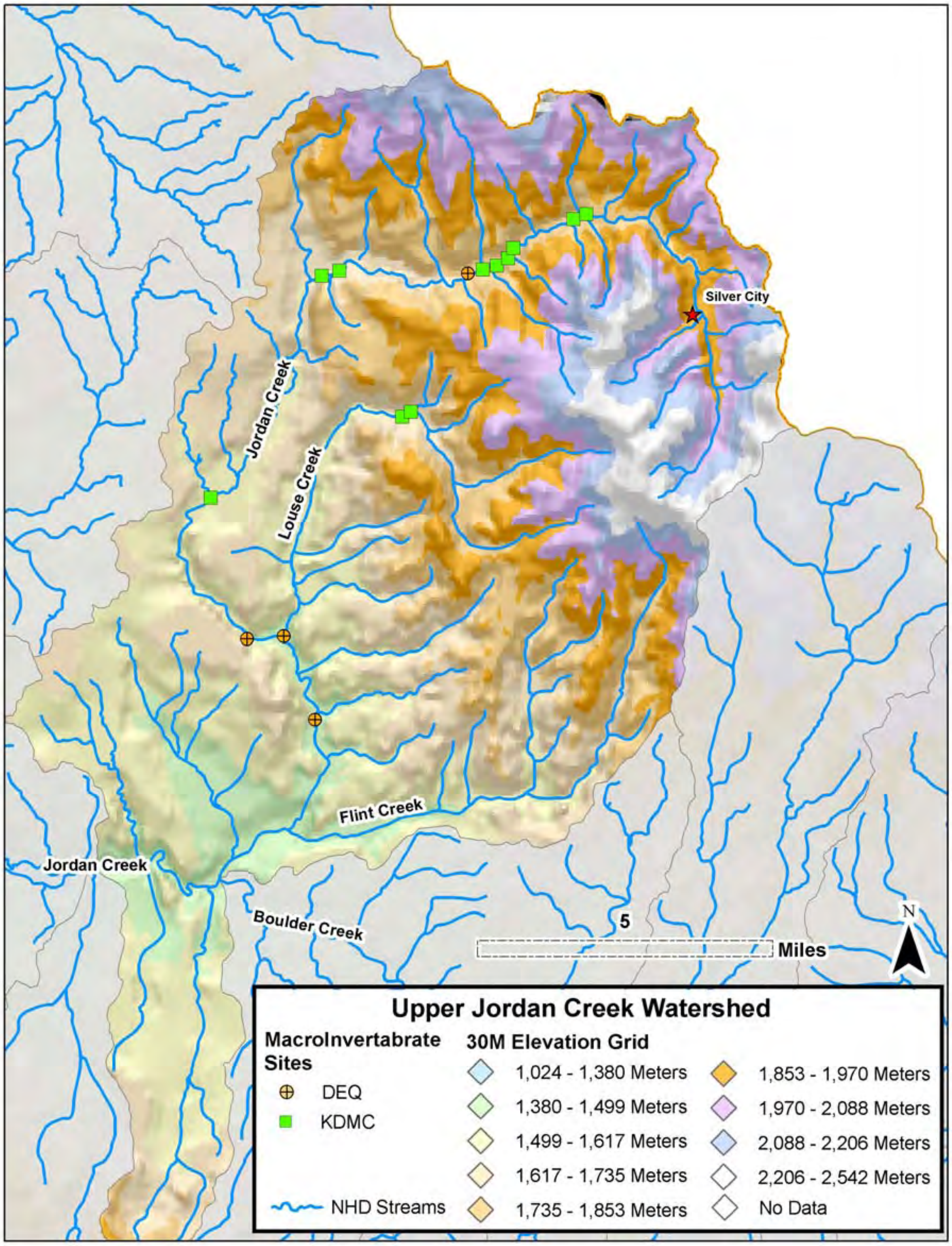


Figure 28. Upper Jordan Creek BURP sites and macroinvertebrate monitoring sites 2003 (DEQ 1998 & 2003, KDMC 2003.)

The macroinvertebrate sample collected in 2003 did not yield any literature referenced cold water indicators at the site above Louse Creek. The upper site below Jacob Gulch yielded cold water obligates, with a total of 2.7% of the total assemblage identified as cold water.

At the lower site, most species were considered to be either cool summer or mixed water indicators. Using a sediment tolerant-intolerant species indicator, or the fine sediment bioassessment index (FSBI) developed by Relyea, Minshall and Danehy (2000), 25% of the sample collected below Jacob Gulch contained individuals that were identified as moderately sediment intolerant, while 27.6% of the population were identified as moderately sediment tolerant (Table 20).

However, 8.6% of the sample was classified as sediment tolerant. 17.6% of the individuals found above Louse Creek were identified as moderately sediment intolerant, while 4.3% of the population was identified as moderately sediment tolerant (Table 20).

Table 20. Sediment tolerant-intolerant evaluation of Jordan Creek below Jacob Gulch (DEQ 2003).

FSBI[a] Score	Jordan Creek below Jacob Gulch		Jordan Creek above Louse Creek		Interpretation
	Number of Individuals with FSBI Rating	Percent of Individuals with FSBI Rating	Number of Individuals with FSBI Rating	Percent of Individuals with FSBI Rating	
8-10 0		0%	0	0.0%	Sediment Intolerant
6-7 704		25.5%	392	17.6%	Moderately Sediment Intolerant
4-5 764		27.6%	96	4.3%	Moderately Sediment Tolerant
1-3 138		8.6%	28	1.2%	Sediment Tolerant

a Fine Sediment Biotic Index, Scale of "1-10" with "10" Being Most Intolerant to Fine Sediments

The 2003 macroinvertebrate data was applied to the SMI metric calculation (Grafe 2001). This index, along with at least one other index (SFI and/or SHI), is used to determine the final "Support Status" as described in Water Body Assessment Guidance, second edition (Grafe et al. 2002). The average score of at least two of the indices are required to determine the support status (cold water aquatic life) of a water body.

In the case of upper Jordan Creek, two indices are available to assist in determining the overall support status for cold water aquatic life. As seen in Table 21, the SMI final condition rating for upper Jordan Creek is a "3." Further discussion on the overall condition rating is located in the support status section.

In addition to the final SMI and FSBI, other indicators or indices are helpful in judging the health or overall cause of impairment in a water body. Table 21 also displays some of the key indicators of specie diversity and indicators of water quality conditions, mainly EPT richness and percent EPT composition. Values reported for both sites on Jordan Creek indicate good biological diversity and a strong presence of pollution intolerant species.

Two indices, MBI and MTI, also indicate that the expected biological community structure is present and that the effects on the biological structure show little impairment from metals. These two indices are used extensively by KDMC (see Appendix D) as major indicators for surface water and macroinvertebrate reporting requirements for the mine's permits and closure plan (KDMC 2003). DEQ does not use MBI scoring, but rather SMI, so the MBI from KDMC's data is not shown here.

Table 21. SMI metric results and EPT richness, % EPT, HBI, and MTI for Jordan Creek below Jacob Gulch and Jordan Creek above Louse Creek (DEQ 2003).

Index	Jordan Creek above Louse Creek		Jordan Creek below Jacob Gulch	
	Metric Score	Adjusted Metric Score a	Metric Score	Adjusted Metric Score a
Total Taxa	123.53	100.00	135.29	100.00
Ephemeroptera Taxa	55.56	55.56	111.11	100.00
Plecoptera Taxa	16.67	16.67	83.33	83.33
Trichoptera Taxa	57.14	57.14	85.71	85.71
% Plecoptera	0.90	0.90	74.00	74.00
HBI [b] 73.42		73.42	87.12	87.12
% 5 Dominate Taxa	83.23	83.23	124.70	100.00
Scraper Taxa	112.50	100.00	87.50	87.50
Clinger Taxa	135.29	100.00	152.94	100.00
		586.92		817.67
SMI [c] =		65.21 90.85		
Condition Rating		"3"		"3"
EPT [d] Richness		21.0		10.0
% EPT		53.5%		46.3%
MTI [e]		3.48		3.47

a Adjusted Value in accordance with Grafe 2001 b Hilsenhoff Biotic Index c Stream Macroinvertebrate Index d Ephemeroptera-Plecoptera- Trichoptera e Metal Tolerance Index (Montana DEQ))

Additional macroinvertebrate data became available from KDMC after the TMDL was written. Data for 1999 are shown in Appendix D. Reference is also made in Appendix D to specific KDMC publications that became available after the TMDL was completed. Table 22, Table 23, and Table 24 show some of the indices results from the KDMC data for the numerous Jordan Creek sites for 2003 (Pfieffer 2004).

Table 22. SMI metric results and EPT richness, % EPT, HBI, and MTI for Jordan Creek below LAT, below Henrietta Gulch, and above Henrietta Gulch (KDMC 2003).

Index	Jordan Creek below Land Application Treatment		Jordan Creek below Henrietta Gulch		Jordan Creek above Henrietta Gulch	
	Metric Score	Adjusted Metric Score a	Metric Score	Adjusted Metric Score a	Metric Score	Adjusted Metric Score a
Total Taxa	128.4	100.0	58.8	58.8	124.5	100.0
Ephemeroptera Taxa	111.1	100.0	96.3	96.3	85.2	85.2
Plecoptera Taxa	55.6	55.6	72.2	72.2	72.2	72.2
Trichoptera Taxa	57.1	57.1	128.6	100.0	100.0	100.0
% Plecoptera	7.1	7.1	15.8	15.8	13.1	13.1
HBI [b] 73.3		73.3	82.1	82.1	80.0	80.0
% 5 Dominate Taxa	158.1	100.0	138.4	100.0	116.5	100.0
Scraper Taxa	79.2	79.2	95.8	95.8	95.8	95.8
Clinger Taxa	135.3	100.0	129.4	100.0	127.5	100.0
SMI [c] =		74.7		80.1		82.9
Condition Rating		3		3		3
EPT [d] Richness	18.7		20.0		19.0	
% EPT	34.3		43.7		29.8	
MTI [e]	3.27		2.88		3.04	

a Adjusted Value in accordance with Grafe 2001 b Hilsenhoff Biotic Index c Stream Macroinvertebrate Index d Ephemeroptera-Plecoptera- Trichoptera e Metal Tolerance Index (Montana DEQ)

Table 23 . SMI metric results and EPT richness, % EPT, HBI, and MTI for Jordan Creek below Jacob Gulch, above Jacob Gulch, and below Last Chance Gulch (KDMC 2003).

Index	Jordan Creek below Jacob Gulch		Jordan Creek above Jacob Gulch		Jordan Creek below Last Chance Gulch	
	Metric Score	Adjusted Metric Score [a]	Metric Score	Adjusted Metric Score [a]	Metric Score	Adjusted Metric Score [a]
Total Taxa	139.2	100.0	118.6	100.0	121.6	100.0
Ephemeroptera Taxa	107.4	100.0	111.1	100.0	107.4	100.0
Plecoptera Taxa	77.8	77.8	44.4	44.4	66.7	66.7
Trichoptera Taxa	100.0	100.0	57.1	57.1	128.6	100.0
% Plecoptera	19.6	19.6	17.1	17.1	13.7	13.7
HBI [b] 94.0		94.0	88.8	88.8	86.7	86.7
% 5 Dominate Taxa	123.0	100.0	93.9	93.9	140.7	100.0
Scraper Taxa	133.3	100.0	125.0	100.0	120.8	100.0
Clinger Taxa	162.7	100.0	135.3	100.0	152.9	100.0
SMI [c]=		87.9		77.9		85.2
Condition Rating		3		3		3
EPT [d] Richness	22.7		17.7		21.3	
% EPT	65.6		52.9		51.2	
MTI [e] 3.08			3.10		3.31	

a Adjusted Value in accordance with Grafe 2001 b Hilsenhoff Biotic Index c Stream Macroinvertebrate Index d Ephemeroptera-Plecoptera- Trichoptera e Metal Tolerance Index (Montana DEQ

Table 24. SMI metric results and EPT richness, % EPT, HBI, and MTI for Jordan Creek above Last Chance Gulch, below Blue Gulch, and above Blue Gulch (KDMC 2003).

Index	Jordan Creek above Last Chance Gulch		Jordan Creek below Blue Gulch		Jordan Creek above Blue Gulch	
	Metric Score	Adjusted Metric Score [a]	Metric Score	Adjusted Metric Score [a]	Metric Score	Adjusted Metric Score [a]
Total Taxa	110.8	100.0	112.7	100.0	119.6	100.0
Ephemeroptera Taxa	107.4	100.0	122.2	100.0	151.9	100.0
Plecoptera Taxa	50.0	50.0	72.2	72.2	72.2	72.2
Trichoptera Taxa	71.4	71.4	100.0	100.0	128.6	100.0
% Plecoptera	16.8	16.8	21.3	21.3	18.5	18.5
HBI [b] 89.5		89.5	99.3	99.3	89.6	89.6
% 5 Dominate Taxa	128.4	100.0	95.1	95.1	136.3	100.0
Scraper Taxa	112.5	100.0	129.2	100.0	116.7	100.0
Clinger Taxa	52.9	52.9	143.1	100.0	152.9	100.0
SMI [c]=		75.6		87.5		86.7
Condition Rating		3		3		3
EPT [d] Richness	17.3		22.7		21.7	
% EPT	56.6		72.1		55.4	
MTI [e] 3.31			2.56		3.50	

a Adjusted Value in accordance with Grafe 2001 b Hilsenhoff Biotic Index c Stream Macroinvertebrate Index d Ephemeroptera-Plecoptera- Trichoptera e Metal Tolerance Index (Montana DEQ)

The 2003 macroinvertebrate data indicated the presence of cold water indicators species at all sites sampled by KDMC (Pfieffer 2004). However, cold water indicators showed as many as six taxa in the upper portions compared to only one taxon found at the lowest section. Other indices used by Pfieffer (2004) included the metal tolerance index (MTI) [State of Montana DEQ (http://deq.mt.gov/wqinfo/monitoring/SOP/SOP.asp)]. It was concluded in both the final assessments for 2003 that metals were not impairing the expected macroinvertebrate community structure in Jordan Creek (Pfieffer 2004).

When 2003 KDMC macroinvertebrate data were applied to DEQ's SMI (Grafe 2000), the results showed that the macroinvertebrates at all Jordan Creek stations had a condition rating of "3", or that the macroinvertebrates community structure is above the 25th percentile of reference conditions. However, DEQ does not run outside data through our metrics for listing purposes on the 303 (d) list, nor typically for TMDL evaluations.

Overall, the examination of available macroinvertebrate information would indicate conditions support expected community structure and diversity.

Fisheries

During the 2005 mercury evaluation for Jordan Creek, three sites were selected to collect fish tissue samples. All three Jordan Creek sites had cold water salmonid species and at least two salmonid age classes. Redband trout, redside shiners, bridgelip suckers, longnose dace and YOY redband trout were found in upper Jordan Creek. Table 25, Table 26, and Table 27 show the approximate number of each species collected and the average length and weight from the three stations where fish were collected.

Table 25. Fishery data and information for Jordan Creek below tailings near historic Wagontown (DEQ 2005).

Species	Total Number Collected	Size Range (mm)	Weight Range-Average (grams)
Redband trout	5	132-257	28.4-200.4
Reside shiners	NA NA 30.3		(composite weight)
Suckers 1		132	28.4
Longnose dace	NA	NA	118.4 (composite weight)
Northern Pike Minnow	1	NA	4.6

Table 26. Fishery data and information for Jordan Creek below Henrietta Gulch (DEQ 2005).

Species	Total Number Collected	Size Range (mm)	Weight Range-Average (grams)
Redband trout	12	106-260	14.3-209.4 grams
Bridge lip suckers	1	192	65.5 grams
Longnose dace	43	NA	64 grams (composite weight)

Table 27. Fishery data and information for Jordan Creek below Silver City, Idaho (DEQ 2005).

Species	Total Number Collected	Size Range (mm)	Weight Range-Average (grams)
Redband trout	27	88-217	7.5-118.1 grams

The redband trout are identified as cold water species in Water Body Assessment Guidance, second edition (Grafe 2002). Other species collected are classified as cool water indicators, but are often found with cold water species. The two different age classes (sizes) for the salmonid specie are a strong indicator salmonid spawning is an existing use in upper Jordan Creek.

Ideally, to confirm that salmonid spawning is occurring in a water body, it is desirableto find species less than 100 mm to document the presence of fish less than one year old. Since the 2005 fish collection's primary objective was to collect fish tissue for mercury analysis,the data was not run through WBAGII to determine an SFI, despite compatibility with DEQ methodology.

However as WBAGII points out, fish populations are dynamic and may fluctuate considerably, even over short periods of time, regardless of human influence. Redband spawning typically occurs in Idaho's southwestern high desert streams between mid March and mid June. DEQ believes salmonid spawning is being supported in Jordan Creek.

Water Quality Data

Sediment

Water quality monitoring conducted by KDMC provides limited data for sediments, mainly in the form of sample results for total suspended solids (TSS). A review of TSS results for samples collected by KDMC in 2005 showed a range from not detected (<5.0 mg/l) to a maximum of 24 mg/l at two sites.

Temperature

Continuous temperature data are available from both DEQ and BLM for numerous sites in upper Jordan Creek. DEQ placed temperature loggers at one site directly above Louse Creek in 2005. BLM has provided data for three sites from 2002. Additional temperature data from the BLM are available for sites on the lower segment of Jordan Creek.

The DEQ data for the location above Louse Creek showed only 2% of the temperature data exceeded the MDMT criterion of 22 °C, and none of the dates exceeded the MDAT of 19 °C. BLM data for 2002 had one site and it exceeded the MDMT criterion on 23% of the dates water temperatures were recorded. Of the three sites, there were no exceedances of the 19 °C MDAT criterion.

Interpretation of water temperatures would indicate that nighttime ambient air in the upper section of the watershed adequately provides a mechanism to keep the daily average temperature below the CWAL criterion. However, the salmonid spawning criteria is not being met. Daytime solar radiation tends to drive the increased daily maximum temperature. A Potential Natural Vegetation (PNV) temperature TMDL was developed to address this issue.

Bacteria

Bacteria are a listed pollutant on the 2008 §303(d) list. Samples were collected in 2005 at a site directly above the confluence with Flint Creek. To compare bacteria levels to WQS and criteria, five samples for E. coli were collected over a thirty day period in August and September to obtain a geometric mean. Results showed a range of <2 CFU/100 ml to 66 CFU/100 ml with a geometric mean of 20 CFU/100 ml. The geometric mean criteria for both primary and secondary contact recreation are 126 CFU/100 ml. Bacteria should be removed as a pollutant of concern.

Oil and Grease

It is not clear why oil and grease was listed as a pollutant of concern for upper Jordan Creek. There is no reference to oil and grease in the data summary for the monitoring conducted by Idaho in 1975-1976 (IDHW 1980), the evaluation conducted by Hill et al (1973), KDMC monitoring (various years), or by CH2M Hill (1994). At one time, there may have been abandoned equipment adjacent to Jordan Creek/Louse Creek that may have been leaking fuels, hydraulic oil or other petroleum products. Other sources could have included the use of gas-powered pumps used in small scale/recreational dredges which operated throughout the upper Jordan Creek watershed.

In 2005, DEQ conducted a one-time monitoring at two Jordan Creek sites. For the upper Jordan Creek watershed, the Flint Creek Road Bridge was selected as the most accessible site for sampling. This Jordan Creek site is located below Louse Creek and upstream of Flint Creek. EPA Method 1664 was used for oil and grease. The sample was collected on August 17, 2005 and likely represents low flow-baseline conditions for this segment of Jordan Creek. The results showed the water sample was <5.0 mg/l, or was not detected at this detectable/reportable concentration utilizing EPA Method 1664. Oil and grease should be removed as a pollutant of concern.

Pesticides

It is not clear why pesticides were identified as a pollutant of concern for upper Jordan Creek. There is very little agriculture land in this area that would require pest management through the use of pesticides. Pesticides may have been used to control the infestation of moths in the stands of Red fir in the watershed or to control the sporadic outbreaks of Mormon crickets or grasshoppers that occur in southwest Idaho.

In 2005, DEQ conducted a one-time monitoring at one Jordan Creek site for pesticides. For the upper Jordan Creek watershed, the Flint Creek Road Bridge was selected as the most accessible site for sampling.

EPA Method 525.2 was used by the Idaho Bureau of Laboratories for a semi-volatile organic compounds/pesticide scan. The sample was collected on August 8, 2005 and likely represents low flow-baseline conditions for this segment of Jordan Creek. Method 525.2 was used as a scan/analysis of 70 different semi-volatile organic compounds, of which only two were detected above detection limits; Di(2-ethylhexl)phthalate (DEHP) was detected at 0.75 µg/l.

The only reference to DEHP as a pesticide stated that it is an inert ingredient, apparently used to assist in application as a soil/vegetation binder. The primary use of DEHP is a plasticizer for the manufacturing of polyvinylchloride (PVC) and other polymers (EPA, http://www.epa.gov/safewater/dwh/c-soc/phthalat.html). In water, it will be degraded by microbial activity over a short period. However, DEHP has a tendency to accumulate in aquatic organisms (EPA), http://www.epa.gov/safewater/dwh/c-soc/phthalat.html). DEQ has two criteria for DEHP, which are based on human health for consumption. For water and organisms, the criterion is 23,000 µg/l and for organism only the criterion is 120,000 µg/l.

The second compound detected was Di-n-butyl phthalate (DBP) at 1.5 µg/l. DBP is also used mainly used as a plasticizer for the manufacturing of polyvinylchloride (PVC) and other polymers. No reference could be located concerning its use with pesticides or its effects on aquatic biology. DEQ has two criteria for DBP, which are based on human health for consumption. For water and organisms, the criterion is 2,700 µg/l and for organisms only, the criterion is 12,000 µg/l.

Pesticides (now identified as unknown)should be removed as a pollutant of concern.

Mercury

Mercury is a listed pollutant of concern in the upper Jordan Creek. Past studies by Idaho Fish and Game (1971), Hill (1973), DEQ (1980), CH2M Hill (1994), EPA (1998), and KDMC (numerous years from 1997-2005) all identified mercury as a concern for water quality and/or public health. The elevated levels of mercury in fish tissue, and the possible affects to human health from consumption of fish with elevated levels of methyl mercury are the main concerns.

Oregon has issued consumption advisories for Antelope Reservoir, lower Jordan Creek, the Owyhee River, and Owyhee Reservoir, State of Oregon:

http://oregon.gov/DHS/ph/envtox/fishconsumption.shtml

All four water bodies in Oregon have produced fish tissue with mercury levels exceeding the human health criterion of 0.3 mg/kg. Jordan Creek lies upstream of Oregon and Antelope Reservoir.

In 2005, DEQ initiated monitoring in the Jordan Creek watershed (Ingham 2005). The two main goals of the study were to acquire updated fish tissue mercury data and to begin to identify and/or verify sources/locations of mercury in the Jordan Creek watershed. Fish tissue data was also to be used to assess the spatial distribution of fish and fish tissue mercury levels. Water and sediment samples were collected to assist in identifying possible sources; and to determine if there is any correlation between tissue data and mercury levels in the water column and/or stream sediments. The number of samples generated by past studies was small and detection limits were too high to determine if a correlation existed between the three media.

The study outlined four objectives:

- Objective 1: Obtain current mercury fish tissue data and spatial distribution in the watershed, and identify areas where exceedances of the mercury fish tissue criterion might be occurring.
- Objective 2: Identify additional areas with detectable mercury concentrations in stream sediments and the water column.
- Objective 3: Determine correlation between fish tissue data and possible sources (i.e. historic deposits, tributaries, areas of concern).
- Objective 4: Identify spatial depositional pattern of mercury in stream sediments and wetted stream bank soils.

Fish Tissue Data

Fish tissue was collected at four sites in upper Jordan Creek; Jordan Creek below Silver City (JC-2005-11), Jordan Creek below Henrietta Gulch (JC-2005-09), Jordan Creek below historic dredge tailings (JC-2005-08) and Jordan Creek below Boulder Creek (JC-2005-02). The specifics of collection methods, targeted species, fish preparation and analytical methods are discussed in “Quality Assurance Project Plan, Jordan Creek Watershed HUC 1705108 mercury Monitoring Project July-September 2005” (Jordan Creek QAPP) (Ingham 2005). Data results and statistical analysis for all study sites are outlined in “Analysis of Total

Mercury Concentrations in Fish Samples from Jordan Creek and Non-Jordan Creek Sites" (Dai and Ingham 2006).

As seen in Table 28, almost all the 2005 samples showed exceedances of the 0.3 mg/kg criterion. Figure 29 shows the sites where fish were collected. As described in the "Implementation Guidance for the Idaho Mercury Water Quality Criteria" consumption by trophic level should be factored in when computing the average mercury concentrations in fish tissue. All the upper Jordan Creek sites were calculated using this formula and showed the weighted average based on trophic level was 0.534 mg/kg.

The statistical evaluation of the data indicates there is no significant difference between fish tissue mercury levels at the sampling sites, nor is there a pattern of increasing levels from downstream sites to upstream sites or upstream to downstream sites (Dai and Ingham 2006). Other conclusions were:

- The average fish total mercury concentration at Jordan Creek sites is 0.56 mg/kg, while the non-Jordan Creek sites had an average 0.13 mg/kg.
- In Jordan Creek, the average total mercury concentrations in redband trout (YOY whole body composites samples) were 0.49 mg/kg. At the non-Jordan Creek sites, the average total mercury concentration of redband trout (YOY whole body composites) was 0.03 mg/kg.
- Total mercury concentrations in redband trout at Jordan Creek sites in 2005 were significantly higher than in 1973 ($p < 0.001$) (Hill et al. 1973). However, no statistical difference was found in the fish mercury level between 2005 and 1973 for the non-Jordan Creek sites ($p = 0.60$).
- Total mercury concentrations in Jordan Creek redband trout are predictable, provided the methyl mercury concentrations of the water and the sediments are known. Fish weights and lengths are also good predictors for mercury levels in Jordan Creek. In the non-Jordan Creeks sites, fish sizes do not influence fish mercury levels significantly.

In conclusion, the mercury fish tissue data for 2005 show an exceedance of the criterion. The results also supported issuance of a fish consumption advisory for Jordan Creek, which has occurred.

Table 28. Fish tissue results for Upper Jordan Creek sites (DEQ 2005).

Station	Sample Type	Species	Mercury Fish Tissue Levels (mg/kg)
JC-2005-02 WB-COMP	[a] Sucker		0.783
	WB-COMP	Red sided shiner	0.526
	WB-COMP	Chisel mouth sucker	0.502
WB-COMP		Dace	0.687
	WB-COMP	Northern Pike Minnow	0.777
WB-COMP		Sucker	0.574
	WB-COMP	Long nose dace	0.429
	WB-COMP	Red sided shiner	0.525
	WB-COMP	Bridge lip sucker	0.605
WB-COMP		Sculpin	0.488
		Average	0.590
JC-2005-08 WB-COMP		Dace	0.500
WB-COMP		Dace	0.532
COMP-I	ND[b] Redband	trout	0.356
COMP-I	ND	Redband trout	0.417
	WB-COMP	Northern Pike Minnow	0.437
WB-COMP		Sucker	0.772
COMP-I	ND	Sucker	0.146
	WB-COMP	Red sided shiner	0.531
		Average	0.461
JC-2005-09 WB-COMP		Dace	0.589
COMP-I	ND	Redband trout	0.246
COMP-I	ND	Redband trout	0.578
COMP-I	ND	Redband trout	0.572
COMP-I	ND	Redband trout	0.448
COMP-I	ND	Sucker	0.737
		Average	0.527
JC-2005-11 COMP-I	ND	Redband trout	0.552
COMP-I	ND	Redband trout	0.481
COMP-I	ND	Redband trout	0.688
	WB-COMP	Redband trout –Young of the Year	0.485
		Average	0.551

a Whole Body Composite Sample b Individual Fillets Composite Samples

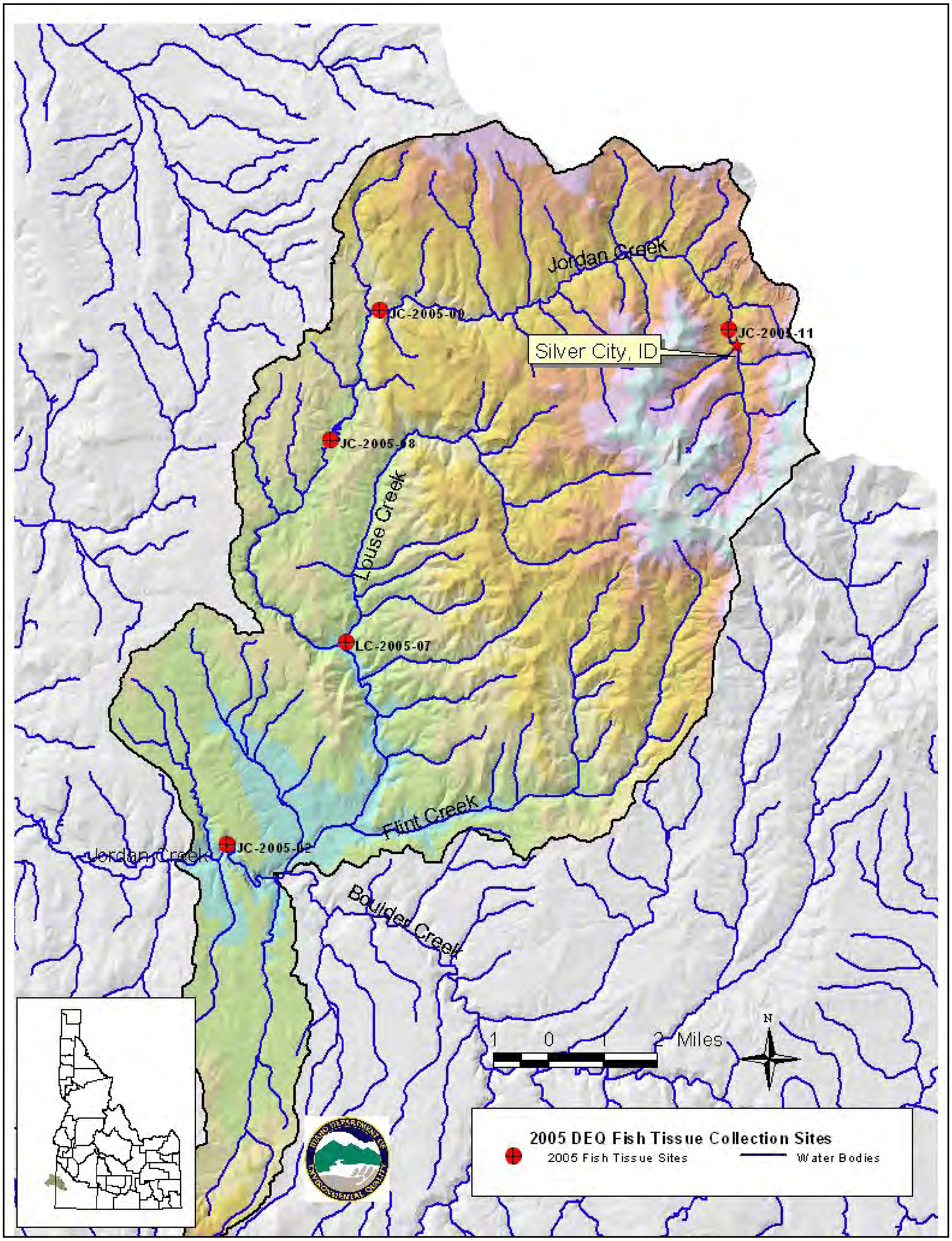


Figure 29. DEQ 2005 fish tissue collection sites (DEQ 2005).

Mercury and Water Quality

Elemental mercury (Hg^o) does not demonstrate great solubility or mobility in water. It is only under certain chemical-physical-biological conditions that speciation of mercury to the ionic form [(dissolved mercury (Hg++)], or reactive gaseous mercury (RGHg) will occur.

It is in the ionic state that most of the "mercury" is detected within the water column (personal communication, Sunderland 2006). Once in the water column, ionic mercury may attach to particulates (inorganic or organic), be released to the atmosphere (evasion), form complex salts, be reduced to elemental mercury or mercuric sulfide (HgS), or undergo methyaltion. Methylation is the process where ionic mercury is transformed to the organic form of methyl mercury (CH3Hg) + or de-methylation where methyl mercury forms dimethyl mercury ((CH3)2Hg). It should also be noted that methyl mercury can be changed to inorganic forms through de-methylation, forming such compounds as mercuric sulfide.

The above description of speciation is simplistic. There are many different and complex variations of mercury speciation that are not fully understood. It is only in recent years that the role of mercury speciation and the effects on human health has come under closer examination. Analytical methods have evolved in the last ten years, which provide results that more accurately determine water concentrations in the parts per trillion (ppt) range and lower.

Historic water quality data for mercury did not indicate water column concentrations were at levels that would have exceeded EPA's historic chronic criterion of 0.012 µg/l. Most water quality data presented by Hill et al. (1973) showed that water column concentrations were below detectable levels of 0.2 parts per billion (ppb), (0.2 µg/l). Additionally, the description of sites where samples were taken is confusing. The "Study of mercury and heavy metals in Jordan Creek drainage, Silver City Project" (Hill et al. 1973) does not provide a clear description of sampling locations, nor is a map provided showing monitoring sites.

Other available data includes the 1998 STARS (EPA 1998) study, which showed only one station with mercury concentrations above the detectable level, and the "Stone Cabin Mine EIS" (CH2M Hill 1994) which documents surface water monitoring for various years from 1984 through 1992. Results reported in the EIS ranged from <0.7 µg/l to a maximum of 7 µg/l for dissolved mercury. More recent water quality data provided by KDMC for samples collected in 2005 showed all samples were below the detection limit of 0.1µg/l (KDMC 2006). Figure 28 (page 80) shows the KDMC surface water monitoring sites.

For the 2005 water quality/sediment mercury sampling event by DEQ, eleven sites in the watershed were selected for monitoring. Information on all monitoring sites, sampling methods, parameters, QA/QC, detection levels and analytical methods can be found in "Quality Assurance Project Plan, Jordan Creek Watershed HUC 1705108 Mercury Monitoring Project July-September 2005" (Ingham 2005). For the upper Jordan Creek segment, five sites were selected to have water quality and sediment sampling (Figure 30). These sites included all the fish tissue collection sites, plus an additional site on Jordan Creek below Blue Gulch (JC-2005-10). The 2005 study established detection limits at 0.00057 µg/l with a reporting limit of 0.005 µg/l. This represents a significant improvement over the 1973 detection limits for reportable/available data for total mercury, dissolved mercury, and methyl mercury analysis.

Physical Attributes

Substrate

In 2003, BURP monitoring was conducted at two sites in upper Jordan Creek. One site was located upstream of Louse Creek (BURP ID 2003BOIA039) and the other below Blue Gulch (BURP ID 2003BOIA045). At the lower site, upstream of Louse Creek, 13.1% of the substrate was composed of material classified as sand and/or silt/clay (<2.5mm). The upstream site below Blue Gulch, 5.9% of the substrate was composed of material classified as sand and/or silt/clay (<2.5mm). Most reference literature indicate that when ≥30% of the substrate is composed of fine sediment (<2.5mm), the benthic community begins to shift to more sediment tolerant macroinvertebrate, algae and fish species.

Canopy Cover

Canopy cover at the Jordan Creek site above Louse Creek was calculated at 35% in 2003. At the BURP site below Blue Gulch canopy cover was calculated at 51% for the same year.

Streambanks

Streambank stability for both BURP sites was 98-100% covered and stable. This would indicate that the vegetation is adequately protecting the streambanks from erosion during peak discharge periods.

Habitat

DEQ utilizes an index scoring mechanism for determining the support status of beneficial uses in water bodies. One of the indexes used is the stream habitat index (SHI), which employs metrics related to habitat indicators. These indicators are described in the "Idaho Small Stream Ecological Assessment Framework" document (Grafe 2002c). Along with at least one other index (SMI and/or SFI), the support status can be determined as described in Water Body Assessment Guidance, second edition (Grafe et al 2002).

In Jordan Creek above Louse Creek, the final SHI was 49.0, or a "condition rating" of "1". The site below Blue Gulch scored a SHI of 64.0, a "condition rating of "3." The final "condition rating" of "3" represents conditions above the median of reference based on the SHI bioregion scoring criteria. A condition rating of a "1" is within the 5th and 25th percentile of the reference condition using the same criteria.

Status of Beneficial Uses

Determining the beneficial use support status in upper Jordan Creek involves the condition ratings from the two available indices, which for Jordan Creek include both the SMI and the SHI results presented above. The site below Blue Gulch (BURP ID 2003BOIA045) has a combined score of 3 (SMI=3, SHI=3). The site above Louse Creek (BURP ID 2003BOIA039) has combined score of 2 (SMI=3, SHI=1). In accordance with Water Body Assessment Guidance, second edition (Grafe et al. 2002), the scores from these sites are "full support". However, other elements come into play in making the ultimate determination of beneficial use support, including numeric criteria exceedances.

Examination of the different biological community structures provides some evidence that sediments and metal toxicity are present in upper Jordan Creek, but are not at levels causing impairment or significant alteration of the expected biological indicators. As mentioned above, upper Jordan Creek exhibits stream substrate and habitat conditions that would not be considered impaired. Based on the analsysis of biological indicators DEQ will delist sediment.

Bacteria levels in upper Jordan Creek do not exceed state water quality standards. Bacteria will be delisted.

The listing of "oil and grease," as a pollutant of concern would indicate that portions of the general surface water criteria are not being met (IDAPA §58.01.02.200). However, sample results for both do not indicate concentrations found to be of public health significance and do not exceed state water quality standards.

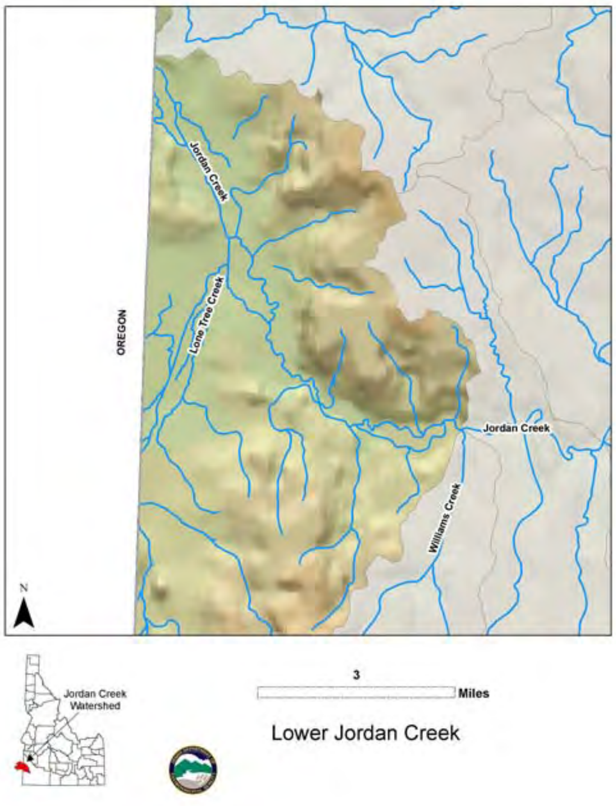
The listing of pesticides as a pollutant of concern would indicate a criteria for a compound is exceeded as established in the WQS (IDAPA §58.01.02.210). Most of the compounds sampled were below the detectable limits. Two compounds were reported above the detection limit, but were well below the criteria established for those compounds. DEQ will delist unknown (pesticides presumed).

Measurements show exceedance of both coldwater and salmonid spawning temperature criteria; thus, water temperatures do not support either use. BLM provided continuous temperature data from one site that exceeded the MDMT of 22 degrees C on 22% of the dates temperature was recorded. A Potential Natural Vegetation (PNV) temperature TMDL was developed to address this issue.

Fish tissue data collected in 2005 exceeded Idaho's fish tissue mercury criterion of 0.3mg/kg. Collection methods, sample preparation, and analytical procedures established a high degree of confidence that the results were not caused by outside contamination. Water and sediment samples provided additional data that confirm high concentrations of total mercury, dissolved mercury, and methylmercury are present from Williams Creek to the headwaters near the historic mining area. The analysis of water, sediment, and fish tissue results show the contamination is not a watershed issue as a whole, but is confined to the Jordan Creek channel itself.

A mercury TMDL for fish tissue was completed for Upper Jordan Creek.

Lower Jordan Creek



Water Body	Jordan Creek Williams Creek to Oregon state line
8th Field HUC	17050108
Assessment Units	ID17050108SW001_02 ID17050108SW001_05 (De-listed in 2002)
Miles of impaired water body	34.37
Total Acres	81,903
Listed pollutant(s)	Sediment, oil and grease, fecal coliform, unknown, and mercury
Impaired designated uses	Cold Water Aquatic Life, Contact Recreation
TMDL/Allocations goals	Potential Natural Vegetation temperature and mercury TMDLs were developed.
Further listing recommendations	Remove oil and grease, sediment and fecal coliform as pollutants of concern, add flow and habitat alteration
Potential sources	Overland flow, riparian-stream bank erosion, legacy mining/milling activity

Discharge (Flow) Characteristics

As mentioned in Section 1.0, USGS operated a discharge measurement gage in the lower Jordan Creek watershed from 1945 through 1971 and from 2002 through 2003 (USGS 13178000). Data for this period demonstrates how "flashy" Jordan Creek can be. Highest average monthly discharge recorded at this site was 2098 cfs in April 1952; the lowest discharge recorded was 1.2 cfs in September 1962. Peak discharge usually occurs in April, but discharges in the 1000 cfs range can occur anytime from January through June. During low discharge periods, the data reflects recorded discharge after irrigation water is diverted from Jordan Creek. Figure 30 shows and compares average monthly discharge for the USGS gage (USGS 13178000) upstream of Lone Tree Creek and the comparison to the USGS gage located near Delamar (USGS 131787985).

Watershed characteristics were applied to the statewide discharge estimate model developed by Hortness and Berenbrock (2001). The model showed the estimated annual average daily discharge for the Jordan Creek watershed at the Oregon line at 4.8 cfs. Besides obtaining the daily average discharge, Jordan Creek is modeled to obtain the Q80, Q50 and Q20 estimated average daily discharge on a monthly bases. The estimated discharge and the average discharge recorded for the same months at the USGS gage (USGS 13178000) are displayed in Figure 31.

From its confluence with Boulder Creek, Jordan Creek is a 5th order water body, which encompasses almost 500 square miles from the Oregon line to the headwaters. However, the listed assessment unit is Jordan Creek 17050108SW001_05. The location is from Williams Creek to the Oregon Line and it is 10.6 miles in length. No other §303(d) listed water bodies discharge into Jordan Creek along this segment.

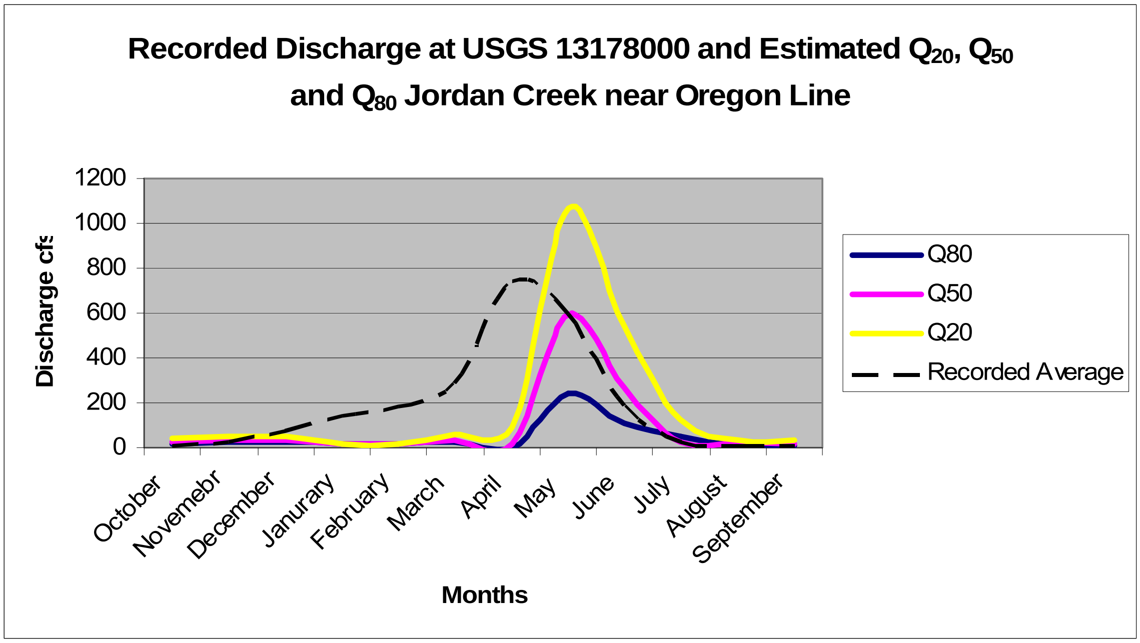
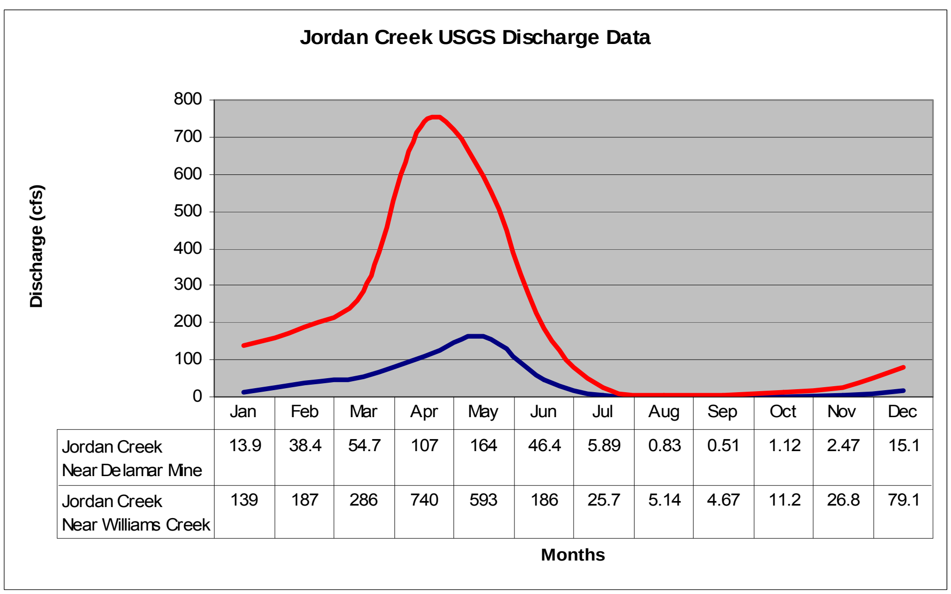


Figure 30. Average monthly measured discharge for Lower Jordan Creek (upstream of USGS Gage) and Lower Jordan Creek (USGS Gage 13178000).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jordan Creek Near Delamar Mine	13.9	38.4	54.7	107	164	46.4	5.89	0.83	0.51	1.12	2.47	15.1
Jordan Creek Near Williams Creek	139	187	286	740	593	186	25.7	5.14	4.67	11.2	26.8	79.1

Figure 31. Estimated Q20, Q50, Q80, and Upper Jordan Creek (Upstream of Boulder Creek).

From Williams Creek to the Oregon line, Jordan Creek has been modified with constructed levees, in-stream diversions, side channel diversion structures along with restricted access to the historic flood plain. Stream alterations, in all likelihood, began with the first attempts at farming and irrigation in the lower valley. Once a reliable source and conveyance for irrigation water was established, dikes and levees were probably constructed to protect the area from the yearly flooding and prevent the erosion associated with these high-energy discharges.

However, with these stream alterations, Jordan Creek no longer shows the same historic characteristics it once had. These characteristics included a wide-wet meadow valley type/flood plain, high sinuosity meandering water body and a nutrient rich soil horizon supporting a variety of hydrophilic and hydrophobic woody vegetation and grasses.

During peak discharge, water flowed down from Boulder Creek and upper Jordan Creek watersheds through the confined/restricted canyons with little access to a flood plain to disperse energy. When these high-energy flows reached the wide valley and low gradient sections, the energy along with the sediment being transported would be dispersed with heavier sediments and bedload being deposited at the head of the valley and the finer nutrient rich material being deposited further downstream and/or along the margins of the flood plain.

In a channelized system, the energy continues down the channel with that energy being directed to areas downstream and/or the channel itself causing scouring. Scouring in lower Jordan is very evident with the volume of “bars” of small boulders, cobbles and gravels now present from Williams Creek to the Oregon line.

Figure 32 shows an area about ½ mile upstream from the Oregon line. A levee system can be seen confining both streambanks to an area 100 meters or so wide. Areas of fine sediment deposition are noted by the area supporting some sedge grasses and the limited woody vegetation. Figure 33 shows a distant view of the Pleasant Valley area just upstream of the Oregon line. The photo shows a defined channel with very little overland flow into the flood plain.

Figure 34 shows an aerial view of the Pleasant Valley area. The current channel is clearly noticeable by the brighter margins associated within the current Jordan Creek zone of influence. Figure 35 provides a closer view where historic meanders can be seen, along with the current and historic flood plain.

Under current irrigation practices, in-stream diversions are the main mechanism for diverting water to ditches. Once high waters have receded, local landowners use the available bedload material to construct earthen structures across the entire channel to divert water to irrigation ditches. In all, there are six known in-stream structures from Williams Creek to the Oregon line. It is not uncommon for these diversions to reduce flows below these structures to zero (Personal Communication, Stanford 2005). These structures also impede the delivery of fine organic material needed for vegetation growth on gravel bars, and the margin of the channel.

Figure 32. Jordan Creek, 1/2-mile upstream of the Oregon Line (DEQ 2005).

Figure 33. Jordan Creek at Pleasant Valley, near the Oregon Line (DEQ April 2006).

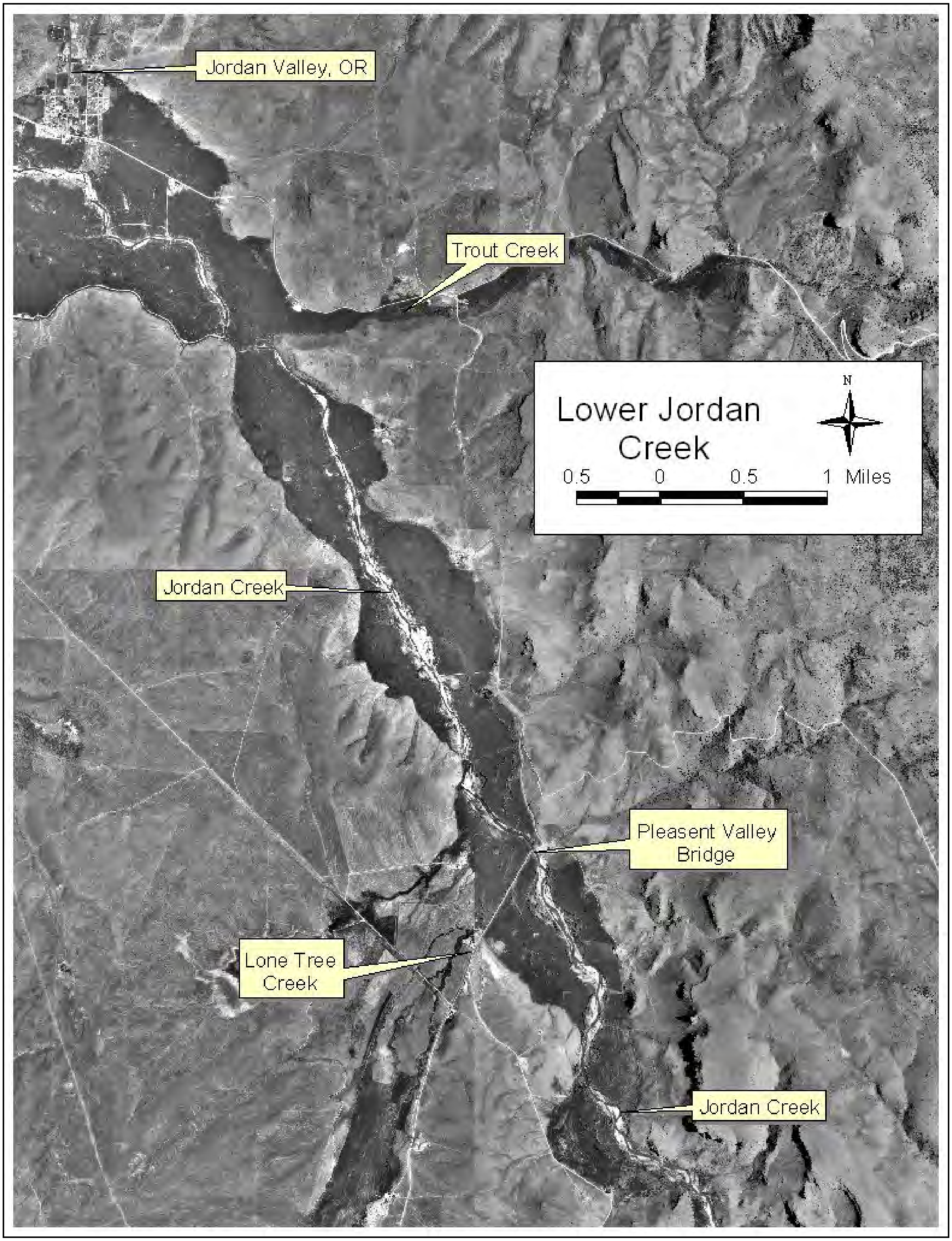


Figure 34. Lower Jordan Creek, Pleasant Valley.

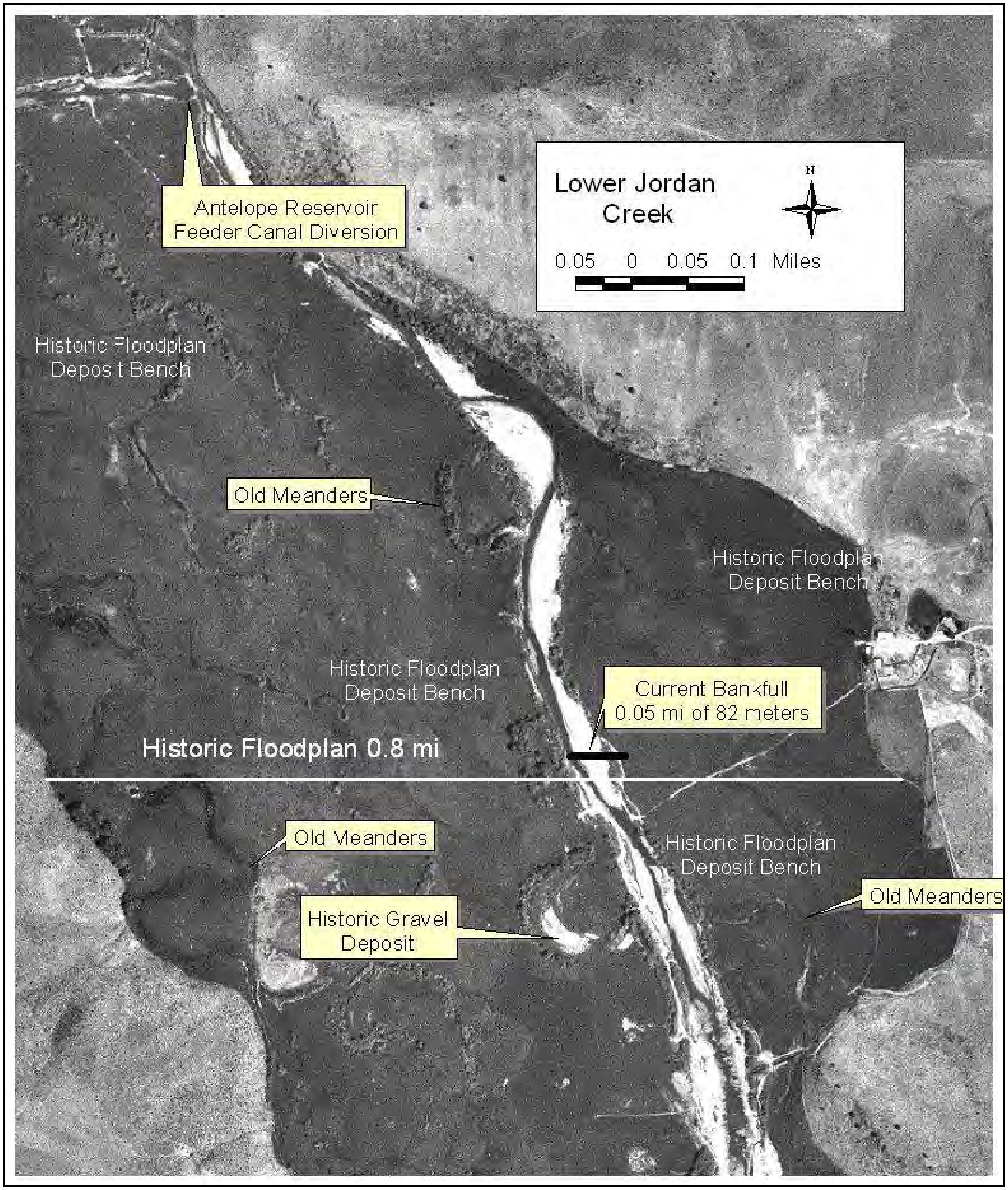


Figure 35. Lower Jordan Creek, at the Oregon state line.

Biological and Other Data

Due to the limited access, and denial of entry to private land, biological information is not available, except for fisheries data collected in 2005.

Periphyton

There are no periphyton data to evaluate.

Macroinvertebrates

There are no macroinvertebrates data to evaluate.

Fisheries

During the 2005 mercury evaluation for Jordan Creek, one site in lower Jordan Creek was selected for collection of fish tissue samples (JC-2005-01). In 2005 there were no fish collected from lower Jordan Creek that met the desirable-catchable-edible criteria. No cold water species were collected. Fish species collected in lower Jordan Creek consisted of redside shiners, suckers, northern pike minnow, chisel mouth sucker and dace.

Table 29 shows the approximate number (if available) of each specie collected and the average length (if available) and weight for fish collected.

Table 29. Fishery Data and Information. Jordan Creek ½ Mile Upstream of the Oregon Line. DEQ 2005.

Species	Total Number Collected	Size Range (mm)	Weight Range-Average (grams)
Chisel mouth sucker	1	NA	11.5
Redside shiners	NA	NA	101.3 (Composite Weight)
Suckers NA		NA	26.4
Dace	NA	NA	197.2 (Composite Weight)
Northern Pike Minnow	1	NA	89.9

During the development of the “Jordan Creek Mercury Evaluation Study Quality Assurance Project Plan” (Ingham, 2005), mercury concentrations in fish, water and sediments were to be examined throughout the watershed. The lack of appropriate habitat may have been the reason no larger fish were captured. It is possible that the larger fish were located behind the earthen structures in place for water diversions. The areas between these structures offer little refuge due to the lack of pools and cool water. Since access to these areas was denied and the closest diversion was actually in Oregon, which was not within the boundaries of the collection permit issued by Idaho, the analysis had to utilize the data collected.

Considering the in-stream structures, diversion structures in Oregon and intermittent flows in both Idaho and Oregon, the migration of fish from the Owyhee River is in all likelihood extremely limited. If there are any large fish remaining in the open channel they might be trapped in intermittent pools that would be subject warmer temperatures possibly affecting the available dissolved oxygen. The direct solar radiation might increase water temperature above a survivable limit. However, limited habitat may be available in the pools located behind the diversion structures, where deeper waters may maintain adequate temperature and dissolved oxygen levels with ground water inflows. However, it is not actually known if this has occurred.

Water Quality Data

Oil and Grease

It is not clear why oil and grease was listed as a pollutant of concern for lower Jordan Creek. There is no reference to oil and grease in the data summary for the monitoring conducted by Idaho in 1975-1976 (IDHW 1980), or other evaluations conducted by Hill et al (1973), KDMC (various years) and CH2M Hill (1994).

In 2005, DEQ collected samples for oil and grease from two Jordan Creek sites. For lower Jordan Creek, samples were collected at the Pleasant Valley Road Bridge. The site is located about 6 miles upstream from the Oregon line and about the same distance from the confluences of upper Jordan and Boulder Creek.

The sample was collected on August 17, 2005 and in all likelihood represents low flow-baseline conditions for this segment of Jordan Creek. The analytical method used for oil and grease was EPA Method 1664. The result of the sample was <5.0 mg/L, i.e., was not found at the detectable/reportable concentration utilizing EPA Method 1664. Oil and grease should be removed as pollutants of concern.

Pesticides

It is not clear why pesticides were identified as a pollutant of concern for lower Jordan Creek. There is very little agriculture lands in this area that would require pest management through the use of pesticides. The presence of pesticides in Jordan Creek could include the use of pesticides to control the infestation of moths in the stands of Red fir in the upper sections of the watershed or to control the sporadic outbreaks of Mormon crickets or grasshoppers that occur in southwest Idaho.

In 2005, DEQ collected samples for pesticides from two Jordan Creek sites. For lower Jordan Creek, samples were collected at the Pleasant Valley Road Bridge. The sample was taken above the bridge free flowing water and collected on August 17, 2005 and in all likelihood represents low flow-baseline conditions for this segment of Jordan Creek. EPA Method 525.2 was used by the Idaho Bureau of Laboratories for a semi-volatile organic compounds/ pesticide scan. Method 525.2 was used as a scan/analysis of 70 different semi-volatile organic compounds, of which none were detected above detection limits. Pesticides should be removed as a pollutant of concern.

Sediment

There are no sediment data to evaluate.

Temperature

Continuous temperature data are available from both DEQ and BLM for sites in lower Jordan Creek. DEQ placed temperature loggers at one site directly above the Oregon line in 2005. BLM has provided data for one site from 2004.

The DEQ 2005 data logger was placed about ½ mile upstream of the Oregon line. The 2005 data showed 58% of the dates the MDMT criterion of 22 ^{o}C was exceeded, and 44% of the dates the MDAT criterion of 19 ^{o}C was exceeded. The 2004 BLM data showed 45% of the dates the MDMT criterion of 22 ^{o}C was exceeded, and 40% of the dates the MDAT criterion of 19 ^{o}C was exceeded.

Interpretation of water temperatures would indicate that nighttime ambient air temperature in the lower section of the watershed is not cool enough to keep the daily average temperature below the criterion. Other factors may include the minimization of ground water inflows, substrate material radiating heat at night and lack of water from upstream sources. Daytime heating is partly due to lack of vegetation, lack of inflows from upstream sources, water impoundments and diversions, and altered stream morphology.

Direct solar radiation is the source of heat that is most likely to be controlled or manipulated. The primary factors affecting or controlling the amount of solar radiation hitting a stream are shade and stream morphology. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high banks. Stream morphology affects how closely riparian vegetation grows together and water storage in the alluvial aquifer. In the lower Jordan Creek segment, the placement of dikes and levees has altered the dispersal of energy associated with high flows, decreased the flood plain area to a narrow band and reduced the amount of available alluvial water storage. A potential natural vegetation temperature TMDL was developed.

Bacteria

Bacteria are a listed pollutant of concern for the lower Jordan Creek segment. Samples were collected in 2005 at the Pleasant Valley Bridge. To compare bacteria counts to WQS and criteria, six samples for E. coli were collected over a thirty-day period in August and September to obtain a geometric mean. Results showed a range of 44 CFU/100ml to 280 CFU/100ml with a geometric mean of 124 CFU/100ml. The geometric mean criteria for both primary and secondary contact recreation are 126 CFU/100 ml. Bacteria should be removed as a pollutant of concern.

Mercury

Mercury is a listed pollutant of concern for the lower Jordan Creek segment. During the 2005 mercury evaluation for Jordan Creek, one site in lower Jordan Creek (JC-2005-01) was selected for collection of fish tissue, water and sediment samples (Ingham 2005).

Mercury and Fish Tissue

As mentioned in the biological section, no desirable-catchable-edible fish were found in the lower segment of Jordan Creek. Those fish that were collected, weighed only a few grams and none were classified as a game fish to be caught and consumed within Idaho. This does not rule out the possibility that large fish are present in lower Jordan Creek. At the Pleasant Valley Bridge, numerous large suckers and trout were observed in an area impounded by an in-stream diversion (Personal Observation, Ingham 2005).

To offset the lack of data and to still provide an estimate of mercury tissue concentrations, various best-fit models were applied using data from fish tissue, water samples and sediment samples collected in other parts of the watershed in 2005 as well as the fish tissue data from Hill (1973). A complete analysis of models developed and used is described in "Analysis of Total mercury Concentrations in Fish Samples from Jordan Creek and Non-Jordan Creek Sites" (Dai and Ingham 2005). The results of the predictive model are shown in Table 30. Data used in development of the models can be found in the above referenced document.

Table 30. Estimated mean total mercury concentrations in redband trout at Jordan Creek site JC-2005-01. DEQ 2005

Statistical Evaluation	Estimated Mercury Concentration in Redband Trout (mg/kg)
Mean 0.75	
Lower 95% limit	0.61
Upper 95% limit	0.90

If the predictive model is representative of mercury levels in fish in lower Jordan Creek, this would be an exceedance of the fish tissue criterion of 0.3 mg/kg.

Mercury and Water Quality

Water samples were analyzed for total mercury, dissolved mercury and methyl mercury.

Mercury and Stream Sediments

The production of methyl mercury from total mercury occurs mainly in stream sediments. In the methyl mercury phase it is readily available for uptake by the lower trophic levels such as bacteria, periphyton and zooplankton, which are the primary food for the next trophic level and so forth up the food chain. Supporting data for all current mercury analysis is located in Appendix E.

The data presented in Appendix E shows the mercury concentrations in sediment are over 1000 times those found in sites determined not to have been influenced by historic mining. The results also show the lower segment's sediment mercury concentrations are at least twice of those found at other Jordan Creek sites. This would be expected since this is the low gradient section of the watershed and deposition of fine sediments should occur in this area. However, it should be noted, collection of sediment samples was difficult at this location due to the lack of fine sediments and the associated organic material in the substrate. Most of the substrate is composed of gravels and small cobble sized material (Personal Observation, Ingham 2006).

The current practice for diverting water for irrigation might be compounding the availability of methyl mercury. Since the production of methyl mercury occurs in sediments primarily composed of organic material and fine sediments, the areas behind these impoundment structures would probably be the primary areas of methylation in lower Jordan Creek. These impoundments appear to be the only available habitat in lower Jordan Creek and are going to be the primary areas for bioaccumulation in the biological communities. If access is granted from local land owners, these areas should be the primary focus for any future mercury evaluations (fish tissue, water and sediments) in the lower Jordan Creek watershed.

Physical Attributes

Substrate

There is no quantitative data available to evaluate the substrate in lower Jordan Creek. A subjective/qualitative evaluation from aerial photos along with personal observation provides an appraisal of current condition.

As described in the section that discusses discharge, the hydrology of lower Jordan Creek has been altered, which in turn has altered the composition of the substrate. If the morphology of the water body had not been altered, the stream would be composed of larger heavier bedload material at the outlet of the canyon. There would be a progression of smaller material as you progress further down the valley. Fine sediments would be deposited in the flood plain during peak flows. Fine sediments and organic material would have also been carried during base flow condition providing the material for in-stream point bar development.

Current stream morphology prevents the build up of finer material, in a sense producing a sterile ecosystem. Re-establishment of large woody species (e.g., willows) within the area of influence from peak discharges will be difficult without fine sediments and the associated organic material.

Streambanks

Streambanks are composed of dikes and levees from the head of the valley to the Oregon line. During peak discharges, it is expected there would be erosion occurring due to the channeling of energy to downstream sites. After peak discharges, private landowners typically repair any eroded streambank and maintain the stream in its altered state to provide irrigation water.

Habitat

Aquatic habitat would appear to be impacted after consideration of the above physical features including substrate, canopy cover, and streambanks. Lower Jordan Creek consists mainly of intermittent flows between diversions structures in a confined channel. The disconnect from the historic flood plain has reduced the inflow of ground water needed to keep water temperatures cooler in summer months. The lack of fine sediments and organic material has reduced the available area for recruitment of vegetation needed for stream shading and bank stabilization. The influence of peak-high energy discharges has produced a channel subject to scouring and the movement of large bedload material. All these features have reduced the water body's ability to naturally construct pools needed as refuge areas.

Status of Beneficial Uses

The listed pollutants of concerns, oil and grease, and pesticides were evaluated through water quality monitoring to determine if these pollutants were violating the provisions in the general surface water quality criteria (IDAPA 58.01.02.200). Using EPA recommended analytical methods, neither pollutant was detected. It is recommended these pollutants be removed as pollutants of concern.

Samples to evaluate possible impacts to contact recreation showed no exceedance of the geometric mean criteria for E. coli of 126 CFU/100ml. It is recommended bacteria be removed as a pollutant of concern.

When evaluating sediments, the general surface water quality criterion is applied (IDAPA 58.01.02.200.08). For the lower Jordan Creek segment, a quantitative analysis is lacking to compare to literature-referenced targets such as percent fines, suspended sediment concentrations, embeddedness and turbidity. These targets focus on the fine sediments (<2.5mm) that reduce water clarity, deposit over spawning gravels and/or fill interstitial spaces required for primary food production. It is believed these are not a factor in impairing beneficial uses in lower Jordan Creek. The lack of aquatic habitat associated with current stream morphology and the management for flood control and irrigation water diversions appears to be a source of impairment. It is recommended sediment be removed as a pollutant of concern. It is also recommended that Jordan Creek be added to the §303(d) list Section 4c for flow and habitat alteration.

Temperature data for the lower Jordan Creek segments shows exceedance of both the MDAT and the MDMT for cold water aquatic life. A Potential Natural Vegetation (PNV) temperature TMDL was developed to address this issue.

Mercury is a listed pollutant of concern on the 2008 §303(d) list. The predictive model used to estimate mercury levels in fish for lower Jordan Creek would indicate an exceedance of the fish tissue criterion of 0.3 mg/kg. See Appendix H.

2.7 Conclusion

Table 31 summarizes assessment outcomes for the Jordan Creek watershed.

Table 31. Summary of assessment outcomes for the Jordan Creek Watershed.

Water Body Segment/AU	TMDLs/ Allocations Completed	Recommended Changes to §303(d) List	Justification
Cow Creek ID17050108SW021_02 ID17050108SW021_03	Potential Natural Vegetation temperature TMDL completed	Remove sediment as a pollutant of concern; Move temperature TMDL to § 4a	Water body is intermittent, Data does not indicate sediment impairment
Soda Creek ID17050108SW022_02 ID17050108SW022_03	Potential Natural Vegetation temperature TMDL completed; Sediment TMDL completed	Move to § 4a	Water body is intermittent, Data does indicate sediment is impairing expected biological composition Impaired but unlisted for Temperature
Rock Creek ID17050108SW013_02	Potential Natural Vegetation temperature TMDL completed	Remove sediment as a pollutant of concern; Move temperature TMDL to § 4a	Water body is intermittent, Data does not support sediment impairment
Louisa Creek ID17050108SW014_02	Potential Natural Vegetation temperature TMDL completed	Support status requires verification; Move temperature TMDL to § 4a	Lack of sediment data
Spring Creek (Meadow Creek) ID17050108SW015_02 ID17050108SW015_03	Potential Natural Vegetation temperature TMDL completed	Move to § 4a	
Jordan Creek ID17050108SW004_02	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Remove oil and grease, unknown, sediment and bacteria as pollutants of concern. Move mercury and temperature TMDLs to § 4a	Water quality data showed no exceedance of numeric criteria
Jordan Creek ID17050108SW004_03	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Remove oil and grease, unknown, sediment and bacteria as pollutants of concern. Move mercury and temperature TMDLs to § 4a	Water quality data showed no exceedance of numeric criteria
Jordan Creek ID17050108SW004_04	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Move to § 4a	Impaired but unlisted for mercury and temperature
Jordan Creek ID17050108SW004_05	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Remove oil and grease, pesticides, sediment and bacteria as pollutants of concern. Move mercury and temperature TMDLs to § 4a	Water quality data showed no exceedance of numeric criteria
Jordan Creek ID17050108SW001_02	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Remove oil and grease, pesticides, sediment and bacteria as pollutants of concern. Move mercury and temperature TMDLs to § 4a.	Water quality data showed no exceedance of numeric criteria
Jordan Creek ID17050108SW001_05	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed,	De-listed in 2002 for oil and grease, pesticides, sediment and bacteria as pollutants of concern; add Flow and habitat alteration; Move to § 4a for temperature and mercury	Water quality data showed no exceedance of numeric criteria; Impaired but unlisted for mercury and temperature

3. Subbasin Assessment–Pollutant Source Inventory

Mercury and suspended sediment are the only identifiable pollutants requiring further analysis for possible sources. Water temperature issues will be addressed in the potential natural vegetation TMDL. Data shows the only impaired water bodies are Jordan Creek, headwaters to Oregon Line, for mercury, and Soda Creek, headwaters to Cow Creek, for sediment.

Jordan Creek and Mercury

The following discussion of the speciation of mercury and its behavior in the environment is important in understanding the sources, fate and transport of mercury in the environment.

Due to legacy mining activities as well as airborne deposition Jordan Creek has been impacted by mercury. These same sources may impact downstream water bodies including Antelope and Owyhee Reservoirs. The latter being approximately 80 river miles from the headwaters of Jordan Creek. The water quality issue associated with mercury in the Jordan Creek watershed is elevated levels of methyl mercury in fish tissue that exceed Idaho's fish tissue criterion.

Mercury in the environment exists in various forms, including natural mineral sources such as cinnabar (mercuric sulfide) which is mined to produce mercury for other uses. The predominant organic form of mercury is methyl mercury, which is highly toxic and readily bioaccumulates in the food chain. Mercury is released to the environment in many different chemical forms or species; elemental mercury is the most common found in air emissions from industrial sources such as coal-fired power plants and retorting operations from gold mining. Elemental mercury can travel hundreds of miles from its source before depositing on the landscape and entering waterways.

In addition to air releases, various industrial processes and commercial uses of mercury, including sewage treatment works, release mercury directly to waterways. Historic uses of mercury included its use as a softening agent for felt hats, as a pesticide, wide ranging medical applications, tanning and dyeing of animal pelts, pigmentation for paints, and for the extraction (augmentation) of gold and silver from sulfide bearing ore. Mercury is still widely used, but in much smaller quantities than it was just a decade ago. Current uses include pharmaceuticals, electronic switches, dental amalgams and mercury vapor and fluorescent lights, flat panel computer monitors to name a few of the many industrial and commercial uses. The use of mercury for extracting gold and silver is still practiced around the world and is released from mineral forms in the processing of certain ores, such as gold ore roasting in northern Nevada south of the Jordan Creek watershed. In many undeveloped countries, the use of elemental mercury for gold and silver extraction is common and is notable in small family/community types of mining/milling operations for its immediate health as well as far reaching environmental effects.

Unlike most metals, elemental mercury is volatile, with a vapor pressure of 0.3 Pa at 25 °C, and transforms into the vapor phase at room temperatures. In an aquatic environment, elemental mercury does not demonstrate great solubility or mobility (56 µg/l at 25 °C), but this solubility can be enhanced under certain chemical, physical and biological conditions. Ionic forms (dissolved mercury) within the water column will easily attach to particulates and be re-deposited, be reduced back to elemental mercury (a portion of which will be released to the atmosphere, known as evasion) or mercuric sulfide, or be methylated. Methylation is a process mediated by microbes by which ionic mercury is transformed to the organic form of methyl mercury. An additional step of de-methylation to dimethyl mercury may then occur. It should also be noted that methyl mercury can be changed to inorganic forms through de-methylation, forming such compounds as mercuric sulfide. Methyl mercury is of concern because of both its much higher toxicity, and the ease with which it bioaccumulates, dramatically increasing in concentration in the tissues of aquatic organisms, most notably fish.

It is thought that the presence of sulfate reducing bacteria and their production of enzymes are most important in the transformation of ionic mercury to organic methyl mercury. These enzymes can convert the bacteria's environment of mercury into a more soluble form (methyl or ionic mercury) and this is more easily transported through the air or water. Methyl mercury is then available to the biota through absorption, ingestion, or other means. Methyl mercury will bioaccumulation through the food chain, meaning mercury levels will increase if the primary food sources levels remain the same. Methyl mercury is effectively taken up by aquatic biota and bioconcentration factors in the order of 104 to 107 have been documented (Ullrich, Tanton and Abdrashitova 2001). Of total mercury in the water column, only a fraction is usually in the form of methyl mercury. This can vary from 1-30% depending on the available and potential areas for methylation. Typically in sediments methyl mercury accounts for 1-1.5% of the total mercury. However, pore water levels can be much higher (Ullrich, Tanton and Abdrashitova 2001). In fish tissue, methyl mercury accounts for 85-95% of the total mercury.

With all the ways mercury acts-reacts to the biological, chemical and physical condition in an aquatic environment, it stands to reason that aquatic mercury is difficult to trace to its primary source. In many situations the areas of concern for methyl mercury maybe hundreds of miles from the primary source of the elemental mercury.

Due to its density, any transport of elemental mercury would be associated with high flow periods and/or the movement of bedload material, but mercury could also be transported within the water column if droplets are small enough that surface tension produces adequate buoyancy. Transport of ionic mercury occurs more easily, and is associated with water flow as well as suspended sediments or organic material, including dissolved organic material (i.e. organic carbon). Wherever sediment bound ionic mercury is deposited, methylation may occur. This can be hundreds of miles from the instream source, let alone aerial sources.

3.1 Sources of Pollutants of Concern

Jordan Creek and Mercury

The exact location of original mining sources and current secondary source(s) of elemental mercury in the watershed cannot be pinpointed with available data. Mercury is a major concern for only one water body in the watershed, Jordan Creek. Louse Creek, Williams

Creek, Flint Creek, East Creek and Boulder-Rock Creek did not have mercury loadings sufficient to cause elevated concentrations of methyl mercury in fish tissue, nor did they exhibit water column concentrations that would indicate a major source of mercury is located in these watersheds.

Present data is consistent with conclusions by Hill et al (1973) which indicate the headwaters, near Silver City, is a continuing source of mercury. The one sample collected from Jordan Creek below Silver City in 2005 had the higher results for both total mercury (0.093 µg/l) and the dissolved mercury fraction (0.089 µg/l) than any other sites sampled in 2005. That sample was collected during baseflow conditions and during a period of dry weather, which indicates the source is not from soil erosion or overland flow, but from a source or sources within or near the current stream channel or nearby tributary. This source could be in the stream substrate, stream bank material and/or ground water inflow, or a combination. About a mile upstream from the site sampled in 2005, just above the Sawpit Gulch, Hill et al (1973) found a decrease in mercury and other chemical parameters, suggesting a source in that area. To find the exact source of the mercury would require intensive sampling at close intervals moving upstream to a site above the historic mining and milling activity. Appendix E contains water quality data collected in 2005.

Point Sources

Jordan Creek and Mercury

There is currently only one NPDES permitted facility in the watershed: Kinross-Delamar Mine. The mine is located on the ridge between Jordan Creek and Louse Creek, about 10 miles northeast of Jordan Valley, Oregon. Mining has ceased and the operation is currently in the final stages of closure, with final earth moving activity ending in 2006.

This facility falls under the multi-sector general storm water permit. Their Notice of Intent application (NPDES Storm Water Permit Multi-Sector General Permit and SWPPP No. IDR05C177) classifies the operation as active and applies to approximately 2000 acres within the Kinross-Delamar Mine area of operation. Under provisions of the general permit, active operations are required to conduct chemical monitoring of storm water and visual assessments of storm water discharges. Chemical monitoring results are to be reported to EPA within 30 days of receiving complete laboratory results. Additional requirements of the permit address the general application of best management practices (BMPs) for controlling storm water runoff and erosion. The general storm water permit can be viewed at:

http://yosemite.epa.gov/r10/water.nsf/Stormwater/industrial/

In 2004, Kinross-Delamar initiated a voluntary monitoring plan to evaluate and confirm the effectiveness of implemented BMPs. The Reclamation Performance Evaluation (RPE) Monitoring Plan (KDMC 2004) is designed to assist Kinross-Delamar personnel, along with federal and state agencies, to evaluate BMPs applied for managing storm water runoff and erosion control efforts during reclamation of disturbed areas. The areas evaluated included land being reclaimed, as outlined in the Kinross-Delamar Mine Closure Plan (KDMC 2003), and included historic mining activity, road system, plant operation, mine/mill tailings, and water impoundments.

Data reported for the RPE monitoring conducted in 2005 showed most water quality samples were below the detection limit of 0.1µg/l for mercury. Two surface water sites that reported results above the detection limit ranged from 0.1 µg/l to 0.4 µg/l. In 2004, all monitoring results were below the 0.1 µg/l detection limit (KDMC 2005 and KDMC 2006). Very low level detection limit monitoring was conducted by Tetra Tech for KDMC in 2007 as part of the NOI for their multi sector permit. Tetra Tech used EPA method 1631 and the six sites reported results (KDMC 2007). However, it was unclear the exact location of these sites as there was no map available or coordinates.

A precise mercury load within the NPDES permitted area cannot be determined with available data. In addition, the storm water permit does not specify a load limit for mercury for the Kinross-Delamar Mine or the reclamation activity associated with the closure of the facility.

Since the goal of the closure and reclamation of the mine is to minimize pollutants (sediments, metals….etc.) associated with the operation from being discharged to nearby water bodies, it would stand to reason that the long term goal is to achieve background levels, or the best water quality achievable. After reviewing biological, physical and chemical data submitted by KDMC for the past 3-4 years it appears the reclamation activity has achieved that goal. All biological data collected by DEQ and KDMC have shown all water bodies (Louse and Jordan Creeks) that receive outfall from the mine are either full support, or water quality data indicates the general runoff from the facility is not a significant source of additional mercury. Fish tissue data show mercury levels are not exceeding criteria for Louse Creek, which receives discharge from the mine. In fact, Louse Creek was delisted by DEQ in the 2008 Integrated Report and approved by EPA.

Water quality data collected by DEQ and KDMC has indicated the mine currently is not discharging pollutants at levels that can be shown to exceed criteria in Jordan Creek. It appears that impairment to fish tissue likely is a result of the legacy mining issues. Louse Creek data collected by DEQ and KDMC shows there are no exceedances of any metals criteria, and further indicates current discharge from the mine is not a contributing factor for fish tissue criteria not being met in Jordan Creek. This begs the question “Is a TMDL the right vehicle as a remedy?”

In summary, the data show current water quality and mercury loads associated with the mine appear to be at acceptable levels and therefore no wasteload allocations have been developed at this time. DEQ believes if KDMC complies with all conditions of their current NPDES permit including full application of BMPs they will be fulfilling the requirements and intent of the TMDL. In light of the complexity of accurately characterizing pollutants it may be prudent to increase the frequency of monitoring to determine if mercury is being delivered to the system. Additional data with lower detection limits would be useful for future analysis and should be shared with DEQ.

Should KDMC determine they need to discharge in the future, as identified in their public comments on the draft TMDL, DEQ has created a reserve for growth to accommodate that discharge relying upon Idaho’s narrative toxics criteria and to assure compliance with downstream states standards.

Soda Creek and Sediments

There are no known point sources in the Soda Creek Watershed associated with sediments.

Nonpoint Sources

Jordan Creek and Mercury

Historic Mining/Milling Activity

In 2005, DEQ commissioned a member of the Owyhee County Historic Society and a part-time Silver City resident to compile a narrative report on the historic use of mercury in the mining/milling operations in the Jordan Creek watershed. The completed report "Mercury Use in Mining in the Area near Silver City, Idaho" developed by Jim Hyslip (2006) is included as Appendix D. Hyslip's report provides a review of historic newspaper accounts, reference materials, and personal interviews of accounts of gold extraction, milling operations and production, and other related mining and milling activity in the Jordan Creek watershed.

A quote found in the report illustrates the importance of mercury in the Jordan Creek watershed;

> If gold and silver are the precious metals, then quicksilver—mercury is the essential metal. Without mercury, 19th century precious metal mining would not have been possible in most districts. Nearly all of the gold mining districts relied on amalgamation in arrastras, stamps, and pans for recovery of the values.

Anecdotal accounts of "hundreds of pounds of mercury wasted/spilled daily", "using a ladle to dip quicksilver from the stream to sell back to the mills", "a bathtub full of mercury as a collection vessel", "empty mercury flasks used as part of the Silver City Hotel's foundation"…….and others as described in Hyslip (2006) seem to indicate there was an abundance of mercury used in the area, and it is speculated most of it found its way to Jordan Creek. Considering that the actual documented production of usable mercury from local cinnabar deposits was limited to a few flasks, it is surmised most mercury was imported.

Although the wide use of mercury in Jordan Creek is well documented, its fate is not well documented. One theory is that loss of mercury was just part of "the cost of doing business" in the Silver City area. The high yielding ore produced millions of dollars in gold and silver bullion for the owners. Extraction was the main priority of the mills; recovery of a $70-80 flask of mercury likely was not. Today the main unanswered questions are the extent of recovery and reuse of mercury during active mining, methods of recovery (if any), disposal of "spent" mercury and the location of the tailings from mills which operated in the area.

Evaluation of Sources of Current Mercury Loadings

Elemental mercury is still found in the substrate and within the bedrock of Jordan Creek, even after the 80-120 years of its widespread historic use (Hill 1972 and Hyslip 2006). It is buried in deposits of sediments only to be exposed and moved during high discharge events. Elemental mercury may not be confined to the current stream channel but could be deposited in the flood plain, buried deep in old meanders, and/or spread out on irrigated land in the valleys. Water quality data collected in 2005 still show a high concentration in the Silver City area, indicating there is still a source, or sources, located near where major milling operations took place a hundred years ago.

Sediment samples collected by EPA (START 1998) show somewhat of a pattern where high mercury concentrations are located. The study focused a majority of its sampling effort in the Silver City area. As seen in Figure 36, high concentrations in sediments are located in the Silver City area and in the low gradient areas below the tailings above Louse Creek and then again below Boulder Creek into the Pleasant Valley area.

To assist in identifying possible mercury sources associated with historic mining/milling on public administered lands, the BLM conducted sampling of mine tailings in 1994 and 1995 (Seronko 1995). The Seronko study focused on mine tailings, which may not provide adequate information to conclude that mines located on BLM administered lands are not a source of mercury to the watershed. The study did not analyze identifiable mill tailings or the tailings profiles on public lands. Hill et al (1973) showed mercury concentrations increased with depth, and the highest concentrations were associated with the ground water interface. The Seronko (1995) study used a single surface sample that may not have been representative of increasing concentrations through the tailing's profile. Mine tailings are usually waste rock from the surrounding geology and should represent natural levels of mercury associated with that geology. However, exposure to acid mine wastewater, sunlight and/or microbial factors may enhance the release of ionic mercury from mercuric sulfides found in the area. Mill tailings are the leftovers of processing metal bearing ore and would be expected to yield higher levels of contamination.

Additional information is required to pinpoint mine tailings as possible sources. Additional sampling on public lands should focus on sites that are identified as historic milling operations and address mercury concentrations within the tailing's profile, especially in the area of ground water interface.

Fate and Transport of Mercury in the Jordan Creek Watershed

No known new "supplies" or sources of mercury have been identified in the Jordan Creek watershed with the exception of airborne deposition; leaving the *legacy use of mercury* as the primary source in the Jordan Creek watershed. Considering the complex behavior of mercury in the aquatic environment and the data available, this primary source likely augments the production of methyl mercury in downstream areas, from secondary sources of floodplain and channel deposits. This is not a unique situation to just Jordan Creek. Studies conducted on the mercury contamination in San Francisco Bay in central California (Guadalupe River TMDL Project), Walker Lake in eastern Nevada (Seiler, 2004), Cache Creek in Central California (Domagalski 2004) and Steamboat Creek in eastern Nevada (Stamenkovic 2003) have all demonstrated that mercury contamination and/or elevated mercury in fish tissue is associated with redistributed mercury from mining sources. These studies demonstrated that the introduction of elemental mercury to the environment has had both far-reaching and long lasting impacts.

Physical, chemical and biological conditions in an aquatic environment will cause elemental mercury to oxidize to ionic form, which is then more readily transported in solution. But even without such transformation mercury does move. Downstream, in low gradient depositional areas, mercury attached to particulates or as precipitated salts may accumulate. Such areas exist for several miles in lower Jordan Creek and have physical conditions that enhance methylation of mercury. Erosion/re-suspension is dependent on flow conditions and may be an ongoing source to downstream locations. Mercury attached particulates buried under deeper sediments outside of the stream channel may re-suspend years later during high flows as the stream meanders through the valley bottom. Thus, reduction of mercury loading in Jordan Creek is likely a very long term proposition, decades if not centuries.

Current elevated concentrations of methyl mercury in fish tissue found in Brownlee Reservoir may be, in part, from legacy mercury use in the Silver City area of Jordan Creek (SRHC SBA-TMDL 2004). Prior to construction of the Owyhee Dam, high spring flows from Jordan Creek and the Owyhee River may have transported mercury contaminated sediments to the Snake River. These sediments may have been deposited within the stream substrate of the lower Snake River. With the construction of the Brownlee Dam most sediment is trapped and any attached mercury in the reservoir may be prevented from further migration downstream. Cinnabar is among the native geologic material of the Owhyee Mountains and may contribute mercury due to changing water elevations in Owhyee Reservoir. There are also air sources, including the cement kiln at Durkee, Oregon, whose relative contributions are yet to be determined.

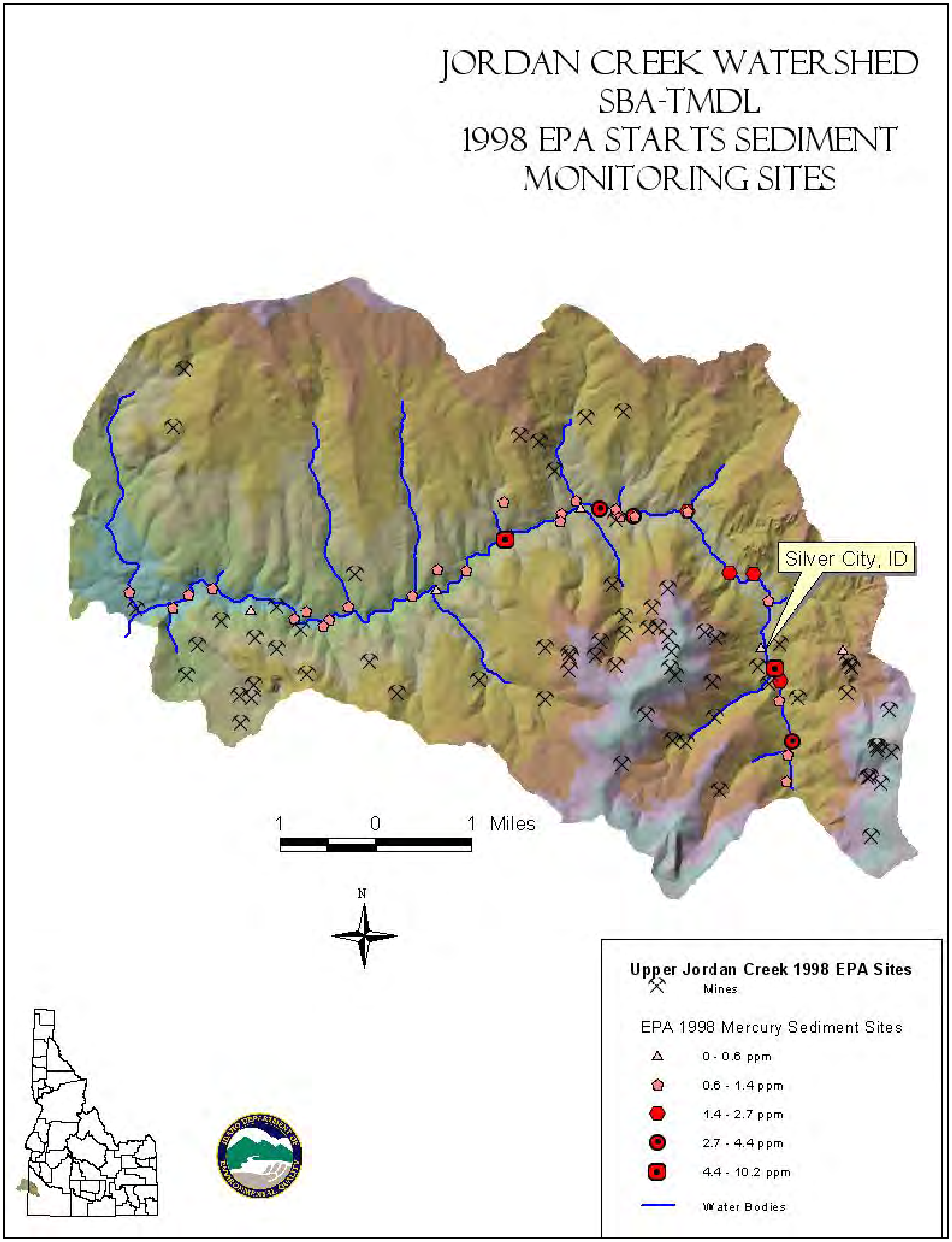


Figure 36. Location of EPA START sampling results and sampling sites in 1998.

Background Mercury Sources

Natural background mercury loading is associated with non-anthropogenic induced erosion from geological features and pre-industrial atmospheric deposition levels. Background mercury loading in the Jordan Creek watershed was extrapolated and includes elevated air deposition of mercury, for which there is no means of control or abatement – an unnatural but non-mining impacted background load that evidence suggests is much lower than that due to historic mining This classification includes loading associated with both regional and global atmospheric deposition in the watershed but produces fish tissue meeting the criterion.

Atmospheric sources contribute to a water body through both the mercury associated with erosion and overland flow and direct deposition on the water surface. The combined geological and atmospheric mercury loading was approached by selecting water bodies from un-mined watersheds that have fish that meet the tissue criterion and have significantly lower mercury concentrations in stream sediments and the water column. The ‘background load’ for these watersheds was used to represent the background load for the entire watershed.

Background was calculated using the data from watersheds identified as having little impact from historic mining/milling activity. The calculated load was determined using the data from sampling in 2005. The total area (in acres) of the watersheds was calculated from the point where discharge and water samples were collected. Area was determined using 10-meter DEM GIS coverages. The watersheds were then delineated with the use of the Automated Geospatial Watershed Assessment (AGWA) v. 1.42, a hydrologic modeling tool for GIS developed by the EPA and the USDA Agriculture Research Service.

With the total area determined and the mercury load calculated in grams/day, a regression analysis was conducted with the predicted mercury load (Y-axis) as a function of the watershed size (X-axis). The resulting predictive equation was then applied to estimate the background load elsewhere in the watershed. Table 32 shows the values used in calculating mercury background loadings for watershed without exceeding the fish tissue criterion.The flow and total mercury measurements are one time only measurements from August 2005. Figure 37 shows the results of the regression analysis.

Table 32. Regression analysis data used for water bodies determined not in exceedance of fish tissue mercury criterion. DEQ 2005.

Background Stations	Total Acres	Total mercury µg/l	Flows cfs	Calculated Load grams/day
East Creek	2,844	0.00076	0.1	0.000186
Williams Creek	5,819	0.00180	1.1	0.004845
Flint Creek	9,495	0.00122	0.2	0.000597
Louse Creek	13,715	0.00140	0.2	0.000685
Boulder-Rock Creeks	18,260	0.00124	3.1	0.009406

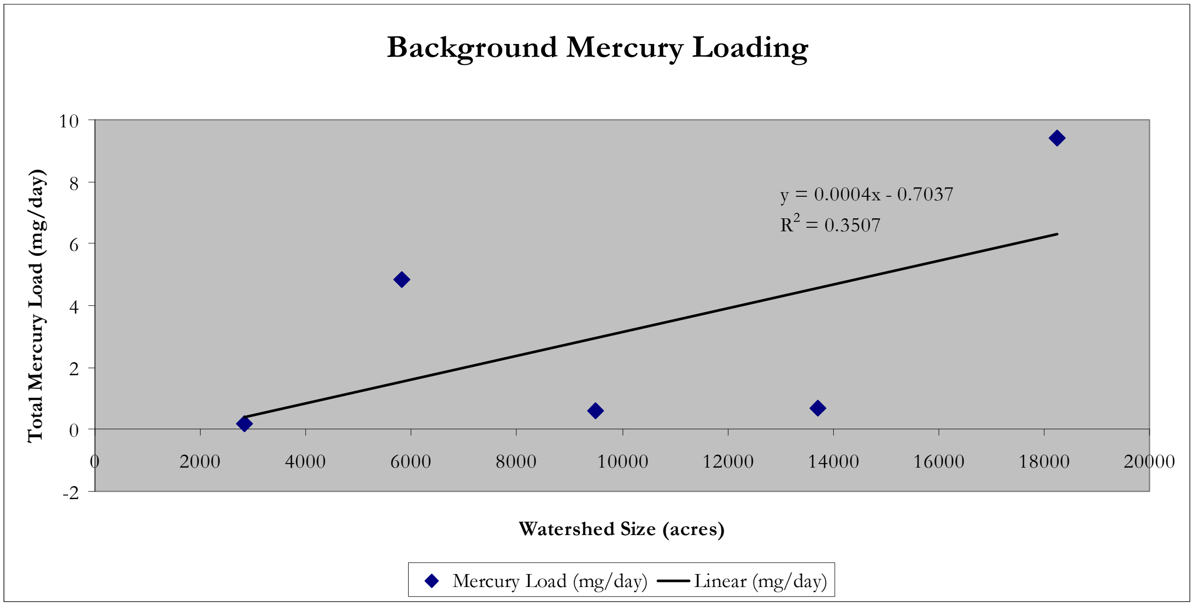


Figure 37. Estimation analysis of background total mercury loading as a function of watershed size.

Watershed size was input to the above formula to calculate background mercury loading. Table 33 shows the results for the estimated background mercury loadings.

Table 33. Estimated background mercury loadings for Jordan Creek.

Site	Total Acres	Estimated Background Mercury Load (mg/day)
Jordan near Stateline	316,000	125.6963[a]
Jordan Below Boulder Cr.	266,366	105.8427
Jordan Below Placer Tailings	28,979	10.8879[a]
Jordan Below Delamar Mine	22,706	8.3787
Jordan Below Blue Gulch	11,521	3.9047
Jordan Below Silver City	5,829	1.6279

a Background analysis calculations do not take in account diversions upstream of location.

The loading analysis presented here is not in terms of the soil's or geology's mercury concentrations [i.e. grams (Hg)/kg (soils)], but a delivery rate of grams (Hg)/day to the water body. This is a simplistic approach with the available data and without applying a complex erosion model. It does provide an analysis of background mercury within the water column and a corresponding load estimate.

Two assumptions were used in this analysis: first, atmospheric deposition of mercury is uniform throughout the Jordan Creek watershed; second, the natural background level of mercury due to erosion from geological features is also uniform in all sub watersheds. In other words, no matter which sub watershed is chosen, the rate of background loading is the same on a per acre basis.

The draft TMDL had errors in Table 32 due to a misalignment of data rows. This subsequently meant that the calculated regression analysis then applied and extrapolated to Figure 37 as a function of watershed area was incorrect. The R^2 value went from .49 to an R^2 of .35 in the final analysis. DEQ did not believe this correleation was strong enough to estimate subwatershed specific background loadings. In light of the dearth of point sources, the overwhelming amount of source loading is either background, air deposition or legacy mining activity. DEQ recommends that at implementation actions for minimizing future mercury loading be focused on stabilizing mercury inputs from legacy mining activities.

It is important to remember that while attempting to identify sources and estimate background loads, the mercury TMDL will be written to achieve Idaho's water quality standard of 0.3 mg/kg methyl mercury in fish tissue.

Soda Creek and Sediments

It is assumed any sediment load to Soda Creek is associated with non-point sources. Sediment load in the watershed is probably linked to stream bank erosion, overland flow, and internal bedload re-suspension. All can be associated with natural background and/or anthropogenic condition. The available data does not provide adequate information to determine a primary source or to calculate a traditional mass/unit/time load analysis.

3.2 Data Gaps

As discussed above, the sources of mercury in the watershed are not easily identified. It is likely that the stream substrate, including the current and historic flood plain, throughout the watershed contains elevated mercury. Additional airborne deposition monitoring and modeling would be helpful.

Point Sources

The effectiveness of BMPs for the area within the KDMC NPDES storm water permit should be evaluated as well as incorporating appropriate detection limits in the the facility's NPDES permit.

Nonpoint Sources

Since the primary source of mercury is believed to be associated with legacy milling activity, additional monitoring is needed in these areas. Likely areas are historic stamp mill sites, arrastra mills, and placer operations in the Blue Gulch area.

Additionally, since the methods employed by mills to recover mercury is not known, sampling of the upper reaches of the soils in the watershed would be helpful. If roasting/retorting methods were employed for the recovery of mercury, this may have provided a source of contamination to soils in the area. Aerial dispersal of mercury into the watershed is a possible source that has not received much attention, but should be considered for future evaluation.

Mapping and sampling of low gradient segments, old meanders, and irrigated areas of Jordan Creek would assist in identifying secondary sources of mercury in contaminated sediments and soils. Attempts to sample sediment profiles at defined depths to quantify mercury contamination and methylation potential is desirable. The potential for transport of mercury through pore water within the Jordan Creek substrate exists and should be studied. The lower trophic biota should be evaluated at the same time as they may prove to be a good marker of areas with elevated levels of mercury. Areas where stream bank erosion occurs should also be mapped and near stream soil/sediment samples collected to determine contribution from areas susceptible to erosion.

Tissue mercury concentrations in large fish in the lower Jordan Creek area could not be determined due to lack of large fish. Therefore, the Analysis of Total mercury Concentrations in Fish Samples from Jordan Creek and Non-Jordan Creek Sites (Dai and Ingham 2005) provided predicted concentrations; however, actual data from fish tissue from lower Jordan Creek would be useful in confirming the estimates. See Appendix H.

Water samples could be collected during low, medium and high discharge periods at multiple locations to determine mercury concentrations associated with sediment transport. This monitoring is difficult, because clean hands techniques would be required and discharge measurements and access may not be possible at all flows.

As with all water quality data gaps, adequate financial resources will be needed for any future analysis and studies.

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

There are no specific prevention or control measures in place or planned to abate the sources of mercury in the stream channel. Best management practices are being applied to those areas described in the KDMC Mine Closure Plan (KDMC 2003). Most of the BMPs applied address storm water management, which will assist in controlling mercury contributions from disturbed areas. Additional past efforts from KDMC have addressed possible historic sources (e.g., abandoned adits and mill/mine tailings) that were located near Jordan Creek.

The BLM is applying grazing BMPs in accordance with conditions described in the Idaho Rangeland Standards and Guidelines. This may have a secondary affect by reducing stream bank erosion within the Jordan Creek watershed.

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5. Total Maximum Daily Load(s)

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 wasteload allocation (WLA); and nonpoint sources, each of which receives a load allocation (LA). Natural background (NB), when present, is considered part of the LA, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR Part 130) require a margin of safety (MOS) be a part of the TMDL.

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

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

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

5.1 In-stream Water Quality Targets

The goal of the TMDL is to restore "full support of designated beneficial uses" on all 303(d) listed streams within the Jordan Creek Watershed. Water quality pollutants of concern for which a TMDL will be written are total mercury, sediment, and temperature:

- For total mercury, the target is based on the percent (%) reduction required to meet the fish tissue criterion of 0.3 mg/kg methyl mercury.
- For sediment in Soda Creek, total suspended solids or suspended sediment targets are based on literature-referenced concentration when discharge measurements are equal to or greater than 1 cfs.
- For temperature TMDLs, a potential natural vegetation (PNV) approach, as explained below, will be used. Idaho water quality standards include a provision (IDAPA 58.01.02.200.09), which establishes that if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered to be a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and the natural level of shade and channel width become the target of the TMDL. The instream temperature that results from attainment of these conditions is consistent with the water quality standards, even though it may exceed numeric temperature criteria.

For further discussion of water quality standards and background provisions, see Appendix B. For further discussion of the PNV approach, see the following.

Potential Natural Vegetation for Temperature TMDLs

There are several important contributors of heat to a stream, including ground water temperature, air temperature, and direct solar radiation (Poole and Berman 2001). Of these, direct solar radiation is the source of heat most likely to be controlled or manipulated. Parameters that affect or control the amount of solar radiation hitting a stream are shade and stream morphology:

- Shade is provided by the surrounding vegetation and other physical features, such as hillsides, canyon walls, terraces, and high banks.
- Stream morphology affects how closely riparian vegetation grows together and water storage in the alluvial aquifer. Streamside vegetation and channel morphology are factors influencing shade and are most likely to have been influenced by anthropogenic activities that can be corrected and addressed by a TMDL.

Depending on how much vertical elevation also surrounds the stream, vegetation further away from the riparian corridor can provide shade. However, riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity.

We can measure the amount of shade that a stream enjoys in a number of ways. Effective shade, that shade provided by all objects that intercept the sun as it makes its way across the sky, can be measured in a given spot with a solar pathfinder or with optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and the stream's aspect. In addition to shade, canopy cover is a similar parameter that affects solar radiation. Canopy cover is the vegetation that hangs directly over the stream, and it can be measured using a densiometer or estimated visually (either on site or on aerial photography.) All of these methods provide information about how much of the stream is covered and how much of it is exposed to direct solar radiation.

Potential Natural Vegetation Concept

Potential natural vegetation (PNV) along a stream is that riparian plant community that has grown to an overall mature state that provides maximum shading. Vegetative shade can be removed by disturbance, either naturally (wildfire, disease/old age, wind-blown, wildlife grazing) or anthropogenically (domestic livestock grazing, vegetation removal, erosion). Our implementation of PNV allows for natural disturbance.

The idea behind PNV as targets for temperature TMDLs is that PNV provides a natural level of solar loading to the stream without any anthropogenic removal of shade producing vegetation. Anything less than PNV results in the stream heating up from anthropogenically created additional solar inputs.

We can estimate PNV from models of plant community structure (shade curves for specific riparian plant communities), and we can measure existing vegetative cover or shade. Comparing the two will tell us how much excess solar load the stream is receiving, and what potential there is to decrease solar gain. Streams disturbed by wildfire require their own time to recover. Streams that have been disturbed by human activity may require additional restoration above and beyond natural recovery.

PNV Applied to Jordan Creek

Existing shade or cover for Jordan Creek and associated tributaries was estimated from visual observations of aerial photos. These estimates were field verified by measuring shade with a solar pathfinder at systematically located points along the streams. (See below for a discussion of the methodology.) PNV targets were determined from an analysis of probable vegetation at the streams, comparing that to shade curves developed for similar vegetation communities in other TMDLs.

A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, shade decreases because the vegetation has less ability to shade the center of wide streams. As vegetation gets taller, it provides more shade at any given channel width.

Existing and PNV shade was converted to solar load, using data collected on flat plate collectors at the nearest National Renewable Energy Laboratory (NREL) weather stations. In this case, the Boise, Idaho weather station was used.

The difference between existing and potential solar load, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards (see Appendix B). PNV shade and loads are assumed to be the natural condition, thus stream temperatures under PNV conditions are assumed to be natural (so long as there are no point sources or any other anthropogenic sources of heat in the watershed), and are thus considered to be consistent with the Idaho water quality standards, even though they may exceed numeric criteria.

Pathfinder Methodology

The solar pathfinder is a device that allows one to trace the outline of shade producing objects on monthly solar path charts. The percentage of the sun's path covered by these objects is the effective shade on the stream at the spot that the tracing is made. To adequately characterize the effective shade on a reach of stream, ten traces should be taken at systematic or random intervals along the length of the stream in question.

At each sampling location, the solar pathfinder should be placed in the middle of the stream about the bankfull water level. Follow the manufacturer's instructions (orient to true south and level) for taking traces. Systematic sampling is easiest to accomplish and still not bias the location of sampling. Start at a unique location such as 100 m from a bridge or fence line and then proceed upstream or downstream stopping to take additional traces at fixed intervals (e.g. every 50m, every 50 paces, every degree change on a GPS, every 0.1 mile change on an odometer, etc.). One can also randomly locate points of measurement by generating random numbers to be used as interval distances.

It is a good idea to measure bankfull widths and take notes while taking solar pathfinder traces and to photograph the stream at several unique locations. Pay special attention to changes in riparian plant communities and what kinds of plant species (the large, dominant, shade producing ones) are present. Additionally, or as a substitution, one can take densiometer readings at the same location as solar pathfinder traces. These readings provide the potential to develop relationships between canopy cover and effective shade for a given stream.

Aerial Photo Interpretation

Canopy coverage estimates or expectations of shade based on plant type and density are provided for natural breaks in vegetation density, marked out on a 1:250K hydrography. Each interval is assigned a single value representing the bottom of a10%-canopy coverage or shade class as described below (*adapted from the CWE process, IDL, 2000)*.

For example, if we estimate that canopy cover for a particular stretch of stream is somewhere between 50% and 59%, we assign the value of 50% to that section of stream. The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and the width of the stream.

The typical vegetation type (Table 34) shows the kind of landscape a particular cover class usually falls into for a stream 5m wide or less. For example, if a section of a 5m wide stream is identified as 20% cover class, it is usually because it is in agricultural land, meadows, open areas, or clearcuts. However, that does not mean that the 20% cover class cannot occur in shrublands and forests, because it does on wider streams.

Table 34. Typical vegetation type by cover class.

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

It is important to note that the visual estimates made from the aerial photos are strongly influenced by canopy cover. It is not always possible to visualize or anticipate shade characteristics resulting from topography and landform. We assume that canopy coverage and shade are similar based on research conducted by Oregon DEQ.

The visual estimates of ‘shade’ in this TMDL were field verified with a solar pathfinder. The pathfinder measures effective shade and takes into consideration other physical features that block the sun from hitting the stream surface (e.g. hillsides, canyon walls, terraces, man-made structures). The estimate of ‘shade’ made visually from an aerial photo does not always take into account topography or any shading that may occur from physical features other than vegetation. However, research has shown that shade and cover measurements are remarkably similar (OWEB, 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade.

Stream Morphology

Measures of current bankfull width or near stream disturbance zone width may not reflect widths that were present under PNV. As impacts to streams and riparian areas occur, width-to-depth ratios tend to increase such that streams become wider and shallow. Shadow length produced by vegetation covers a lower percentage of the water surface in wider streams, and widened streams can also have less vegetative cover if shoreline vegetation has been eroded away.

The only factor not developed from the aerial photo work presented above is channel width (i.e., NSDZ or Bankfull Width). Accordingly, this parameter must be estimated from available information. We use regional curves for the major basins in Idaho, data compiled by Diane Hopster of Idaho Department of Lands (Figure 38).

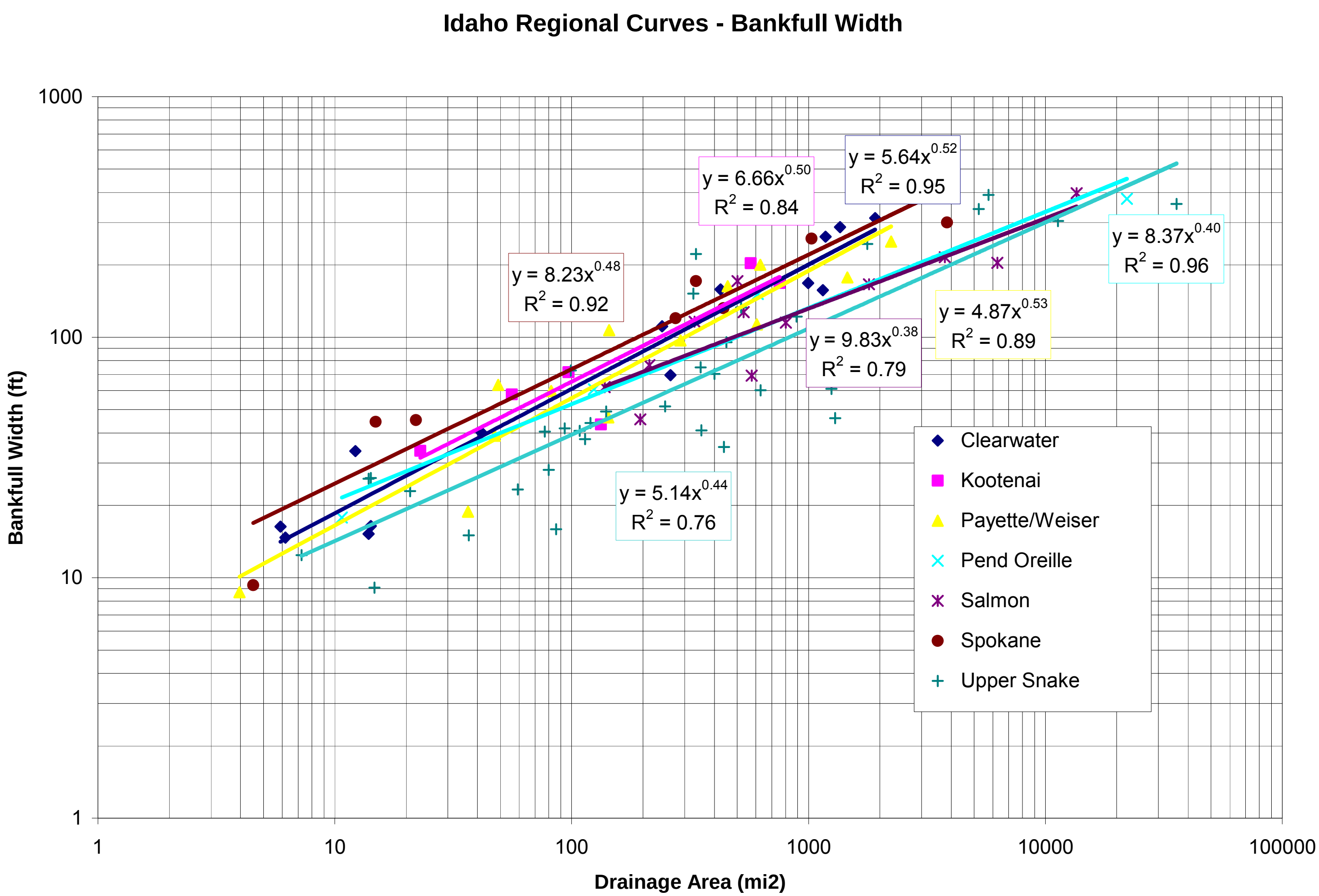

Figure 38. Bankfull width as a function of drainage area.

For each stream evaluated in this loading analysis, bankfull width is estimated based on drainage area of the Upper Snake curve from Figure 38. Although Jordan Creek is not within the Upper Snake region, this regional curve is most representative of the area's low precipitation and basalt-influenced geomorphology. Additionally, existing width is evaluated from available data:

- If the stream's existing width is equal to or larger than that predicted by the Upper Snake curve, then the estimate of bankfull width is used in the loading analysis for natural width in the loading analysis.
- If the existing width is smaller, then existing width is used in the loading analysis for natural width. In most cases, existing width data were almost identical to curve estimates (Table 35), hence curve estimates are used in this analysis.

Table 35. Drainage Area Estimates of Bankfull Width based on the Upper Snake Regional Curve (US) and Existing Data.

Location	area (sq mi)	US (m)	existing (m)
Jordan Cr @ OR/ID	519	25	
Jordan Cr ab Big Boulder Cr	115	13	
Louse Cr @ mouth	21.5	6	6.8
Jordan Cr ab Louse Cr	51.9	9	7.5
Jordan Cr ab DeLamar	31.3	7	6.5
Jordan Cr ab Silver City	6.47	4	4.8
Soda Cr @ mouth	22.5	6	
Cow Cr ab Soda Cr	14.4	5	
Cow Cr @ OR/ID	65.3	10	11.4
Louisa Cr @ mouth	9.02	4	
Rock Cr ab Triangle Reservoir	45.3	8	6.1
Rock Cr bl Meadow Cr	110	12	12.4
Rock Cr @ mouth	166	15	
Meadow Cr @ mouth	38.4	8	
Meadow Cr ab Spencer Res.	23.5	6	
Meadow Cr ab road	15.1	5	
Spring Cr @ mouth	13	5	
Spring Cr bl tributary	4.21	3	
Spring Cr ab tributary	2.54	2	

Design Conditions

Design conditions for achieving the TMDL targets for mercury, sediment, and temperature are described in the following.

Mercury

The mercury TMDL is designed to achieve compliance with the mercury human health criteria (HH) in Jordan Creek, and DEQ will use five different locations to judge whether appropriate reductions have occurred. The EPA approved human health fish tissue criterion in Idaho is its sole water quality criterion for mercury and was developed by EPA (EPA 2001). Idaho further protects its aquatic life through application of its narrative criteria prohibition on toxics in amounts that would impair aquatic life. While this criterion provides a direct link to public health, it also provides protection of aquatic dependent life when applied to the highest trophic level of fish (Implementation Guidance for the Idaho Mercury Water Quality Criteria, DEQ 2005)

Movement of mercury in a lotic environment is a complex and not fully understood science. It may be that the primary source of elemental mercury is not so much the problem as the production of organic methyl mercury (methylation) in areas as far away from the primary sources. Understanding the transport of mercury from the primary source is complex, and is not within the scope of this document. Nor is examination of mercury methylation and bioaccumulation beyond Idaho's borders.

The critical period affecting mercury bioaccumulation in the fish of Jordan Creek occurs when water temperatures, dissolved oxygen, and other factors favor methylation. These periods are usually during summer months when water temperatures are warmer, dissolved oxygen concentrations decrease and microbial activity increases in the sediments. Methylation involves certain biological, physical, and chemical conditions and likely occurs where mercury laden sediment has been deposited. These areas include wetted margins, flood plains, in-stream low gradient segments, and impoundments. However, the process of bioaccumulation integrates environmental exposure over space and time, making seasonality of methylation uncritical to accumulated fish tissue levels.

Design of the TMDL for mercury takes the approach that the reduction in total mercury load at any given time (temporal) needs to equal the reduction in fish tissue mercury levels required to achieve the fish tissue criterion. It is an assumption that the total mercury load reductions will produce a commensurate reduction in fish tissue mercury. While this reduction may not occur immediately—because other conditions, such as temperature, pH, and organic matter have also changed to increase methylation rates— ultimately fish tissue mercury levels should drop and aquatic life is thus protected. If fish tissue mercury levels do not respond to total mercury loading reductions there is no point in specifying a total maxiumum daily load for mercury.

Sediments

The design for the sediment load reductions for Soda Creek is based on water column concentrations of sediment that have been determined not to affect the biology of the water body.

Temperature

Riparian plant communities in the Jordan Creek subbasin are typical of many southern Idaho streams with headwaters in higher elevation, open coniferous forests or forest/meadow type vegetation to predominately willow dominated shrub communities at lower elevations. Also, grass meadow complexes with a minor shrub component occur at various places where springs influence stream flow or where streams submerge and flow largely just below ground level. Streams in southwestern Idaho can be intermittent or ephemeral in places along its course from headwaters to mouth. Thus, there will be periodic dry spots where it does not appear that the stream flows above ground at any time other than during snow melt.

To describe the system potential shading characteristics for streams in the Jordan Creek subbasin, we have developed shade targets for five basic vegetation types:

1. a coniferous forest type occurring at high elevations on Jordan Creek;

2. a conifer/shrub type that is often very open in canopy density and may contain junipers with or without other conifers;
3. a higher elevation mixed deciduous shrub type consisting of a variety of species including aspens, alders, willows, and dogwoods;
4. a lower elevation mixed deciduous shrub type that is predominantly willows; and
5. a grass dominated meadow type that may have small stature shrubs as a minor component.

Target Selection

Mercury, as total mercury, total suspended solids/suspended sediments (TSS/SS) and heat, as affected by Potential Natural Vegetation, are the pollutants for which TMDLs have been developed in the Jordan Creek watershed. The two water bodies to have TMDLs are Jordan Creek, headwaters to the Oregon state line for mercury and temperature, and Soda Creek, headwaters to Cow Creek for sediment.

Mercury

In-stream water quality targets are based on the percent (%) reduction of total mercury required to meet the fish tissue criterion of 0.3 mg/kg methyl mercury, plus a margin of safety (20%). Thus the 0.24 mg/kg target should achieve an acceptable methyl mercury level protective of human health and aquatic life.

Sediments

For Soda Creek, sediments and total suspended solids or suspended sediment targets are based on literature-referenced concentrations when discharge measurements are equal to or greater than 1 cfs.

Temperature

To determine potential natural vegetation shade targets for the Jordan Creek subbasin, effective shade curves developed specifically for Idaho vegetation types were examined. These shade curves were developed by DEQ and EPA, using vegetation community modeling of Idaho specific data and are presented in the Idaho DEQ's procedures manual on PNV-style TMDLs (Shumar and De Varona, 2009). Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis.

As a stream becomes wider, a given vegetation type loses its ability to shade wider and wider streams. Although these TMDLs reflect a wide variety of geomorphologies and topographies, effective shades at the same stream width were remarkably similar.

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

Shade Curves

For the conifer vegetation type and the subsequent conifer/shrub vegetation type, we selected two shade curves developed for potential vegetation groups (PVGs) in the Boise National Forest. Although the Owyhee Mountains are not in a National Forest system, the Boise Front Range of the Boise National Forest some 90 km to the northeast was a comparable substitute. The dominant PVGs in the Boise Mountains are the cool, moist Douglas fir (PVG3) zone at the highest elevations and the warm, dry Douglas fir/moist Ponderosa pine (PVG2) zone on remaining portions of the conifer zone. Thus, we chose to use the PVG3 shade curve at the highest conifer zone in the Jordan Creek analysis and the PVG2 shade curve for the next conifer/shrub zone.

The high elevation mixed deciduous shrub type represents a wide variety of tree and shrub dominated riparian types in the subbasin. From the non-forest shade curves developed by DEQ for southern Idaho (Shumar and De varona, 2009), we chose the mountain alder shade curve to represent this next zone of higher elevation shrubs. The mountain alder shade curve is based on a plant community consisting of several conifer species, mountain alder, water birch, and dogwood.

The low elevation mixed deciduous shrub type represents a wide variety of willow dominated riparian types in the subbasin where trees are not present. From our experience in southern Idaho, this vegetation zone is typically dominated by yellow willow (*Salix lutea*), although coyote willow (*S. exigua*) is often a dominant component. From the non-forest shade curves developed by DEQ for southern Idaho (Shumar and De Varona, 2009), we chose the yellow willow shade curve to represent this lower elevation shrub zone. The yellow willow shade curve is based on a plant community of yellow willow, coyote (or sandbar) willow, and dogwood species.

The graminoid shade curve from the southern Idaho non-forest shade curves developed by DEQ (Shumar and De varona, 2009) was useful in describing shade targets for the meadow vegetation type. This is a curve based on 100% cover of graminoid species with an average height of 70cm.

Monitoring Points

Mercury

Future monitoring should focus on the evaluation of mercury concentrations in fish tissue to track achievement of the TMDL goal. Since fish have a tendency to move during their life, fish found in a particular location may not be a resident population from year to year.

Fish movement can be affected by many factors, including water temperature, water availability and spawning preference. With this in mind, fish tissue collection should include both water bodies determined in the SBA as non-impacted as well as those impacted by mercury sources in the subbasin. The evaluation of non-impacted water bodies will assist in tracking changes not associated with historic use of mercury for gold and silver extraction, the primary source in the watershed, as well as impacts from airborne deposition.

Sediments

Sediment monitoring, in the form of either TSS or SS, on Soda Creek should be conducted as soon as possible. The current water column sediment load is not known. Target selection is based on literature referenced material and other established sediment TMDLs in Idaho. Future monitoring should focus on both water column concentrations and evaluation of the response of the biological communities and structures.

Temperature

Accuracy of aerial photo interpretations were field verified against 52 solar pathfinder traces at six sites. When compared to the original aerial photo interpretations, field measurements of shade differed from photo estimates by 10% ± 8.47 (mean ± 95% C.I.). As a result, the original aerial photo interpretations were re-examined and in most cases estimates were decreased by one 10% class interval.

Existing shade estimates shown in this document represent these corrected values. Additionally, locations on Cow Creek and Meadow Creek were adjusted based on shade data provided by Duane LaFayette, ISCD.

Effective shade monitoring can take place on any reach throughout the Jordan Creek subbasin and is compared to estimates of existing shade, seen in Figure 39 and Figure 43 and described in Table 36 through Table 42. Those areas with the largest disparity between existing shade estimates and shade targets should be monitored with solar pathfinders to verify the existing shade levels and to determine progress towards meeting shade targets. Table 36 through Table 42 show the PNV shade targets (identified as Target or Potential Shade) and their corresponding potential summer load (in $kWh/m^2/day$ and kWh/day) that serve as the loading capacities for the streams. Potential loads vary from 4.3 million kWh/day on Jordan Creek (Table 36), the largest creek examined, to 58,783 kWh/day on Louisa Creek (Table 40).

It is important to note that many existing shade estimates have not been field verified, and may require adjustment during the implementation process. Stream segments for each change in existing shade vary in length depending on land use or landscape that has affected that shade level. It is appropriate to monitor within a given existing shade segment to see if that segment has increased its existing shade towards target levels. Ten equally spaced solar pathfinder measurements within that segment averaged together should suffice to determine new shade levels in the future.

Table 36. Existing and Potential Solar Loads for Jordan Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Jordan Creek
320	0.9	0.638	0.96	0.2552	-0.38	1	1	320	204.16	320	81.664	-122.496	-6	cool, moist Douglas fir
80	0.7	1.914	0.96	0.2552	-1.6588	1	1	80	153.12	80	20.416	-132.704	-26	PVG3
170	0.9	0.638	0.96	0.2552	-0.3828	1	1	170	108.46	170	43.384	-65.076	-6	
130	0.7	1.914	0.96	0.2552	-1.6588	1	1	130	248.82	130	33.176	-215.644	-26	
420	0.8	1.276	0.96	0.2552	-1.0208	1	1	420	535.92	420	107.184	-428.736	-16	
470	0.6	2.552	0.78	1.4036	-1.1484	2	2	940	2398.88	940	1319.384	-1079.496	-18	warm,dry Douglas fir
120	0.7	1.914	0.78	1.4036	-0.5104	2	2	240	459.36	240	336.864	-122.496	-8	moist Ponderosa pine
280	0.6	2.552	0.78	1.4036	-1.1484	2	2	560	1429.12	560	786.016	-643.104	-18	PVG2
220	0.7	1.914	0.78	1.4036	-0.5104	2	2	440	842.16	440	617.584	-224.576	-8	
870	0.6	2.552	0.7	1.914	-0.638	3	3	2610	6660.72	2610	4995.54	-1665.18	-10	
90	0.8	1.276	0.93	0.4466	-0.8294	3	3	270	344.52	270	120.582	-223.938	-13	PVG3
190	0.6	2.552	0.7	1.914	-0.638	3	3	570	1454.64	570	1090.98	-363.66	-10	PVG2
130	0.7	1.914	0.7	1.914	0	3	3	390	746.46	390	746.46	0	0	
960	0.6	2.552	0.59	2.6158	0.0638	4	4	3840	9799.68	3840	10044.672	244.992	0	mountain alder
890	0.5	3.19	0.59	2.6158	-0.5742	4	4	3560	11356.4	3560	9312.248	-2044.152	-9	
270	0.4	3.828	0.59	2.6158	-1.2122	4	4	1080	4134.24	1080	2825.064	-1309.176	-19	
490	0.6	2.552	0.5	3.19	0.638	5	5	2450	6252.4	2450	7815.5	1563.1	0	
210	0.5	3.19	0.5	3.19	0	5	5	1050	3349.5	1050	3349.5	0	0	
310	0.3	4.466	0.5	3.19	-1.276	5	5	1550	6922.3	1550	4944.5	-1977.8	-20	
120	0	6.38	0.5	3.19	-3.19	5	5	600	3828	600	1914	-1914	-50	
220	0.1	5.742	0.5	3.19	-2.552	5	5	1100	6316.2	1100	3509	-2807.2	-40	
170	0.2	5.104	0.5	3.19	-1.914	5	5	850	4338.4	850	2711.5	-1626.9	-30	
130	0.4	3.828	0.5	3.19	-0.638	5	5	650	2488.2	650	2073.5	-414.7	-10	
150	0.3	4.466	0.5	3.19	-1.276	5	5	750	3349.5	750	2392.5	-957	-20	
350	0.5	3.19	0.5	3.19	0	5	5	1750	5582.5	1750	5582.5	0	0	
340	0.4	3.828	0.5	3.19	-0.638	5	5	1700	6507.6	1700	5423	-1084.6	-10	
720	0.6	2.552	0.55	2.871	0.319	5	5	3600	9187.2	3600	10335.6	1148.4	0	PVG2
260	0.5	3.19	0.55	2.871	-0.319	5	5	1300	4147	1300	3732.3	-414.7	-5	
370	0.3	4.466	0.55	2.871	-1.595	5	5	1850	8262.1	1850	5311.35	-2950.75	-25	
610	0.4	3.828	0.5	3.19	-0.638	6	6	3660	14010.48	3660	11675.4	-2335.08	-10	

2840	0.3	4.466	0.43	3.6366	-0.8294	6	6	17040	76100.64	17040	61967.664	-14132.976	-13	mountain alder
460	0.4	3.828	0.43	3.6366	-0.1914	6	6	2760	10565.28	2760	10037.016	-528.264	-3	
360	0.5	3.19	0.43	3.6366	0.4466	6	6	2160	6890.4	2160	7855.056	964.656	0	
220	0.4	3.828	0.38	3.9556	0.1276	7	7	1540	5895.12	1540	6091.624	196.504	0	
530	0.3	4.466	0.38	3.9556	-0.5104	7	7	3710	16568.86	3710	14675.276	-1893.584	-8	
1310	0.4	3.828	0.38	3.9556	0.1276	7	7	9170	35102.76	9170	36272.852	1170.092	0	
620	0.3	4.466	0.38	3.9556	-0.5104	7	7	4340	19382.44	4340	17167.304	-2215.136	-8	
170	0.2	5.104	0.38	3.9556	-1.1484	7	7	1190	6073.76	1190	4707.164	-1366.596	-18	
420	0.3	4.466	0.38	3.9556	-0.5104	7	7	2940	13130.04	2940	11629.464	-1500.576	-8	
1140	0.5	3.19	0.38	3.9556	0.7656	7	7	7980	25456.2	7980	31565.688	6109.488	0	
200	0.4	3.828	0.34	4.2108	0.3828	8	8	1600	6124.8	1600	6737.28	612.48	0	
560	0.5	3.19	0.34	4.2108	1.0208	8	8	4480	14291.2	4480	18864.384	4573.184	0	
730	0.4	3.828	0.34	4.2108	0.3828	8	8	5840	22355.52	5840	24591.072	2235.552	0	
360	0.3	4.466	0.34	4.2108	-0.2552	8	8	2880	12862.08	2880	12127.104	-734.976	-4	
320	0.4	3.828	0.34	4.2108	0.3828	8	8	2560	9799.68	2560	10779.648	979.968	0	
520	0.3	4.466	0.34	4.2108	-0.2552	8	8	4160	18578.56	4160	17516.928	-1061.632	-4	
450	0.4	3.828	0.34	4.2108	0.3828	8	8	3600	13780.8	3600	15158.88	1378.08	0	
640	0.5	3.19	0.34	4.2108	1.0208	8	8	5120	16332.8	5120	21559.296	5226.496	0	
200	0.4	3.828	0.34	4.2108	0.3828	8	8	1600	6124.8	1600	6737.28	612.48	0	
1250	0.2	5.104	0.34	4.2108	-0.8932	8	8	10000	51040	10000	42108	-8932	-14	
270	0.3	4.466	0.34	4.2108	-0.2552	8	8	2160	9646.56	2160	9095.328	-551.232	-4	
640	0.2	5.104	0.34	4.2108	-0.8932	8	8	5120	26132.48	5120	21559.296	-4573.184	-14	
3030	0.1	5.742	0.31	4.4022	-1.3398	9	9	27270	156584.34	27270	120047.994	-36536.346	-21	
360	0	6.38	0.31	4.4022	-1.9778	9	9	3240	20671.2	3240	14263.128	-6408.072	-31	
1390	0.1	5.742	0.31	4.4022	-1.3398	9	9	12510	71832.42	12510	55071.522	-16760.898	-21	
2180	0.2	5.104	0.31	4.4022	-0.7018	9	9	19620	100140.48	19620	86371.164	-13769.316	-11	
740	0.3	4.466	0.31	4.4022	-0.0638	9	9	6660	29743.56	6660	29318.652	-424.908	-1	
570	0.2	5.104	0.31	4.4022	-0.7018	9	9	5130	26183.52	5130	22583.286	-3600.234	-11	
910	0.4	3.828	0.31	4.4022	0.5742	9	9	8190	31351.32	8190	36054.018	4702.698	0	
460	0.3	4.466	0.22	4.9764	0.5104	10	10	4600	20543.6	4600	22891.44	2347.84	0	yellow willow
320	0.1	5.742	0.22	4.9764	-0.7656	10	10	3200	18374.4	3200	15924.48	-2449.92	-12	
910	0	6.38	0.22	4.9764	-1.4036	10	10	9100	58058	9100	45285.24	-12772.76	-22	
3590	0	6.38	0.2	5.104	-1.276	11	11	39490	251946.2	39490	201556.96	-50389.24	-20	
980	0.1	5.742	0.19	5.1678	-0.5742	12	12	11760	67525.92	11760	60773.328	-6752.592	-9	
3340	0	6.38	0.19	5.1678	-1.2122	12	12	40080	255710.4	40080	207125.424	-48584.976	-19	
920	0.1	5.742	0.18	5.2316	-0.5104	13	13	11960	68674.32	11960	62569.936	-6104.384	-8	
1060	0	6.38	0.18	5.2316	-1.1484	13	13	13780	87916.4	13780	72091.448	-15824.952	-18	
2800	0.1	5.742	0.15	5.423	-0.319	15	15	42000	241164	42000	227766	-13398	-5	
970	0	6.38	0.12	5.6144	-0.7656	20	20	19400	123772	19400	108919.36	-14852.64	-12	
1480	0.1	5.742	0.12	5.6144	-0.1276	20	20	29600	169963.2	29600	166186.24	-3776.96	-2	
15440	0	6.38	0.09	5.8058	-0.5742	50	25	772000	4925360	386000	2241038.8	-2684321.2	-9	
							Total	**1,220,020**	**7,273,168**	**834,020**	**4,307,893**	**-2,965,275**	**-10**	

Table 37. Existing and Potential Solar Loads for Cow Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Cow Creek**
650	0.8	1.276	0.79	1.3398	0.06	1	1	650	829.4	650	870.87	41.47	0	warm,dry Douglas fir
1170	0.7	1.914	0.79	1.3398	-0.5742	1	1	1170	2239.38	1170	1567.566	-671.814	-9	moist Ponderosa pine
430	0.8	1.276	0.79	1.3398	0.0638	1	1	430	548.68	430	576.114	27.434	0	PVG2
180	0.6	2.552	0.79	1.3398	-1.2122	1	1	180	459.36	180	241.164	-218.196	-19	
520	0.8	1.276	0.78	1.4036	0.1276	2	2	1040	1327.04	1040	1459.744	132.704	0	
270	0.7	1.914	0.78	1.4036	-0.5104	2	2	540	1033.56	540	757.944	-275.616	-8	
250	0.4	3.828	0.86	0.8932	-2.9348	2	2	500	1914	500	446.6	-1467.4	-46	mountain alder
280	0.6	2.552	0.86	0.8932	-1.6588	2	2	560	1429.12	560	500.192	-928.928	-26	
170	0.4	3.828	0.86	0.8932	-2.9348	2	2	340	1301.52	340	303.688	-997.832	-46	
180	0.7	1.914	0.78	1.4036	-0.5104	2	2	360	689.04	360	505.296	-183.744	-8	PVG2
830	0.6	2.552	0.86	0.8932	-1.6588	2	2	1660	4236.32	1660	1482.712	-2753.608	-26	mountain alder
160	0.4	3.828	0.72	1.7864	-2.0416	3	3	480	1837.44	480	857.472	-979.968	-32	
550	0.5	3.19	0.72	1.7864	-1.4036	3	3	1650	5263.5	1650	2947.56	-2315.94	-22	
400	0.4	3.828	0.72	1.7864	-2.0416	3	3	1200	4593.6	1200	2143.68	-2449.92	-32	
110	0.1	5.742	0.72	1.7864	-3.9556	3	3	330	1894.86	330	589.512	-1305.348	-62	
260	0.4	3.828	0.72	1.7864	-2.0416	3	3	780	2985.84	780	1393.392	-1592.448	-32	
320	0.3	4.466	0.72	1.7864	-2.6796	3	3	960	4287.36	960	1714.944	-2572.416	-42	
490	0.2	5.104	0.72	1.7864	-3.3176	3	3	1470	7502.88	1470	2626.008	-4876.872	-52	
650	0.5	3.19	0.59	2.6158	-0.5742	4	4	2600	8294	2600	6801.08	-1492.92	-9	
290	0.2	5.104	0.16	5.3592	0.2552	4	4	1160	5920.64	1160	6216.672	296.032	0	meadow
1540	0.1	5.742	0.16	5.3592	-0.3828	4	4	6160	35370.72	6160	33012.672	-2358.048	-6	grass
230	0.2	5.104	0.39	3.8918	-1.2122	5	5	1150	5869.6	1150	4475.57	-1394.03	-19	yellow willow
660	0.6	2.552	0.39	3.8918	1.3398	5	5	3300	8421.6	3300	12842.94	4421.34	0	
920	0.1	5.742	0.13	5.5506	-0.1914	5	5	4600	26413.2	4600	25532.76	-880.44	-3	meadow
410	0.4	3.828	0.13	5.5506	1.7226	5	5	2050	7847.4	2050	11378.73	3531.33	0	grass
510	0.1	5.742	0.13	5.5506	-0.1914	5	5	2550	14642.1	2550	14154.03	-488.07	-3	
890	0.3	4.466	0.34	4.2108	-0.2552	6	6	5340	23848.44	5340	22485.672	-1362.768	-4	yellow willow
570	0	6.38	0.27	4.6574	-1.7226	8	8	4560	29092.8	4560	21237.744	-7855.056	-27	
200	0.1	5.742	0.27	4.6574	-1.0846	8	8	1600	9187.2	1600	7451.84	-1735.36	-17	
5270	0.1	5.742	0.07	5.9334	0.1914	10	10	52700	302603.4	52700	312690.18	10086.78	0	meadow
							Total	**102,070**	**521,884**	**102,070**	**499,264**	**-22,620**	**-18**	

Table 38. Existing and Potential Solar Loads for Soda Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Soda Creek**
1180	0.7	1.914	0.73	1.7226	-0.1914	2	2	2360	4517.04	2360	4065.336	-451.704	-3	yellow willow
360	0.4	3.828	0.46	3.4452	-0.3828	4	4	1440	5512.32	1440	4961.088	-551.232	-6	
360	0.2	5.104	0.39	3.8918	-1.2122	5	5	1800	9187.2	1800	7005.24	-2181.96	-19	
190	0.1	5.742	0.39	3.8918	-1.8502	5	5	950	5454.9	950	3697.21	-1757.69	-29	
450	0	6.38	0.39	3.8918	-2.4882	5	5	2250	14355	2250	8756.55	-5598.45	-39	
360	0.1	5.742	0.39	3.8918	-1.8502	5	5	1800	10335.6	1800	7005.24	-3330.36	-29	
510	0.3	4.466	0.39	3.8918	-0.5742	5	5	2550	11388.3	2550	9924.09	-1464.21	-9	
50	0	6.38	0.34	4.2108	-2.1692	6	6	300	1914	300	1263.24	-650.76	-34	
150	0.3	4.466	0.34	4.2108	-0.2552	6	6	900	4019.4	900	3789.72	-229.68	-4	
420	0.1	5.742	0.34	4.2108	-1.5312	6	6	2520	14469.84	2520	10611.216	-3858.624	-24	
540	0	6.38	0.34	4.2108	-2.1692	6	6	3240	20671.2	3240	13642.992	-7028.208	-34	
460	0.2	5.104	0.34	4.2108	-0.8932	6	6	2760	14087.04	2760	11621.808	-2465.232	-14	
							Total	**22,870**	**115,912**	**22,870**	**86,344**	**-29,568**	**-20**	

Table 39. Existing and Potential Solar Loads for Rock Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Rock Creek
1240	0.1	5.742	0.55	2.871	-2.87	1	1	1240	7120.08	1240	3560.04	-3560.04	-45	Meadow grass
270	0.3	4.466	0.55	2.871	-1.595	1	1	270	1205.82	270	775.17	-430.65	-25	
870	0.1	5.742	0.55	2.871	-2.871	1	1	870	4995.54	870	2497.77	-2497.77	-45	
880	0	6.38	0.55	2.871	-3.509	1	1	880	5614.4	880	2526.48	-3087.92	-55	
870	0.1	5.742	0.31	4.4022	-1.3398	2	2	1740	9991.08	1740	7659.828	-2331.252	-21	
160	0.2	5.104	0.73	1.7226	-3.3814	2	2	320	1633.28	320	551.232	-1082.048	-53	Yellow willow
160	0.1	5.742	0.73	1.7226	-4.0194	2	2	320	1837.44	320	551.232	-1286.208	-63	
230	0.2	5.104	0.73	1.7226	-3.3814	2	2	460	2347.84	460	792.396	-1555.444	-53	
480	0.1	5.742	0.31	4.4022	-1.3398	2	2	960	5512.32	960	4226.112	-1286.208	-21	Meadow grass
540	0.2	5.104	0.31	4.4022	-0.7018	2	2	1080	5512.32	1080	4754.376	-757.944	-11	
420	0.1	5.742	0.31	4.4022	-1.3398	2	2	840	4823.28	840	3697.848	-1125.432	-21	
470	0	6.38	0.56	2.8072	-3.5728	3	3	1410	8995.8	1410	3958.152	-5037.648	-56	Yellow willow
190	0.2	5.104	0.56	2.8072	-2.2968	3	3	570	2909.28	570	1600.104	-1309.176	-36	
290	0.1	5.742	0.56	2.8072	-2.9348	3	3	870	4995.54	870	2442.264	-2553.276	-46	
220	0	6.38	0.56	2.8072	-3.5728	3	3	660	4210.8	660	1852.752	-2358.048	-56	
120	0.1	5.742	0.56	2.8072	-2.9348	3	3	360	2067.12	360	1010.592	-1056.528	-46	
110	0	6.38	0.56	2.8072	-3.5728	3	3	330	2105.4	330	926.376	-1179.024	-56	
100	0.1	5.742	0.56	2.8072	-2.9348	3	3	300	1722.6	300	842.16	-880.44	-46	
540	0.2	5.104	0.56	2.8072	-2.2968	3	3	1620	8268.48	1620	4547.664	-3720.816	-36	
590	0.1	5.742	0.56	2.8072	-2.9348	3	3	1770	10163.34	1770	4968.744	-5194.596	-46	
2210	0.3	4.466	0.46	3.4452	-1.0208	4	4	8840	39479.44	8840	30455.568	-9023.872	-16	
1560	0.4	3.828	0.39	3.8918	0.0638	5	5	7800	29858.4	7800	30356.04	497.64	0	
230	0.3	4.466	0.39	3.8918	-0.5742	5	5	1150	5135.9	1150	4475.57	-660.33	-9	
1050	0.2	5.104	0.39	3.8918	-1.2122	5	5	5250	26796	5250	20431.95	-6364.05	-19	
520	0.3	4.466	0.34	4.2108	-0.2552	6	6	3120	13933.92	3120	13137.696	-796.224	-4	
560	0.4	3.828	0.34	4.2108	0.3828	6	6	3360	12862.08	3360	14148.288	1286.208	0	
510	0.2	5.104	0.34	4.2108	-0.8932	6	6	3060	15618.24	3060	12885.048	-2733.192	-14	
320	0.1	5.742	0.34	4.2108	-1.5312	6	6	1920	11024.64	1920	8084.736	-2939.904	-24	
750	0	6.38	0.34	4.2108	-2.1692	6	6	4500	28710	4500	18948.6	-9761.4	-34	
380	0.1	5.742	0.3	4.466	-1.276	7	7	2660	15273.72	2660	11879.56	-3394.16	-20	
1420	0.4	3.828	0.3	4.466	0.638	7	7	9940	38050.32	9940	44392.04	6341.72	0	
360	0.3	4.466	0.3	4.466	0	7	7	2520	11254.32	2520	11254.32	0	0	
250	0.1	5.742	0.3	4.466	-1.276	7	7	1750	10048.5	1750	7815.5	-2233	-20	
900	0.2	5.104	0.3	4.466	-0.638	7	7	6300	32155.2	6300	28135.8	-4019.4	-10	
4020	0.4	3.828	0.27	4.6574	0.8294	8	8	32160	123108.48	32160	149781.984	26673.504	0	
1380	0.3	4.466	0.24	4.8488	0.3828	9	9	12420	55467.72	12420	60222.096	4754.376	0	
150	0.5	3.19	0.22	4.9764	1.7864	10	10	1500	4785	1500	7464.6	2679.6	0	
440	0.2	5.104	0.22	4.9764	-0.1276	10	10	4400	22457.6	4400	21896.16	-561.44	-2	
340	0.1	5.742	0.22	4.9764	-0.7656	10	10	3400	19522.8	3400	16919.76	-2603.04	-12	
990	0	6.38	0.22	4.9764	-1.4036	10	10	9900	63162	9900	49266.36	-13895.64	-22	
1190	0.1	5.742	0.2	5.104	-0.638	11	11	13090	75162.78	13090	66811.36	-8351.42	-10	
1940	0	6.38	0.19	5.1678	-1.2122	12	12	23280	148526.4	23280	120306.384	-28220.016	-19	
670	0	6.38	0.19	5.1678	-1.2122	12	12	8040	51295.2	8040	41549.112	-9746.088	-19	
2330	0	6.38	0.18	5.2316	-1.1484	13	13	30290	193250.2	30290	158465.164	-34785.036	-18	
490	0.1	5.742	0.17	5.2954	-0.4466	14	14	6860	39390.12	6860	36326.444	-3063.676	-7	
610	0	6.38	0.17	5.2954	-1.0846	14	14	8540	54485.2	8540	45222.716	-9262.484	-17	
730	0.2	5.104	0.17	5.2954	0.1914	14	14	10220	52162.88	10220	54118.988	1956.108	0	
180	0	6.38	0.17	5.2954	-1.0846	14	14	2520	16077.6	2520	13344.408	-2733.192	-17	
650	0.2	5.104	0.15	5.423	0.319	15	15	9750	49764	9750	52874.25	3110.25	0	
1680	0.1	5.742	0.15	5.423	-0.319	15	15	25200	144698.4	25200	136659.6	-8038.8	-5	
							Total	**280,610**	**1,499,549**	**280,610**	**1,341,371**	**-158,177**	**-23**	

Table 40. Existing and Potential Solar Loads for Louisa Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Louisa Creek
280	0.4	3.828	0.55	2.871	-0.96	1	1	280	1071.84	280	803.88	-267.96	-15	meadow
740	0.4	3.828	0.55	2.871	-0.957	1	1	740	2832.72	740	2124.54	-708.18	-15	grass
1700	0.7	1.914	0.79	1.3398	-0.5742	1	1	1700	3253.8	1700	2277.66	-976.14	-9	PVG2
330	0.4	3.828	0.89	0.7018	-3.1262	1	1	330	1263.24	330	231.594	-1031.646	-49	yellow willow
2900	0.7	1.914	0.78	1.4036	-0.5104	2	2	5800	11101.2	5800	8140.88	-2960.32	-8	PVG2
50	0.1	5.742	0.31	4.4022	-1.3398	2	2	100	574.2	100	440.22	-133.98	-21	meadow
3060	0.7	1.914	0.7	1.914	0	3	3	9180	17570.52	9180	17570.52	0	0	PVG2
110	0.5	3.19	0.46	3.4452	0.2552	4	4	440	1403.6	440	1515.888	112.288	0	yellow willow
310	0.2	5.104	0.46	3.4452	-1.6588	4	4	1240	6328.96	1240	4272.048	-2056.912	-26	
310	0.5	3.19	0.61	2.4882	-0.7018	4	4	1240	3955.6	1240	3085.368	-870.232	-11	PVG2
740	0.6	2.552	0.61	2.4882	-0.0638	4	4	2960	7553.92	2960	7365.072	-188.848	-1	
270	0.5	3.19	0.61	2.4882	-0.7018	4	4	1080	3445.2	1080	2687.256	-757.944	-11	
270	0.3	4.466	0.46	3.4452	-1.0208	4	4	1080	4823.28	1080	3720.816	-1102.464	-16	yellow willow
330	0.5	3.19	0.46	3.4452	0.2552	4	4	1320	4210.8	1320	4547.664	336.864	0	
							Total	**27,490**	**69,389**	**27,490**	**58,783**	**-10,605**	**-13**	

Table 41. Existing and Potential Solar Loads for Spring Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Spring Creek
950	0.7	1.914	0.79	1.3398	-0.57	1	1	950	1818.3	950	1272.81	-545.49	-9	tributary-PVG2
280	0.5	3.19	0.89	0.7018	-2.4882	1	1	280	893.2	280	196.504	-696.696	-39	yellow willow
350	0.6	2.552	0.89	0.7018	-1.8502	1	1	350	893.2	350	245.63	-647.57	-29	
850	0.5	3.19	0.89	0.7018	-2.4882	1	1	850	2711.5	850	596.53	-2114.97	-39	
740	0.6	2.552	0.78	1.4036	-1.1484	2	2	1480	3776.96	1480	2077.328	-1699.632	-18	PVG2
610	0.5	3.19	0.78	1.4036	-1.7864	2	2	1220	3891.8	1220	1712.392	-2179.408	-28	
220	0.2	5.104	0.31	4.4022	-0.7018	2	2	440	2245.76	440	1936.968	-308.792	-11	meadow grass
450	0.4	3.828	0.73	1.7226	-2.1054	2	2	900	3445.2	900	1550.34	-1894.86	-33	yellow willow
450	0.1	5.742	0.31	4.4022	-1.3398	2	2	900	5167.8	900	3961.98	-1205.82	-21	meadow
390	0	6.38	0.31	4.4022	-1.9778	2	2	780	4976.4	780	3433.716	-1542.684	-31	grass
440	0.6	2.552	0.79	1.3398	-1.2122	1	1	440	1122.88	440	589.512	-533.368	-19	mainstem-PVG2
1310	0	6.38	0.55	2.871	-3.509	1	1	1310	8357.8	1310	3761.01	-4596.79	-55	meadow grass
440	0.4	3.828	0.89	0.7018	-3.1262	1	1	440	1684.32	440	308.792	-1375.528	-49	yellow willow
180	0.1	5.742	0.89	0.7018	-5.0402	1	1	180	1033.56	180	126.324	-907.236	-79	
960	0.2	5.104	0.73	1.7226	-3.3814	2	2	1920	9799.68	1920	3307.392	-6492.288	-53	
1450	0	6.38	0.31	4.4022	-1.9778	2	2	2900	18502	2900	12766.38	-5735.62	-31	meadow
220	0	6.38	0.21	5.0402	-1.3398	3	3	660	4210.8	660	3326.532	-884.268	-21	grass
260	0.1	5.742	0.21	5.0402	-0.7018	3	3	780	4478.76	780	3931.356	-547.404	-11	
300	0	6.38	0.21	5.0402	-1.3398	3	3	900	5742	900	4536.18	-1205.82	-21	
530	0.1	5.742	0.21	5.0402	-0.7018	3	3	1590	9129.78	1590	8013.918	-1115.862	-11	
200	0	6.38	0.21	5.0402	-1.3398	3	3	600	3828	600	3024.12	-803.88	-21	
510	0.1	5.742	0.16	5.3592	-0.3828	4	4	2040	11713.68	2040	10932.768	-780.912	-6	
830	0	6.38	0.16	5.3592	-1.0208	4	4	3320	21181.6	3320	17792.544	-3389.056	-16	
250	0.1	5.742	0.16	5.3592	-0.3828	4	4	1000	5742	1000	5359.2	-382.8	-6	
640	0.2	5.104	0.39	3.8918	-1.2122	5	5	3200	16332.8	3200	12453.76	-3879.04	-19	yellow willow
870	0	6.38	0.13	5.5506	-0.8294	5	5	4350	27753	4350	24145.11	-3607.89	-13	meadow grass
520	0.1	5.742	0.39	3.8918	-1.8502	5	5	2600	14929.2	2600	10118.68	-4810.52	-29	yellow willow
							Total	**36,380**	**195,362**	**36,380**	**141,478**	**-53,884**	**-27**	

Table 42. Existing and Potential Solar Loads for Meadow Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Meadow Creek**
850	0.7	1.914	0.79	1.3398	-0.57	1	1	850	1626.9	850	1138.83	-488.07	-9	PVG2
590	0.5	3.19	0.79	1.3398	-1.8502	1	1	590	1882.1	590	790.482	-1091.618	-29	
440	0.5	3.19	0.73	1.7226	-1.4674	2	2	880	2807.2	880	1515.888	-1291.312	-23	yellow willow
450	0.2	5.104	0.36	4.0832	-1.0208	2	2	900	4593.6	900	3674.88	-918.72	-16	meadow grass
470	0.5	3.19	0.73	1.7226	-1.4674	2	2	940	2998.6	940	1619.244	-1379.356	-23	yellow willow
280	0.2	5.104	0.73	1.7226	-3.3814	2	2	560	2858.24	560	964.656	-1893.584	-53	
730	0.5	3.19	0.56	2.8072	-0.3828	3	3	2190	6986.1	2190	6147.768	-838.332	-6	
240	0.5	3.19	0.56	2.8072	-0.3828	3	3	720	2296.8	720	2021.184	-275.616	-6	
150	0.2	5.104	0.56	2.8072	-2.2968	3	3	450	2296.8	450	1263.24	-1033.56	-36	
500	0.4	3.828	0.56	2.8072	-1.0208	3	3	1500	5742	1500	4210.8	-1531.2	-16	
160	0.1	5.742	0.46	3.4452	-2.2968	4	4	640	3674.88	640	2204.928	-1469.952	-36	
620	0.3	4.466	0.46	3.4452	-1.0208	4	4	2480	11075.68	2480	8544.096	-2531.584	-16	
150	0	6.38	0.46	3.4452	-2.9348	4	4	600	3828	600	2067.12	-1760.88	-46	
320	0.2	5.104	0.46	3.4452	-1.6588	4	4	1280	6533.12	1280	4409.856	-2123.264	-26	
1240	0.1	5.742	0.39	3.8918	-1.8502	5	5	6200	35600.4	6200	24129.16	-11471.24	-29	
200	0	6.38	0.39	3.8918	-2.4882	5	5	1000	6380	1000	3891.8	-2488.2	-39	beaver pond
330	0.1	5.742	0.39	3.8918	-1.8502	5	5	1650	9474.3	1650	6421.47	-3052.83	-29	
640	0	6.38	0.11	5.6782	-0.7018	6	6	3840	24499.2	3840	21804.288	-2694.912	-11	meadow
410	0.1	5.742	0.11	5.6782	-0.0638	6	6	2460	14125.32	2460	13968.372	-156.948	-1	grass
460	0.4	3.828	0.34	4.2108	0.3828	6	6	2760	10565.28	2760	11621.808	1056.528	0	yellow willow
940	0.2	5.104	0.34	4.2108	-0.8932	6	6	5640	28786.56	5640	23748.912	-5037.648	-14	
280	0.3	4.466	0.34	4.2108	-0.2552	6	6	1680	7502.88	1680	7074.144	-428.736	-4	
310	0	6.38	0.34	4.2108	-2.1692	6	6	1860	11866.8	1860	7832.088	-4034.712	-34	
820	0.1	5.742	0.34	4.2108	-1.5312	6	6	4920	28250.64	4920	20717.136	-7533.504	-24	
800	0.2	5.104	0.34	4.2108	-0.8932	6	6	4800	24499.2	4800	20211.84	-4287.36	-14	
250	0.3	4.466	0.34	4.2108	-0.2552	6	6	1500	6699	1500	6316.2	-382.8	-4	
550	0.4	3.828	0.34	4.2108	0.3828	6	6	3300	12632.4	3300	13895.64	1263.24	0	
390	0.5	3.19	0.3	4.466	1.276	7	7	2730	8708.7	2730	12192.18	3483.48	0	
990	0.1	5.742	0.1	5.742	0	7	7	6930	39792.06	6930	39792.06	0	0	meadow grass
780	0.3	4.466	0.27	4.6574	0.1914	8	8	6240	27867.84	6240	29062.176	1194.336	0	yellow willow
890	0.1	5.742	0.08	5.8696	0.1276	8	8	7120	40883.04	7120	41791.552	908.512	0	meadow grass
							Total	**79,210**	**397,334**	**79,210**	**345,044**	**-52,290**	**-18**	

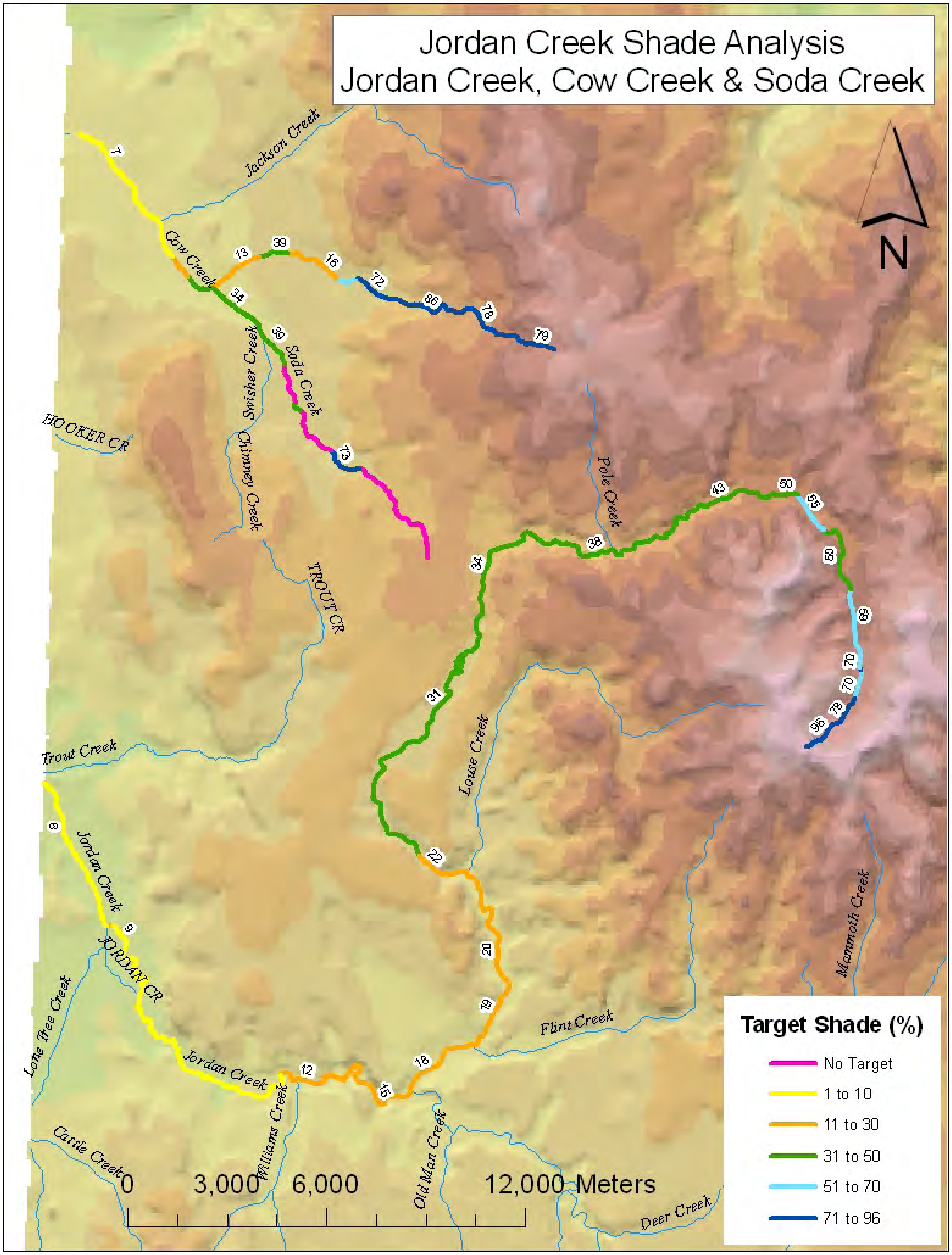

Figure 39. Target Shade for Jordan Creek and Associated Tributaries.

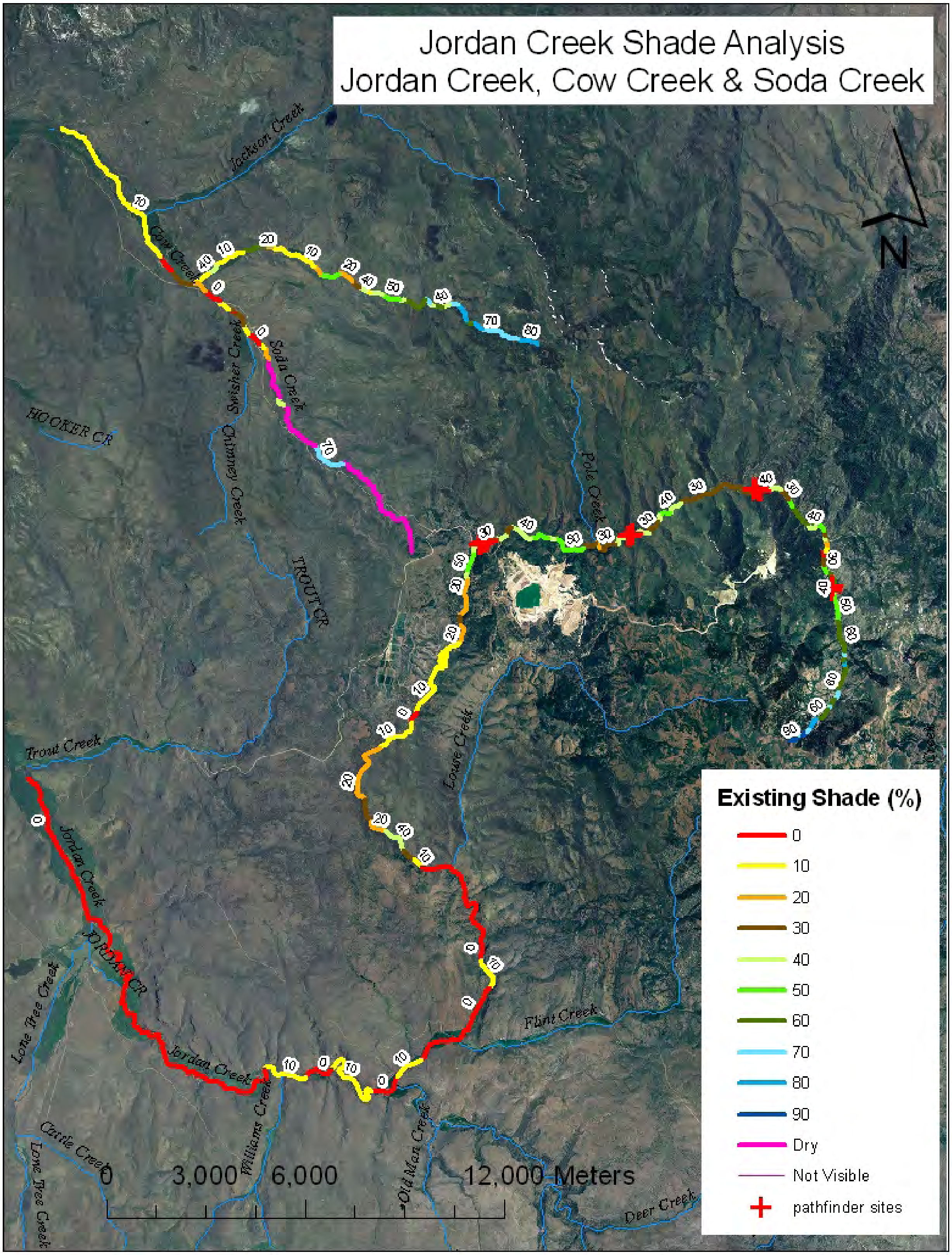

Figure 40. Existing Cover Estimated for Jordan Creek and Associated Tributaries by Aerial Photo Interpretation.

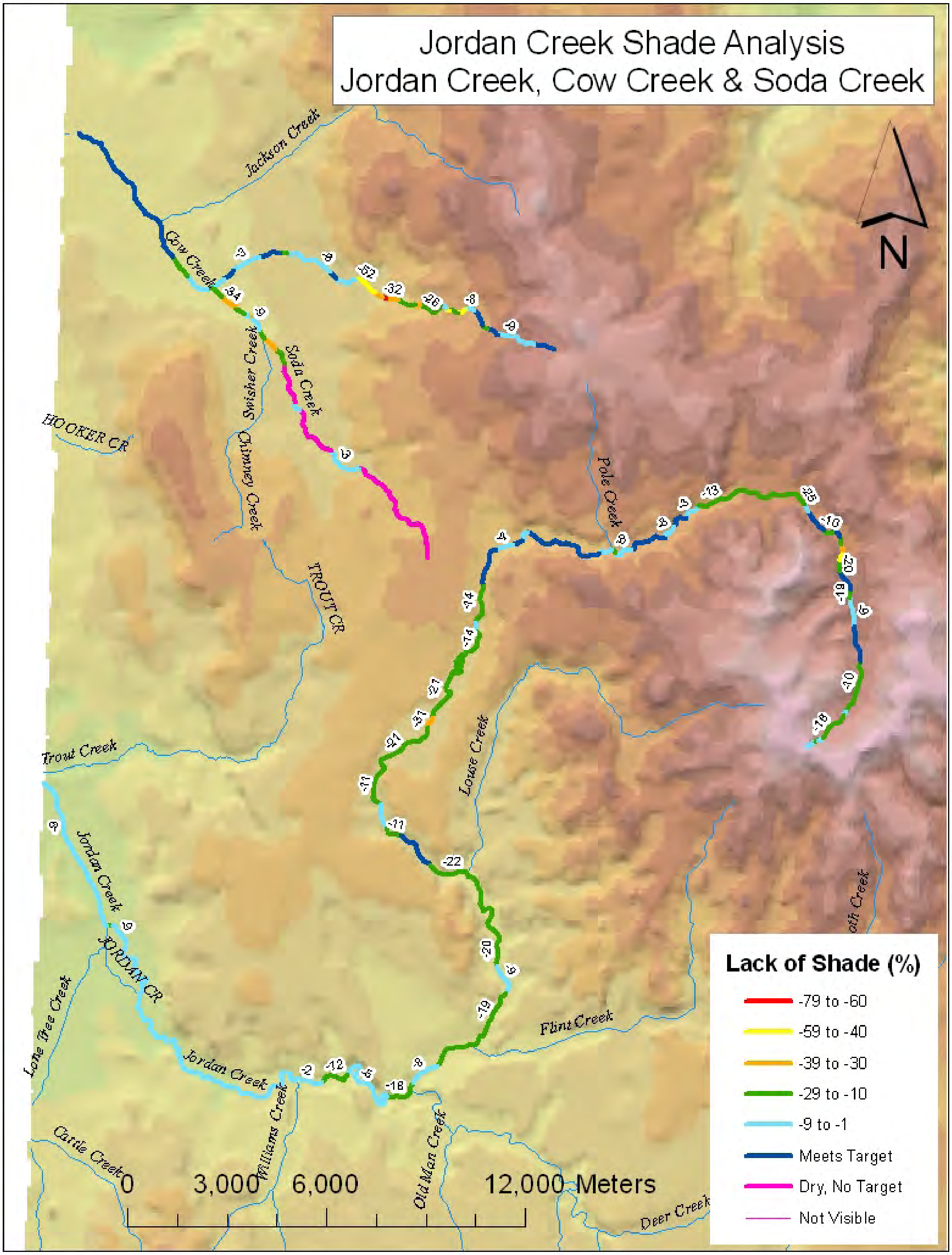

Figure 41. Lack of Shade (Difference Between Existing and Target) for Jordan Creek and Associated Tributaries.

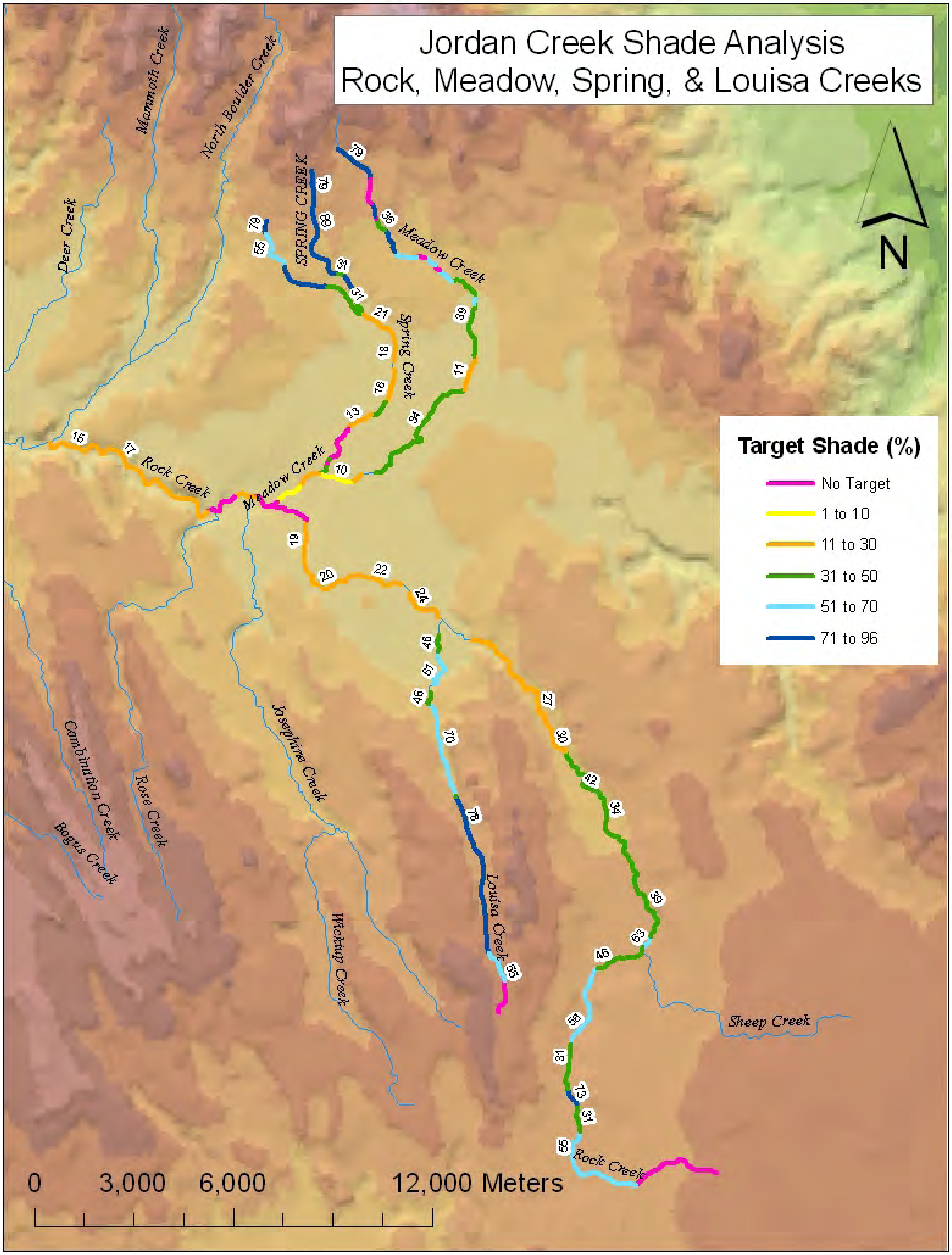

Figure 42. Target Shade for Rock Creek and Associated Tributaries.

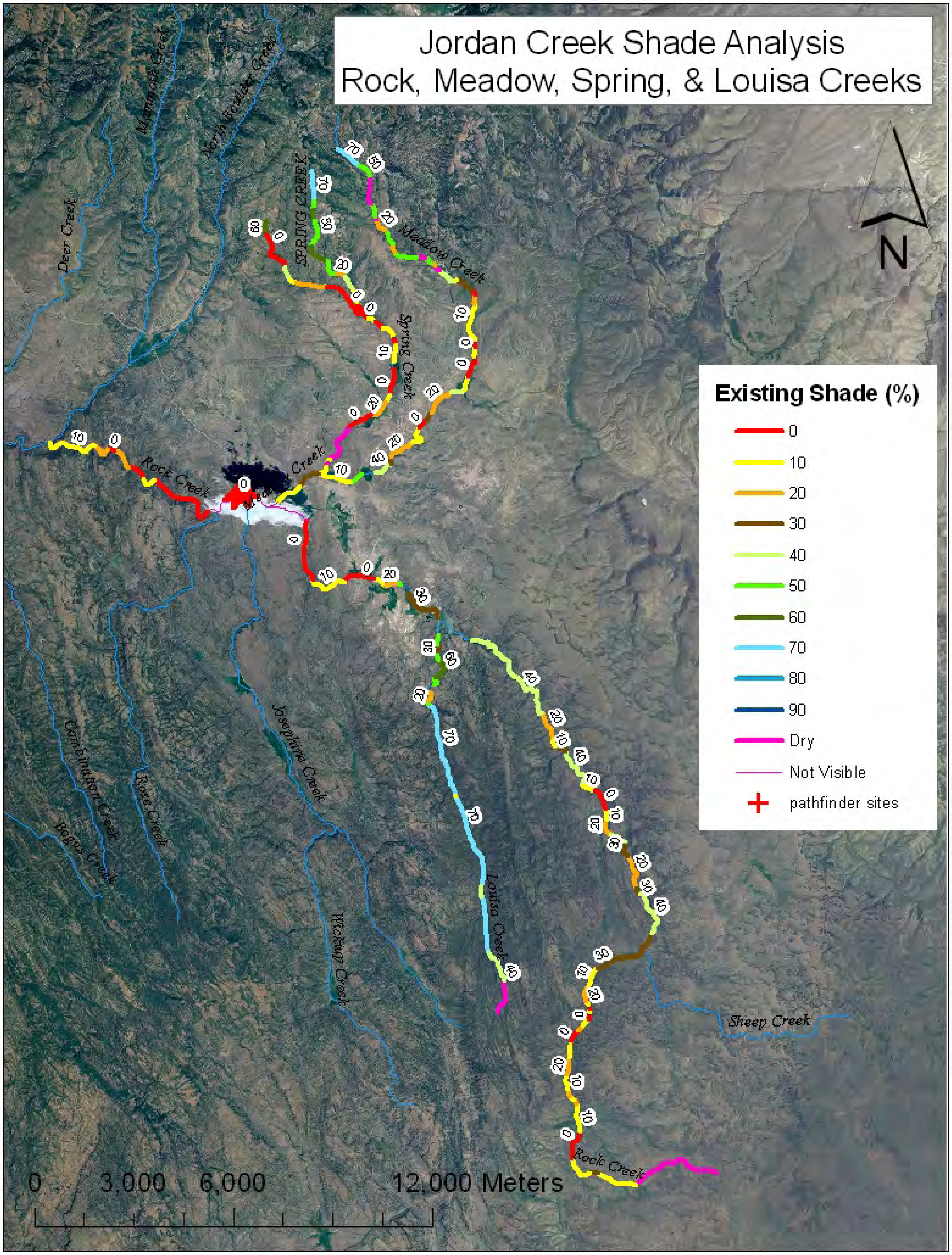

Figure 43. Existing Shade Estimated for Rock Creek and Associated Tributaries by Aerial Photo Interpretation.

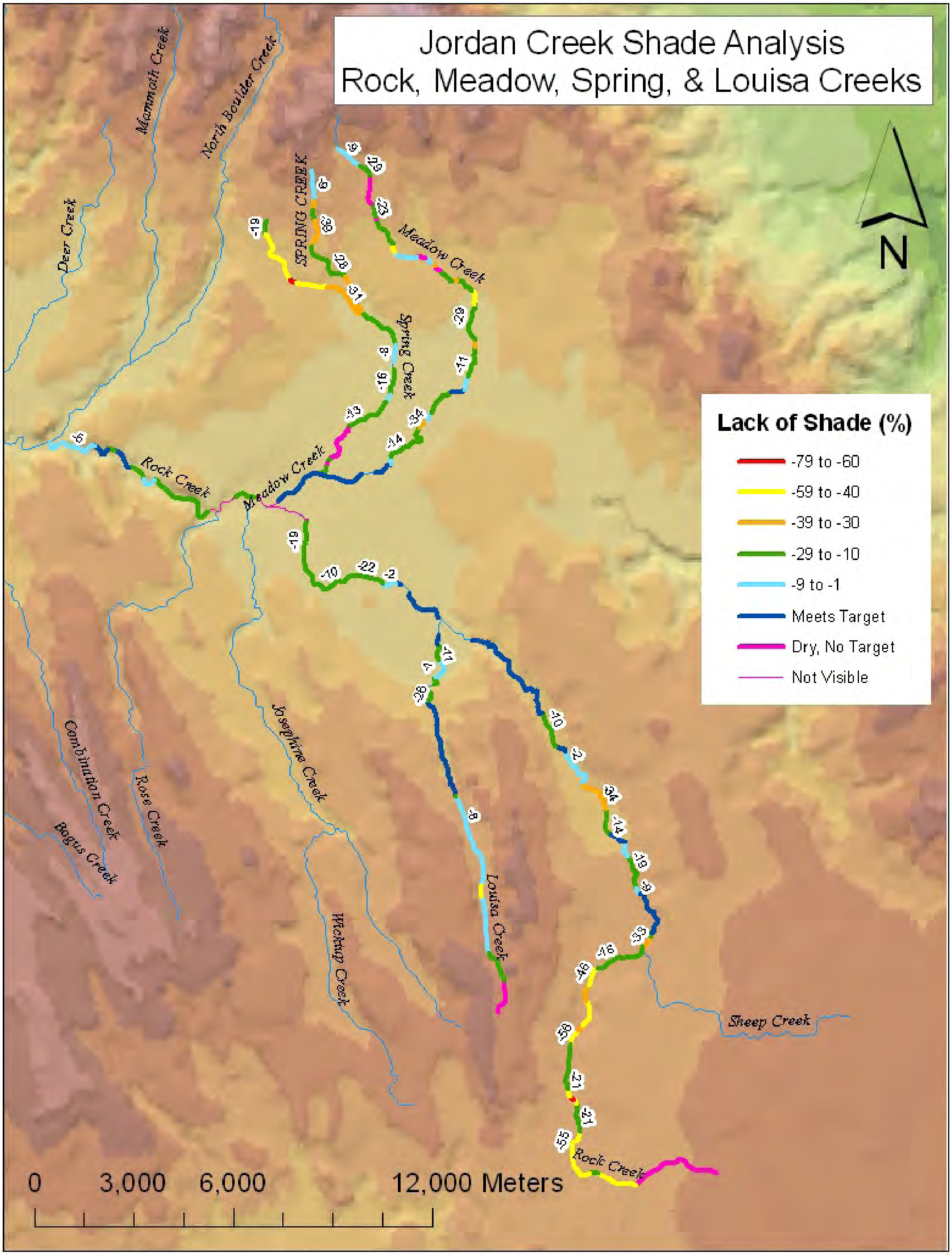

Figure 44. Lack of Shade (Difference Between Existing and Target) for Rock Creek and Associated Tributaries.

5.2 Load Capacity

Mercury

Table 43 shows trophic level weighted average methylmercury tissue concentrations and the resulting fish tissue reduction required for six sites to reach the target fish tissue mercury level of 0.24 mg/Kg (LA). The latter is the fish tissue criterion minus a 20% explicit margin of safety (MOS). Mercury load capacity (LC) of 0.3 mg/kg methyl mercury is based on this reduction in fish tissue mercury levels. Thus, LC (0.3) = MOS (0.06) + LA (0.24) = TMDL for Jordan Creek.

Table 43. Weighted Average Fish Tissue Mercury, Tissue Concentration Reduction, and Percent Reduction in Hg Load Required.

Site	Station ID Number	Weighted Average Tissue Hg (mg/kg)	Needed Tissue Reduction (mg/kg)	Percent reduction in Hg load needed
Jordan near State Line	JC-2005-01	0.750[a]	0.510	68
Jordan Below Boulder Cr	JC-2005-02	0.670[a]	0.430	64
Jordan Below Placer Tailings	JC-2005-08	0.405	0.165	41
Jordan Below Delamar Mine	JC-2005-09	0.473	0.233	49
Jordan Below Blue Gulch	JC-2005-10	0.534	0.294	55
Jordan Below Silver City	JC-2005-11	0.588	0.348	59

a Estimated Mercury Tissue Concentration.

Sediments

Total suspended solids or suspended sediment load capacity is based on the in-stream water quality target derived from literature-referenced values. Table 44 shows the concentration and load capacity based on the optimum flow of 1 cfs.

Table 44. Suspended Sediment/Total Suspended Solids Targets for Soda Creek.

Site	Station ID Number	TSS or SS Geometric Mean Concentration Not to be Exceeded for 30 Days (mg/l)	TSS or SS Geometric Mean Concentration Not to be Exceeded for 14 Days (mg/l)	Optimum Flow Criterion (cfs)	Target Load Capacity 80 mg/l at Confluence with Cow Creek (kg/day)	Target Load Capacity 50 mg/l at Confluence with Cow Creek (kg/day)
Soda Creek	Any Location on Water Body	50 80		≥ 1	197.7	123.6

Temperature

The loading capacity for a stream under PNV is essentially the solar loading allowed under the shade targets specified for the reaches within that stream. These loads are determined by multiplying the solar load to a flat plat collector (under full sun) for a given period by the fraction of the solar radiation that is not blocked by shade (i.e. the percent open or 1-percent shade). In other words, if a shade target is 60% (or 0.6), then the solar load hitting the stream under that target is 40% of the load hitting the flat plate collector under full sun.

We obtained solar load data for flat plate collectors from National Renewable Energy Laboratory (NREL) weather stations near by. In this case, data from the Boise, Idaho station was used. The solar loads used in this TMDL are spring/summer averages, thus, we use an average load for the six month period from April through September. These months coincide with a time of year when stream temperatures are increasing and deciduous vegetation is in leaf.

5.3 Estimates of Existing Pollutant Loads/Sources

Federal regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR § 130.2(g)). An estimate must be made for traditional point sources. However, most construction stormwater and multi sector stormwater NPDES permits do not prescribe numeric limits as these sources traditionally were treated as non point sources. Rather, specific actions and/or BMPs are applied to protect water quality and beneficial uses. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads.

Supporting data for the current mercury loading analysis is located in Appendix E.

Mercury

Because of its complex chemistry, multi-media sources, and bioaccumulation, mercury is not an easy parameter for which to calculate a mass/unit/time loading or conduct a mass balance analysis, especially in a water body where diversions have altered the flow regime.

Many studies of mercury have focused on the cycling of mercury in a lentic (lakes, reservoirs, ponds) environment where historic deposition has a lasting impact because of sediment retention and internal recycling. To a certain extent, the same is true in a lotic (rivers and springs) environment. Ionic forms of mercury become attached to organic and inorganic material (particulate and dissolved) that is transported and redeposited by the river. With favorable conditions, methylation will occur in depositional areas, resulting in increased methylmercury concentrations associated with that locations of elevated mercury. Over short time frames, downstream deposition and methylation likely will not co-vary with loading from upstream sources. In other words, mercury concentrations detected at one location may not be immediately responding to loading upstream. It is not within the scope of this document, nor do the available data allow, quantifying the spatial and temporal variations in the mercury load. Instead, fish tissue methylmercury is used as an integrator of these factors.

Additional issues are the possibility of a "net" loss of mercury due to volatilization and apparent localized loss due to movement by fish. As an example, the monitoring site near Silver City had a high fraction of mercury in the dissolved state in 2005. Additional examination of the data showed both organic and inorganic materials at this site were not a factor in the transport of mercury in the water column. It is believed that most of the mercury detected was in a free ionic state ($Hg(+2)$) with an unknown fraction as other forms (e.g., Hg(0)), readily released from the water column to the atmosphere. Quantifying these phenomena is not within the scope of this assessment.

The draft TMDL examined a simple loading analysis represented by single samples and attempted to calculate current mercury load and apportion it among just three possible sources; mercury load associated with one permitted facility, background load associated natural occurring sources, including atmospheric deposition; and one non-point source, which for Jordan Creek is classified as historic mining/milling activity. The analysis contained numerous assumptions and was difficult to understand, much less replicate, and was removed from the document. Instead DEQ relied on apportioning the fish tissue reductions needed to the watershed by reach. Supporting data for the mercury analysis is located in Appendix E.

Current Mercury Load Associated with Permitted Facilities

The only permitted facility is the Kinross-Delamar mining operation located in the Silver City Mountain Range near Silver City, Idaho. The facility has acquired numerous federal and state required permits for their operation. These permits include permits for the cyanide heap leach operation, haul road construction, storm water discharge, and stream alteration. The facility has a multi-sector storm water permit under the National Pollutant Discharge Elimination System (NPDES), administered in Idaho by Region 10 of the EPA. Typically stormwater permits do not have numeric loads assigned but rather, identify actions and BMPs required to protect water quality. At this time, insufficient data exists to determine numeric wasteload allocations for the Kinross-Delamar facility (KDMC), particularly in light of historic legacy mining activity. KDMC may need to increase the frequency of monitoring in its next permit cycle.

Current Mercury Load Associated with Background Condition

The concept of background mercury load was described in Section 3.0. Background was determined through a simplistic approach that assumes that watersheds without mining impact and not exceeding the fish tissue methylmercury criterion represent non-manageable mercury sources of natural geological erosion and atmospheric deposition. A simple regression analysis using watershed size and estimated mercury loads established an “export” coefficient. However, the strength of the R^2 was not adequate and DEQ opted not to extrapolate it in order to assign estimated loads to legacy mining or the lone point source which is under a mining closure plan.

Current Mercury Load Associated with Historic Mining/Milling Activity

Historic mining/milling activity is a dispersed source that is difficult to quantify piecemeal and thus is discussed in aggregate. Conceptually, this legacy load can be divided into primary (persistent, near original point of use) and secondary (relocated and dispersed through sediment transport and re-deposition) sources. The release and transport of mercury from the primary source is governed by numerous factors, including erosion, hydrologic conditions, biological factors and proximity to the stream channel. The result is areas with elevated concentrations of mercury in sediments, favored areas of methylation, and elevated concentrations of methyl mercury in the water column that could be a few meters to hundreds of miles from the primary source.

Investigations of methylmercury in fish tissue in 1973 (Hill et al. 1973) and 2005 (Dai and Ingham, 2005) detail the concentrations in fish throughout Jordan Creek, as well as sediments and near stream depositional areas.

Temperature

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

Existing loads in this temperature TMDL come from estimates of existing shade as determined from aerial photo interpretations. Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat plate collector at the NREL weather stations. Existing shade data are presented in Table 36 through Table 42. Like loading capacities (potential loads), existing loads are presented on an area basis (kWh/m^2/day) and as a total load (kWh/day).

Existing and potential loads in kWh/day can be summed for the entire stream or portion of stream examined in a single loading table. These total loads are shown at the bottom of their respective columns in each table. The difference between potential load and existing load is also summed for the entire table. Should existing load exceed potential load, this difference becomes the excess load to be discussed next in the load allocation section. The percent reduction shown in the lower right corner of each table represents how much total excess load there is in relation to total existing load.

Existing loads vary from 7.2 million kWh/day on Jordan Creek (Table 36) to 69,389 kWh/day on Louisa Creek (Table 40).

5.4 Load Allocation for Temperature

The load capacity is divided among a margin of safety (MOS), the background pollutant load allocation, the point source pollutant wasteload allocation (WLA), and the non-point pollutant load allocation (LA). The sum of these loads must equal the load capacity (LC), the total maximum daily load the water body can assimilate and still meet water quality standards.

Because this TMDL is based on potential natural vegetation, which is equivalent to background loading, the load allocation is essentially the desire to achieve background conditions. However, to reach that objective, load allocations are assigned to non point source activities that have or may affect riparian vegetation and shade as a whole. Load allocations are therefore stream reach specific and are dependent upon the target load for a given reach.

As discussed earlier, target or potential shade is converted to a potential summer load by multiplying the inverse fraction (1-shade fraction) by the average loading to a flat plate collector for the months of April through September. That is the loading capacity of the stream and it is necessary to achieve background conditions. There is no opportunity to further remove shade from the stream by any activity without exceeding its loading capacity.

Table 45 shows the excess heat load (kWh/day) experienced by each water body examined and the average difference between existing and target shade levels necessary to bring that water body back to target load levels. The size of a stream influences the size of the excess load. Large streams have higher existing and target loads by virtue of their larger channel widths as compared to smaller streams. The table lists the tributaries in order of their excess loads highest to lowest. Therefore, large tributaries tend to be listed first and small tributaries are listed last.

Jordan Creek and Rock Creek were the two largest streams examined, so they have the largest excess loads (2,965,275 and 158,177 kWh/day, respectively). Those excess loads represent 41% and 11%, respectively, of their total existing loads. Smaller streams tend to have smaller excess loads; however, Cow Creek is unique in that it is a relatively large stream with a small excess load (4% of its existing load). Spring Creek and Soda Creek had the highest excess loads relative to existing loads (28% and 26% respectively) compared to other streams. Soda Creek is largely an intermittent waterway and loss of shade in this system maybe more indicative of the lack of water rather than any other kind of disturbance. Louisa Creek and Meadow Creek had excess loads that were 15% and 13% of their respective existing loads.

Average lack of shade is the average of all the differences between existing shade and target shade for each segment of each stream. These differences are seen in the last column of the load tables. The average lack of shade value presented in Table 45 may represent a comparable level of disturbance in each system, however, individual differences between existing shade and target shade for each stream segment needs to be examined carefully for potential stream rehabilitation. These data suggest that streams in the analysis are lacking upto a quarter of their potential shade on average.

Although the table dwells on total heat loads for streams in this TMDL, it is important to note that differences between existing shade and target shade, as depicted in Figures 43 and 46 and the last column of each loading table (Table 41 through Table 45), are the key to successfully restoring these waters to achieving WQS. Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should key in on the largest differences between existing and target shade as locations to prioritize implementation efforts.

Table 45. Total Existing, Target and Excess Solar Loads and Average Lack of Shade for All Tributaries.

WATER BODY	TOTAL EXISTING LOAD (KWH/DAY)	TOTAL TARGET LOAD (KWH/DAY)	EXCESS LOAD (KWH/DAY)	AVERAGE LACK OF SHADE (%)
Jordan Creek	7,273,168	4,307,893 2,965,2	75	-10
Rock Creek	1,499,549	1,341,371 158,1	77	-23
Spring Creek	195,362	141,478	53,884	-27
Meadow Creek	397,334	345,044	52,290	-18
Soda Creek	115,912	86,344	29,568	-20
Cow Creek	521,884	499,264	22,620	-18
Louisa Creek	69,389	58,783	10,605	-13

The loading capacity for Jordan Creek is over 4.3 million kWh/day, and its existing load is about 7.3 million kWh/day (Table 36, page 132). The difference between these two values is the excess load reported in Table 45 (2,965,275 kWh/day). The excess load is 41% of the existing load, which suggests that Jordan Creek is in poor condition. However, the bulk of that excess load is coming from the last segment in the loading table, the section of stream below Williams Creek. This area has experienced excessive widening of the channel, which results in an average bankfull width that is twice its natural bankfull width. Above Williams Creek, Jordan Creek is in relatively good condition and of a lower priority than major water bodies with excess loads representing greater than 20% of their existing loads.

Triangle Reservoir, a 1200m long by 350m wide pond on Rock Creek near the confluence with Louisa Creek, was specifically excluded from the analysis. Although reservoirs obviously play a role in affecting stream temperature, it is not always clear whether that role is a benefit or a detriment to stream temperatures below the impoundment. Triangle Reservoir should be examined in the future to determine what if any influence it may have on Rock Creek water temperatures.All these data suggest that the Jordan Creek watershed is in relatively good condition with respect to shade and is not far from obtaining target conditions. The Jordan Creek watershed has made substantial improvements in riparian vegetation over the years since dredge mining and channelization occurred in the early 1900s. Landowners have demonstrated their respect for the land through maintaining riparian plant communities in many areas throughout the valley.

A certain amount of excess load is created by the method difference inherent in the loading analysis. Because existing shade is reported as a 10% class level and target shade is a unique integer, there is always a difference between them. For example, say a particular stretch of stream has a target shade of 86% based on its vegetation type and natural bankfull width. If existing shade on that stretch of stream were at target level, it would be recorded as 80% existing shade in the loading analysis because it falls into that existing shade class. There is an automatic difference of 6%, which is potentially attributable to the margin of safety.

Wasteload Allocation

Currently here are no traditional point sources in the affected watersheds. Thus, there are no wasteload allocations either. Should a point source be proposed that would have thermal consequence on these waters, then background provisions addressing such discharges in Idaho water quality standards (IDAPA 58.01.02.200.09 & IDAPA 58.01.02.401.03) should be involved (see Appendix B).

Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially background conditions, loads (shade levels) are allocated to lands adjacent to these streams at natural background levels. Because shade levels are established at natural background or system potential levels, it is unrealistic to set shade targets at higher, or more conservative, levels. Additionally, existing shade levels are reduced to the next lower 10% class interval, which likely underestimates actual shade in the loading analysis.

Seasonal Variation

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

Load Allocation for Mercury and Margin of Safety

The establishment of a margin of safety (MOS) for mercury is required by EPA TMDL regulations (40 CFR 130.7). The purpose is to account for any uncertainty in specified load reductions and associated control measures in meeting water quality standards. For mercury, an MOS of 20% recommended by the Implementation Guidance for the Idaho Mercury Water Quality Criteria (DEQ 2005) is used. This explicit MOS is applied by reducing the fish tissue criterion by 20%, so that the target for the TMDL is a tissue mercury value of 0.24 mg/kg or load allocation (LA).

As Hg loads are reduced, and the fish tissue mercury levels approach the criterion value of 0.3 mg/Kg, uncertainty in the relation of load reduction to the criterion also diminishes. Thus, the ultimate measure of compliance for the TMDL remains the fish tissue criterion of 0.3 mg/Kg of mercury. When these levels are attained, no further mercury reduction is required to meet WQS (Table 46).

Table 46. Measured Water Column Total Mercury Hg and Corresponding Load Allocation Based on Fish Tissue Hg Load Reductions

Site	Station ID Number	Water Column Estimated Load (Hg mg/day)	Percent Fish Tissue Reduction (%)	Water Column Load Allocation (Hg mg/day)	Water Column Load Reduction (Hg mg/day)
Jordan Near State Line	JC-2005-01	34.10a 68		23.19	10.91
Jordan Below Boulder Cr.	JC-2005-02	760.67 64		486.83	273.84
Jordan Below Placer Tailings	JC-2005-08	3.25b 41		1.33	1.92
Jordan Below Delamar Mine	JC-2005-09	43.20 49		21.17	22.03
Jordan Below Blue Gulch	JC-2005-10	56.70 55		31.19	25.52
Jordan Below Silver City	JC-2005-11	136.10 59		80.30	55.80

a Overall Reduction in Load from JC-2005-01 and JC-2005-02 Associated with Irrigation Water Withdrawals. b Area between JC-2005-08 and JC-2005-09 is low gradient alluvial depositional area and is suspected to act as a sink for mercury attached.

Load Allocation for Sediment and Margin of Safety

For the sediment TMDL in Soda Creek, a MOS of 14% is established. The 14% MOS represents a 10% allowance for sampling error and 4% allowance for analytical error. Table 47 shows the calculated MOS for the two sediment criterion selected for the TMDL. Thus, the load allocation (LA) for TSS at 80 mg/l is 170 kg/day and at 50 mgl/l is 106.3 kg/day.

Table 47. Suspended Sediment/Total Suspended Solids Targets and Margin of Safety for Soda Creek.

Site	Optimum Flow (cfs)	Target Load Capacity 80 mg/l (kg/day)	Target Load Capacity 50 mg/l (kg/day)	14% MOS at 80 mg/l (kg/day)	14% MOS at 50 mg/l (kg/day)
Soda Creek	≥ 1	197.7	123.6	27.7	17.3

Seasonal Variation

Mercury

The average loads for mercury are estimated using concentration data collected during baseflow conditions. Therefore, seasonal variability in total mercury loads are not accounted for in the present load allocations. However, seasonal variation in Hg loading is irrelevant to fish tissue mercury levels for two reasons: 1) tissue concentrations reflect mercury exposure and uptake over time, during high flows, low flows and all flows in between—fish tissue integrates water column Hg variations; and 2) human health risk is based on lifetime exposure, not a seasonal or even annual peak.

Peaks in mercury concentrations may be important to aquatic life. In this regard it can be noted that EPA's recommended acute aquatic life criterion for Hg (1.4 µg/l dissolved), (EPA 2005) is many times higher than the average instream Hg concentrations likely to result from this TMDL.

Many factors influence the seasonal concentration and mercury load for Jordan Creek, so calculating the seasonal changes in the transport of mercury is not realistic with the available data. Although loads necessarily increase with flow at a constant concentration, it is not known how Hg concentrations, thus loads, vary seasonally in Jordan Creek. It is quite possible that total mercury loading will be higher during high flows. This would mean correspondingly greater seasonal load reductions as well, but would not decrease the target load capacity.

During periods of high flows, movement of inorganic and organic material will increase due to the increased energy for transport. Snow melt and winter-spring precipitation increases the sediment and mercury loads entering the Jordan Creek through erosion and re-suspension of sediments. Any mercury coming from tributaries and direct surface runoff enters Jordan Creek during high flow events. In contrast, deposition of attached (organic or inorganic) ionic forms of mercury will occur in low gradient sections during the low flow periods. Also, during low summer flow periods, mercury loads from upper Jordan Creek are minimized in lower Jordan Creek by irrigation water withdrawals.

Additional monitoring is needed to account for seasonal variability in the Jordan Creek watershed. Establishing links between the transported organic and inorganic material and the mercury loads during various hydrologic events will improve the ability to identify primary sources and devise effective control measures.

Sediments

Targets selected for sediments are based on the use of biological indicator species. Water column targets for SS/TSS are designed to reduce sediment associated with seasonal high flow periods.

Background Load Allocation

Mercury

The background mercury load, as discussed in Section 3.1, was based on the regression analysis using water quality data from those watersheds determined to have little to no influence from legacy mining/milling. Water bodies without these sources do not exceed the fish tissue criterion, have significantly lower mercury concentrations in stream sediments and the water column, and are therefore assumed to represent background loading and resulting fish tissue methylmercury concentrations for the entire watershed.

The background mercury load is associated with non- anthropogenic induced erosion from geological features and direct aerial deposition. The calculated load is determined using the data from sampling in 2005 and watershed size (in acres) calculated from the point where discharge and water samples were collected (Section 3.0).

Two assumptions are used in this analysis: 1) that atmospheric deposition of mercury is uniform throughout the Jordan Creek watershed; 2) the background levels of mercury associated geological features are uniform in all watersheds. In other words, no matter which watershed is chosen, it is assumed the background loading is the same on an acre by acre basis.

Supporting data for the mercury analysis is located in Appendix E.

Sediment

A mass/unit/time background sediment loads in Soda Creek cannot be determined with available data. Based on literature values, the targets set for TSS/SS concentrations are below where impairment to cold water aquatic life occurs.

Temperature

Because the target is essentially background conditions, loads (shade levels) are allocated to lands adjacent to these streams at natural background levels. Because shade levels are established at natural background or system potential levels, it is unrealistic to set shade targets at higher, or more conservative, levels.

Waste Load Allocation and Storm Water

Construction Storm Water

The Clean Water Act requires a permit to discharge wastewater to a water body. Historically, storm water was treated as a non-point source of pollutants and ignored in National Pollution Discharge Elimination System (NPDES) permitting. However, because storm water can be managed on site through management practices or is discharged through a discrete conveyance, such as a storm sewer, it now requires a NPDES Permit. In Idaho, EPA retains primacy for the NPDES program and has prepared a general permit for storm water discharges from construction sites.

The Construction General Permit (CGP)

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

Storm Water Pollution Prevention Plan (SWPPP)

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

Construction Storm Water Requirements

When a stream is on Idaho's § 303(d) list and has a TMDL developed, DEQ may incorporate an aggregate waste load allocation (WLA) for anticipated construction storm water activities. TMDLs developed in the past did not have a WLA for construction storm water. Any entity that obtains the necessary permits will be considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement the appropriate BMPs.

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

Multi Sector Industrial Stormwater Permit

The specifics of the Kinross-Delamar Mine operation were discussed in Section 3.0. As stated, the mine is the only NPDES permitted facility in the watershed. There is insufficient data to establish a numeric wasteload allocation for this facility. However, the Kinross-Delamar storm water discharges will be considered in compliance with this TMDL as long as Kinross-Delamar is covered under the multi-sector industrial general storm water permit or other stormwater permits and complies with all of the terms and conditions of that permit. To evaluate contributions of mercury to Jordan Creek from Kinross-Delamar's storm water discharge, EPA should stipulate more frequent monitoring requirements (e.g. quarterly for the duration of the permit) than those that are in the 2008 permit.

Waste Load Allocation Reserve for Growth

Kinross Delamar anticipates they may need a discharge permit in the future for specific adits that are not covered under their Multi Sector General Permit or a Construction Stormwater Permit. Since these discharges would be discreet point source discharges, Idaho DEQ has created a reserve for growth to discharge total mercury at 0.012 μg/L. This allocation is based on assuring compliance with downstream states standards applying Idaho's narrative toxics criterion to the Jordan Creek watershed.

Sediments

The Soda Creek sediment allocation is presented in Table 48.

Table 48. Allocations for All Sediment Source Loads in the Soda Creek Watershed.

Location/Source	Pollutant	Allocations (kg/day)	Time Frame for Meeting Allocations
Geo Metric Mean of 50 mg/l not to be for 30 days			
Background TSS/SS	[a]	106.3 NA	
Waste Load	TSS/SS	0.0 NA	
Margin of Safety	TSS/SS	17.3 NA	
Non-Point TSS/SS		0.0 10	years
Total	Allocation	123.6 10	years
Geo Metric Mean of 80 mg/l not to be for 14 days			
Background TSS/SS		170.0 NA	
Waste Load	TSS/SS	0.0 NA	
Margin of Safety	TSS/SS	27.7 NA	
Non-Point TSS/SS		0.0 10	years
Total	Allocation	197.7 10	years

a TSS-Total Suspended Solids SS-Suspended Sediment

5.5 Implementation Strategies

DEQ is applying a phased approach to the Jordan Creek mercury TMDL, meaning that load reduction measures will be staged, such that the easiest and most obvious are executed first, and the process escalated thereafter as needed. Additional data are required to determine the areas of greatest concern (i.e. mill tailings near Silver City, stream substrate). Extensive soil and sediment data are needed to locate those areas where legacy mercury use has most contaminated the soils, sediments, and, possibly, ground water. Additional studies are required to determine the secondary sources (due to mercury deposition, both elemental and ionic) that has dispersed Hg throughout the Jordan Creek watershed.

Without additional evaluations and monitoring implementation to control and/or abate mercury from reaching Jordan Creek will not be as effective.

The implementation of the sediment TMDL for Soda Creek will consist of a voluntary approach from private landowners working with the Idaho Department of Agriculture-Soil Conservation Commission (IDA-SCC) in developing and applying BMPs. The BLM will need to comply with provisions of the CWA, with efforts focused on reducing sediments from overland and streambank erosion on lands they administer.

Implementation strategies for TMDLs produced using potential natural vegetation-based shade and solar loading should incorporate the loading tables presented in this TMDL. These tables need to be updated, first to field verify the existing shade levels that have not yet been field verified, and secondly to monitor progress towards achieving reductions and the goals of the TMDL. Using the solar pathfinder to measure existing shade levels in the field is important to achieving both objectives. It is likely that further field verification will find discrepancies with reported existing shade levels in the loading tables. Due to the inexact nature of the aerial photo interpretation technique, these tables should not be viewed as complete until verified. Implementation strategies should include solar pathfinder monitoring to simultaneously field verify the TMDL and mark progress towards achieving desired reductions in solar loads.

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

Reasonable Assurance

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

Under Section 319 of the CWA, each state is required to develop and submit a nonpoint source management plan (NSMP). Idaho's NSMP has been submitted to EPA and has not been approved. The NSMP identifies programs for implementation of BMPs, identifies available funding sources, and includes a schedule for program milestones. It is certified by the Idaho Attorney General that adequate authorities exist to implement the NSMP.

Idaho's NSMP describes many of the voluntary and regulatory approaches the state will take to abate nonpoint source pollution. Section 39-3601, et seq., of the CWA includes provisions for public involvement, such as the formation of Basin Advisory Groups and Watershed Advisory Groups (WAGs) (IDAPA 58.01.02.052). The WAGs are established to assist DEQ and other state agencies in formulating specific actions needed to control point and nonpoint sources of pollution affecting water quality. The Jordan Creek WAG was formed to assist with this report and implementation plan. The implementation plan should be completed within 18 months after approval of the TMDL.

Idaho uses a voluntary approach to control agricultural nonpoint sources. However, regulatory authority can be found in the WQS (IDAPA 58.01.02.350.01 through 58.01.02.350.03). IDAPA 58.01.02.054.07 refers to the Idaho Agricultural Pollution Abatement Plan (Ag Plan), which provides direction to the agricultural community for approved BMPs (IDA-SCC 1993). A portion of the Ag Plan outlines elected groups or responsible agencies (e.g., Soil Conservation Districts [SCDs]) who will take the lead if nonpoint source pollution problems need to be addressed. For agriculture, the Ag Plan assigns the local SCDs to assist the land owner/operator with developing and implementing BMPs to abate nonpoint source pollution associated with the land use.

If a voluntary approach does not succeed in abating the pollutant problem, the state may seek injunctive relief for those situations that are determined to be an imminent and substantial danger to public health or environment (IDAPA 58.01.02.350.02(a)). If water quality monitoring indicates WQSs are not being met, even with the use of BMPs or knowledgeable and reasonable practices, the state may request the designated agency to evaluate and/or modify the BMPs to protect beneficial uses. If necessary, the state may seek injunctive or other judicial relief against the operator of a nonpoint source activity in accordance with Section 39-108, Idaho Code, and IDAPA 58.01.02.350.

Time Frame

Establishing a precise timeframe for meeting the mercury TMDL in Jordan Creek is extremely difficult. DEQ believes it likely will take decades. The global pool of mercury from airborne deposition continues to increase and is not well understood. The mechanics of methylation are really the issue. But DEQ believes that fish tissue reductions will accrue as sources are controlled. Additional data identifying primary and secondary sources will help. Coordination and cooperation from many federal and state agencies will be required to implement any strategy to reduce and/or abate the legacy mercury loading to Jordan Creek. It is proposed that federal and state agencies along with stakeholders in the watershed develop a “source assessment” plan within 18 months of the approval of the TMDL.

The sediment TMDL for Soda Creek will require the development of an “Implementation Plan” to address sediment sources in the watershed. The implementation plan should be completed within 18 months of the approval of the TMDL. The implementation plan should outline the implementation strategy by State of Idaho agencies addressing private lands and those lands administered by the state, and by the BLM to outline an approach to be taken on federally managed lands. On private lands, these BMPs will be applied on a voluntary basis enlisting the cooperation and coordination with private landowners. An adaptive management approach will be an ideal concept to take on both private and public land in the Soda Creek watershed. Identifying key areas of concern and then adopting appropriate management practices to address the issues will be the best use of scarce resources. Depending on the areas and/or sources of sediments to be addressed, some implemented BMPs could be effective immediately. While others, such as BMPs to address stream bank erosion could take 5-10 years before the full benefit of the BMP is achieved.

Approach

For the mercury TMDL, a phased approach is recommended. It is suggested that federal and state agencies along with interested stakeholders, develop a "source assessment concept approach" that is specific to understanding the transport and fates of Hg in Jordan Creek. This source assessment should outline monitoring needs and resources requirements for both primary and secondary sources. It will only be practical to address sources of mercury in Jordan Creek after a more comprehensive assessment is completed. Once areas of concern are identified an adaptive management approach should be taken to apply site specific BMPs. Because of the association of Hg with sediments it is believed the best short-term strategy to limit the further spread of legacy Hg contamination in Jordan Creek is to reduce and minimize sediment movement.

The sediment TMDL will require voluntary participation by private landowners in the Soda Creek watershed. Working with IDA-SCC and United States Department of Agriculture-Natural Resource Conservation Service (USDA-NRCS), areas should be identified where applying BMPs would be the most effective in reducing sediments from streambank and/or overland sources. Applying for and obtaining cost-share funding from federal and/or state sources would greatly offset any financial burden placed on individual landowner who are voluntarily implementing BMPs.

Responsible Parties

The TMDL and any effort to produce a source assessment for mercury in Jordan Creek could possibly involve numerous federal and state agencies (Idaho and Oregon), local government and the stakeholders in the watershed. Federal agencies that may have a regulatory, or a non-regulatory interest, in any development of a source assessments includes, but is not limited to; the EPA, Army Corp of Engineers, USGS, Bureau of Reclamation, NRCS and the BLM. State of Idaho agencies that may have a regulatory, or a non-regulatory interest, in the development of a source assessments includes, but is not limited to, Idaho Department of Lands (IDL); Idaho Department of Water Resources (IDWR); IDHW; DEQ; and the local Health District. Local government could include Owyhee County Commissioners; City of Jordan Valley, Oregon; and Malheur Oregon County Officials. (It is unclear which Oregon agencies would be involved at this time. Oregon is not slated to begin a mercury TMDL for Jordan Creek, within Oregon, until 2010 or later).

For the sediment TMDL in Soda Creek, the primary agency for working with private landowners and developing of an implementation plan is IDA-SCC. The primary federal agency for public lands and development of an implementation plan is the BLM.

Monitoring Strategy

At this time, DEQ is not planning on additional Hg monitoring in the watershed. Although current data are very limited, the considerable cost and resources already expended with mercury studies in Jordan Creek, and priorities elsewhere, makes further ambient monitoring in Jordan Creek a low priority. Fish tissue monitoring will be the ultimate gage of whether the TMDL is successful, but would be premature until some implementation has taken place. The source assessment should have a major monitoring component.

Any monitoring conducted in the Soda Creek TMDL will be in the implementation plan developed by the responsible agencies.

5.6 Conclusions

Table 49 summarizes assessment outcomes.

All streams examined had excess heat loads due to a lack of shade. Jordan Creek and Rock Creek had the largest excess loads due to their size, and percent reductions to achieve loading capacities were 41% and 11%, respectively.

To prioritize water bodies, those streams with high excess loading and percent reductions should be examined for possible shade recovery. Spring Creek and Soda Creek have relatively high excess loads for their size followed by Louisa Creek and Meadow Creek. Cow Creek on the other hand had low excess solar load for its size.

Additionally, high percent reductions may be more a function of the lack of water due to intermittent or ephemeral portions (e.g. Soda Creek). Each stream needs to be examined and further field verified to establish and prioritize any needed implementation activities.Many of the streams are intermittent and the numeric water quality temperature standards do not apply.

Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should key in on the largest differences between existing and target shade as locations to prioritize implementation efforts. Loading analyses for each water body include tables that show where existing shade is less than target shade and thus where excess solar loading is occurring. These tables are important tools for prioritizing, monitoring and directing implementation activities to those areas where shade is needed the most.

Before any implementation begins it is extremely important to further field verify existing shade levels along streams. Field verification of shade presented in this TMDL has only occurred on a small fraction of the water bodies involved. After further field verification, loading tables should be adjusted to reflect the correct existing shade found at each portion of the stream examined.

Table 49. Summary of assessment outcomes for the Jordan Creek Watershed.

Water Body Segment/AU	TMDLs/ Allocations Completed	Recommended Changes to §303(d) List	Justification
Cow Creek ID17050108SW021_02 ID17050108SW021_03	Potential Natural Vegetation temperature TMDL completed	Remove sediment as a pollutant of concern; Move temperature TMDL to §4a	Water body is intermittent, Data does not indicate sediment impairment
Soda Creek ID17050108SW022_02 ID17050108SW022_03	Potential Natural Vegetation temperature TMDL completed; Sediment TMDL completed	Move to §4a	Water body is intermittent, Data does indicate sediment is impairing expected biological composition Impaired but unlisted for Temperature
Rock Creek ID17050108SW013_02	Potential Natural Vegetation temperature TMDL completed	Remove sediment as a pollutant of concern; Move temperature TMDL to §4a	Water body is intermittent, Data does not support sediment impairment

Water Body Segment/AU	TMDLs/ Allocations Completed	Recommended Changes to §303(d) List	Justification
Louisa Creek ID17050108SW014_02	Potential Natural Vegetation temperature TMDL completed	Support status requires verification; Move temperature TMDL to §4a	Lack of sediment data
Spring Creek (Meadow Creek) ID17050108SW015_02 ID17050108SW015_03	Potential Natural Vegetation temperature TMDL completed	Move to §4a	
Jordan Creek ID17050108SW004_02	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Remove oil and grease, unknown, sediment and bacteria as pollutants of concern. Move mercury and temperature TMDLs to §4a	Water quality data showed no exceedance of numeric criteria
Jordan Creek ID17050108SW004_03	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Remove oil and grease, unknown, sediment and bacteria as pollutants of concern. Move mercury and temperature TMDLs to §4a	Water quality data showed no exceedance of numeric criteria
Jordan Creek ID17050108SW004_04	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Move to § 4a	Impaired but unlisted for mercury and temperature
Jordan Creek ID17050108SW004_05	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Remove oil and grease, pesticides, sediment and bacteria as pollutants of concern. Move mercury and temperature TMDLs to § 4a	Water quality data showed no exceedance of numeric criteria
Jordan Creek ID17050108SW001_02	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed	Remove oil and grease, pesticides, sediment and bacteria as pollutants of concern. Move mercury and temperature TMDLs to § 4a.	Water quality data showed no exceedance of numeric criteria
Jordan Creek ID17050108SW001_05	Potential Natural Vegetation temperature TMDL completed; TMDL for mercury completed,	De-listed in 2002 for oil and grease, pesticides, sediment and bacteria as pollutants of concern; add Flow and habitat alteration; Move to § 4a for temperature and mercury	Water quality data showed no exceedance of numeric criteria; Impaired but unlisted for mercury and temperature

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GIS Coverages

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Glossary

305(b)

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

§303(d)

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

Acre-foot

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

Adsorption

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

Aeration

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

Aerobic

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

Adfluvial

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

Adjunct

In the context of water quality, adjunct refers to areas directly adjacent to focal or refuge habitats that have been degraded by human or natural disturbances and do not presently support high diversity or abundance of native species.

Alevin
A newly hatched, incompletely developed fish (usually a salmonid) still in nest or inactive on the bottom of a water body, living off stored yolk.

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

Alluvium
Unconsolidated recent stream deposition.

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

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

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

Anoxia
The condition of oxygen absence or deficiency.

Anthropogenic
Relating to, or resulting from, the influence of human beings on nature.

Anti-Degradation
Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.61).

Aquatic
Occurring, growing, or living in water.

Aquifer
An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding of water to wells or springs.

Assemblage (aquatic)
An association of interacting populations of organisms in a given water body; for example, a fish assemblage or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996).

Assessment Database (ADB)
The ADB is a relational database application designed for the U.S. Environmental Protection Agency for tracking water quality assessment data, such as use attainment and causes and sources of impairment. States need to track this information and many other types of assessment data for thousands of water bodies and integrate it into meaningful reports. The ADB is designed to make this process accurate, straightforward, and user-friendly for participating states, territories, tribes, and basin commissions.

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

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

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

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

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

Beneficial Use

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

Beneficial Use Reconnaissance Program (BURP)

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

Benthic

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

Benthic Organic Matter.

The organic matter on the bottom of a water body.

Benthos

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

Best Management Practices (BMPs)

Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.

Best Professional Judgment

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

Biochemical Oxygen Demand (BOD)

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

Biological Integrity

1) The condition of an aquatic community inhabiting unimpaired water bodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).

Biomass	The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often expressed as grams per square meter.
Biota	The animal and plant life of a given region.
Biotic	A term applied to the living components of an area.
Clean Water Act (CWA)	The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.
Coliform Bacteria	A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria, E. Coli, and Pathogens).
Colluvium	Material transported to a site by gravity.
Community	A group of interacting organisms living together in a given place.
Conductivity	The ability of an aqueous solution to carry electric current, expressed in micro (μ) mhos/centimeter at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.
Cretaceous	The final period of the Mesozoic era (after the Jurassic and before the Tertiary period of the Cenozoic era), thought to have covered the span of time between 135 and 65 million years ago.
Criteria	In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. The U.S. Environmental Protection Agency develops criteria guidance; states establish criteria.

Cubic Feet per Second

A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.

Cultural Eutrophication

The process of eutrophication that has been accelerated by human-caused influences. Usually seen as an increase in nutrient loading (also see Eutrophication).

Culturally Induced Erosion

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

Debris Torrent

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

Decomposition

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

Depth Fines

Percent by weight of particles of small size within a vertical core of volume of a streambed or lake bottom sediment. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 6.5 millimeters depending on the observer and methodology used. The depth sampled varies but is typically about one foot (30 centimeters).

Designated Uses

Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.

Discharge

The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).

Dissolved Oxygen (DO)

The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.

Disturbance
Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment.

E. coli
Short for Escherichia coli, E. coli are a group of bacteria that are a subspecies of coliform bacteria. Most E. coli are essential to the healthy life of all warm-blooded animals, including humans, but their presence in water is often indicative of fecal contamination. E. coli are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.

Ecology
The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature.

Ecological Indicator
A characteristic of an ecosystem that is related to, or derived from, a measure of a biotic or abiotic variable that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability. Ecological indicators are often used within the multimetric index framework.

Ecological Integrity
The condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes (EPA 1996).

Ecosystem
The interacting system of a biological community and its non-living (abiotic) environmental surroundings.

Effluent
A discharge of untreated, partially treated, or treated wastewater into a receiving water body.

Endangered Species
Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act.

Environment
The complete range of external conditions, physical and biological, that affect a particular organism or community.

Eocene
An epoch of the early Tertiary period, after the Paleocene and before the Oligocene.

Eolian
Windblown, referring to the process of erosion, transport, and deposition of material by the wind.

Ephemeral Stream
A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table (American Geological Institute 1962).

Erosion
The wearing away of areas of the earth's surface by water, wind, ice, and other forces.

Eutrophic
From Greek for "well nourished," this describes a highly productive body of water in which nutrients do not limit algal growth. It is typified by high algal densities and low clarity.

Eutrophication
1) Natural process of maturing (aging) in a body of water. 2) The natural and human-influenced process of enrichment with nutrients, especially nitrogen and phosphorus, leading to an increased production of organic matter.

Exceedance
A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.

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

Exotic Species
A species that is not native (indigenous) to a region.

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

Fauna
Animal life, especially the animal's characteristic of a region, period, or special environment.

Fecal Coliform Bacteria
Bacteria found in the intestinal tracts of all warm-blooded animals or mammals. Their presence in water is an indicator of pollution and possible contamination by pathogens (also see Coliform Bacteria, E. coli, and Pathogens).

Fecal Streptococci
A species of spherical bacteria including pathogenic strains found in the intestines of warm-blooded animals.

Feedback Loop
In the context of watershed management planning, a feedback loop is a process that provides for tracking progress toward goals and revising actions according to that progress.

Fixed-Location Monitoring
Sampling or measuring environmental conditions continuously or repeatedly at the same location.

Flow
See Discharge.

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

Focal
Critical areas supporting a mosaic of high quality habitats that sustain a diverse or unusually productive complement of native species.

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

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

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

Geographical Information Systems (GIS)
A georeferenced database.

Geometric Mean	A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.
Grab Sample	A single sample collected at a particular time and place. It may represent the composition of the water in that water column.
Gradient	The slope of the land, water, or streambed surface.
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 Native American nations.

Irrigation Return Flow

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

Key Watershed

A watershed that has been designated in Idaho Governor Batt's State of Idaho Bull Trout Conservation Plan (1996) as critical

	to the long-term persistence of regionally important trout populations.
Knickpoint	Any interruption or break of slope.
Land Application	A process or activity involving application of wastewater, surface water, or semi-liquid material to the land surface for the purpose of treatment, pollutant removal, or ground water recharge.
Limiting Factor	A chemical or physical condition that determines the growth potential of an organism. This can result in a complete inhibition of growth, but typically results in less than maximum growth rates.
Limnology	The scientific study of fresh water, especially the history, geology, biology, physics, and chemistry of lakes.
Load Allocation (LA)	A portion of a water body's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).
Load(ing)	The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration.
Load(ing) Capacity (LC)	A determination of how much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, and a margin of safety, it becomes a total maximum daily load.
Loam	Refers to a soil with a texture resulting from a relative balance of sand, silt, and clay. This balance imparts many desirable characteristics for agricultural use.
Loess	A uniform wind-blown deposit of silty material. Silty soils are among the most highly erodable.
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; 6 is the median of 1, 2, 5, 7, 9, 11.

Metric

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

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

Million Gallons per Day (MGD)
A unit of measure for the rate of discharge of water, often used to measure flow at wastewater treatment plants. One MGD is equal to 1.547 cubic feet per second.

Miocene
Of, relating to, or being an epoch of, the Tertiary between the Pliocene and the Oligocene periods, or the corresponding system of rocks.

Monitoring
A periodic or continuous measurement of the properties or conditions of some medium of interest, such as monitoring a water body.

Mouth
The location where flowing water enters into a larger water body.

National Pollution Discharge Elimination System (NPDES)
A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit.

Natural Condition
The condition that exists with little or no anthropogenic influence.

Nitrogen
An element essential to plant growth, and thus is considered a nutrient.

Nodal
Areas that are separated from focal and adjunct habitats, but serve critical life history functions for individual native fish.

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

Not Assessed (NA)

A concept and an assessment category describing water bodies that have been studied, but are missing critical information needed to complete an assessment.

Not Attainable

A concept and an assessment category describing water bodies that demonstrate characteristics that make it unlikely that a beneficial use can be attained (e.g., a stream that is dry but designated for salmonid spawning).

Not Fully Supporting

Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the Water Body Assessment Guidance (Grafe et al. 2002).

Not Fully Supporting Cold Water

At least one biological assemblage has been significantly modified beyond the natural range of its reference condition.

Nuisance

Anything that is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state.

Nutrient

Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.

Nutrient Cycling

The flow of nutrients from one component of an ecosystem to another, as when macrophytes die and release nutrients that become available to algae (organic to inorganic phase and return).

Oligotrophic

The Greek term for "poorly nourished." This describes a body of water in which productivity is low and nutrients are limiting to algal growth, as typified by low algal density and high clarity.

Organic Matter

Compounds manufactured by plants and animals that contain principally carbon.

Orthophosphate
A form of soluble inorganic phosphorus most readily used for algal growth.

Oxygen-Demanding Materials
Those materials, mainly organic matter, in a water body that consume oxygen during decomposition.

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

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

Pathogens
A small subset of microorganisms (e.g., certain bacteria, viruses, and protozoa) that can cause sickness or death. Direct measurement of pathogen levels in surface water is difficult. Consequently, indicator bacteria that are often associated with pathogens are assessed. E. coli, a type of fecal coliform bacteria, are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.

Perennial Stream
A stream that flows year-around in most years.

Periphyton
Attached microflora (algae and diatoms) growing on the bottom of a water body or on submerged substrates, including larger plants.

Pesticide
Substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.

pH
The negative log10 of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.

Phased TMDL

A total maximum daily load (TMDL) that identifies interim load allocations and details further monitoring to gauge the success of management actions in achieving load reduction goals and the effect of actual load reductions on the water quality of a water body. Under a phased TMDL, a refinement of load allocations, wasteload allocations, and the margin of safety is planned at the outset.

Phosphorus

An element essential to plant growth, often in limited supply, and thus considered a nutrient.

Physiochemical

In the context of bioassessment, the term is commonly used to mean the physical and chemical factors of the water column that relate to aquatic biota. Examples in bioassessment usage include saturation of dissolved gases, temperature, pH, conductivity, dissolved or suspended solids, forms of nitrogen, and phosphorus. This term is used interchangeable with the term “physical/chemical.”

Plankton

Microscopic algae (phytoplankton) and animals (zooplankton) that float freely in open water of lakes and oceans.

Point Source

A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable “point” of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.

Pollutant

Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

Pollution

A very broad concept that encompasses human-caused changes in the environment which alter the functioning of natural processes and produce undesirable environmental and health effects. This includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.

Population

A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.

Pretreatment

The reduction in the amount of pollutants, elimination of certain pollutants, or alteration of the nature of pollutant properties in wastewater prior to, or in lieu of, discharging or otherwise introducing such wastewater into a publicly owned wastewater treatment plant.

Primary Productivity

The rate at which algae and macrophytes fix carbon dioxide using light energy. Commonly measured as milligrams of carbon per square meter per hour.

Protocol

A series of formal steps for conducting a test or survey.

Qualitative

Descriptive of kind, type, or direction.

Quality Assurance (QA)

A program organized and designed to provide accurate and precise results. Included are the selection of proper technical methods, tests, or laboratory procedures; sample collection and preservation; the selection of limits; data evaluation; quality control; and personnel qualifications and training (Rand 1995). The goal of QA is to assure the data provided are of the quality needed and claimed (EPA 1996).

Quality Control (QC)

Routine application of specific actions required to provide information for the quality assurance program. Included are standardization, calibration, and replicate samples (Rand 1995). QC is implemented at the field or bench level (EPA 1996).

Quantitative

Descriptive of size, magnitude, or degree.

Reach

A stream section with fairly homogenous physical characteristics.

Reconnaissance

An exploratory or preliminary survey of an area.

Reference

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

Reference Condition

1) A condition that fully supports applicable beneficial uses with little affect from human activity and represents the highest

level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).

Reference Site

A specific locality on a water body that is minimally impaired and is representative of reference conditions for similar water bodies.

Representative Sample

A portion of material or water that is as similar in content and consistency as possible to that in the larger body of material or water being sampled.

Resident

A term that describes fish that do not migrate.

Respiration

A process by which organic matter is oxidized by organisms, including plants, animals, and bacteria. The process converts organic matter to energy, carbon dioxide, water, and lesser constituents.

Riffle

A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.

Riparian

Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.

Riparian Habitat Conservation Area (RHCA)

A U.S. Forest Service description of land within the following number of feet up-slope of each of the banks of streams:

- 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 in a series of diverging and converging channels.

Runoff	The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.
Sediments	Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.
Settleable Solids	The volume of material that settles out of one liter of water in one hour.
Species	1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.
Spring	Ground water seeping out of the earth where the water table intersects the ground surface.
Stagnation	The absence of mixing in a water body.
Stenothermal	Unable to tolerate a wide temperature range.
Stratification	A Department of Environmental Quality classification method used to characterize comparable units (also called classes or strata).
Stream	A natural water course containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.
Stream Order	Hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher order streams result from the joining of two streams of the same order.
Storm Water Runoff	Rainfall that quickly runs off the land after a storm. In developed watersheds the water flows off roofs and pavement into storm drains that may feed quickly and directly into the

stream. The water often carries pollutants picked up from these surfaces.

Stressors

Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.

Subbasin

A large watershed of several hundred thousand acres. This is the name commonly given to 4th field hydrologic units (also see Hydrologic Unit).

Subbasin Assessment (SBA)

A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.

Subwatershed

A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions. Also proposed for adoption as the formal name for 6th field hydrologic units.

Surface Fines

Sediments of small size deposited on the surface of a streambed or lake bottom. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 605 millimeters depending on the observer and methodology used. Results are typically expressed as a percentage of observation points with fine sediment.

Surface Runoff

Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow.

Surface Water

All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water.

Suspended Sediments

Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.

Taxon

Any formal taxonomic unit or category of organisms (e.g., species, genus, family, order). The plural of taxon is taxa (Armantrout 1998).

Tertiary

An interval of geologic time lasting from 66.4 to 1.6 million years ago. It constitutes the first of two periods of the Cenozoic Era, the second being the Quaternary. The Tertiary has five subdivisions, which from oldest to youngest are the Paleocene, Eocene, Oligocene, Miocene, and Pliocene epochs.

Thalweg

The center of a stream's current, where most of the water flows.

Threatened Species

Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Total Maximum Daily Load (TMDL)

A TMDL is a water body's load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Total Dissolved Solids

Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

Total Suspended Solids (TSS)

The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Franson et al. 1998) call for using a filter of 2.0 microns or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

Toxic Pollutants

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

Tributary

A stream feeding into a larger stream or lake.

Trophic State

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

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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 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.
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.

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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 km2 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 ft3 = 0.09 m3 3 m3 = 105.94 ft3
Flow Rate	Cubic Feet per Second (cfs)a	Cubic Meters per Second (m3/sec)	1 cfs = 0.03 m^3/sec 1 m^3/sec = 35.31 cfs	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/Lb	3 ppm = 3 mg/L
Weight	Pounds (lbs)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lbs	3 lb = 1.36 kg 3 kg = 6.61 lb
Temperature	Fahrenheit (°F)	Celsius (°C)	°C = 0.55 (F - 32) °F = (C x 1.8) + 32	3 °F = -15.95 °C 3 °C = 37.4 °F

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

Appendix B. State and Site-Specific Standards and Criteria

State and site-specific standards and criteria for salmonid spawning are defined in the Idaho Water Quality Standards, IDAPA 58.01.02, at Section 250.f:

> f. Salmonid Spawning. The Department shall determine spawning periods on a waterbody specific basis taking into account knowledge of local fisheries biologists, published literature, records of the Idaho Department of Fish and Game, and other appropriate records of spawning and incubation, as further described in the current version of the "Water Body Assessment Guidance" published by the Idaho Department of Environmental Quality. Waters designated for salmonid spawning, in areas used for spawning and during the time spawning and incubation occurs, are not to vary from the following characteristics due to human activities: (3-30-07)
>
> i. Dissolved Oxygen. (8-24-94)
>
> (1) Intergravel Dissolved Oxygen. (8-24-94)
>
> (a) One (1) day minimum of not less than five point zero (5.0) mg/l. (8-24-94)
>
> (b) Seven (7) day average mean of not less than six point zero (6.0) mg/l. (8-24-94)
>
> (2) Water-Column Dissolved Oxygen. (8-24-94)
>
> (a) One (1) day minimum of not less than six point zero (6.0) mg/l or ninety percent (90%) of saturation, whichever is greater.
>
> ii. Water temperatures of thirteen (13) degrees C or less with a maximum daily average no greater than nine (9) degrees C.

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Appendix C. Historic Perspective of Mercury Use

MERCURY USE IN MINING IN THE AREA NEAR SILVER CITY, IDAHO

By Jim Hyslop

Mercury was used almost exclusively as the recovery method for precious metals for the primary part of the historic mining period in Owyhee County, Idaho. In both placer mining and hard rock mining, mercury provided the best method of maximizing precious mineral recovery. Amalgamation had been in use for two thousand years for gold recovery and was not supplanted in the Owyhees by the new cyanide process until early in the twentieth century. Any amount of information is available to document this early reliance on mercury use from gold discovery in 1863 until about 1905 when the De Lamar Mill converted to the latest cyanide process.

Less easily proved is how efficient miners were in recovering mercury from the amalgamation. It is true that mercury could be reused. It had to be freighted into the Owyhees, likely from California. Its unavailability would require a mill to cease operations. It was relatively easy to recover so one would surmise that every effort was made to closely control the loss of mercury during the milling process. Will Meyerriecks' Drills And Mills, Precious Metal Mining Methods of the Frontier West, Second Edition, provides a pertinent quote from an 1885 paper: "Mercury losses from retorting were relatively small. The California mill lost ½ pound per 1000 pounds of amalgam." (EMMONS 1885 p. 267 a public document, found in Meyerriecks' p. 159).

While prudent stamp mill operators were likely to make every effort to salvage mercury, placer miners and arrastra mills may not have been as fortunate. Certainly, this second group had the same opportunity to retort their recovered amalgam as did the mill man. But, physical losses of mercury from the sluice boxes and arrastra mills were not readily controllable due to the necessary water agitation in the process. "In placer mine operations, loss of mercury during gold recovery was reported to be as high as 30%" (Hunerlach…USGS 99-4018B p. 179). Ditches, from high on the south face of Saw Pit Peak were dug to provide water for placer works on the east face of Florida Mountain. Owyhee miners were afforded the same technology as their industry utilized in California. The above named USGS report provides a review of mercury losses on Bear River, California, which was slightly earlier, but closely contemporary with the Owyhee placer mining era. The Hunerlach, Rytuba, and Alpers-authored report provides these pertinent points:

"In 1852, hydraulic mining technology evolved with the use of water cannons to deliver large volumes of water that stripped the ground… to bedrock."

"Mercury was introduced and distributed throughout the entire sluice box."
"We estimate that a typical sluice box … used up to 800 lb of mercury during initial start-up with an additional 100 lb added monthly."

"The annual loss of mercury… was likely to have been several hundred pounds."

When assessing mercury losses in the Owyhees, one might be better informed by finding out how much of the mercury that had been used there was recycled and taken out of the Owyhees to other markets. Mention is made in the old newspapers of its importation into the Owyhees. An approximate calculation could be made as to the processing needs, given the estimated gold and silver produced. But, has anyone ever heard of mercury being taken out?

The purpose of this paper is to provide some perspective relative to the expected loss of mercury in the historic mining period: from 1863 until about 1920. An attempt is made to provide documentation, where available, to address each deliverable.

Deliverable # 1: Identify through historic records, documents or writings the location of mills in the Silver City area that used amalgamation as the primary process for extracting gold and silver from milled ore. Also and if available, through the use of historic records, documents and writings determine the quantity of bullion produced at these mills.

Find attached list of mills in the area. They all are expected to have relied on the use of mercury up until about 1900.

"If gold and silver are the precious metals, then quicksilver—mercury, is the essential metal. Without mercury, 19th century precious metal mining would not have been possible in most districts. Nearly all of the gold mining districts relied on amalgamation in arrastras, stamps, and pans for recovery of the values. Amalgamation was very often used as the first stage for precious metals recovery, followed by other processes." (Meyerreicks, page 181)

METALLURGICAL TREATMENT

In the effort to obtain the highest possible recovery of precious metals from the Silver City ores, many metallurgical processes and devices have been employed. In the early days of the camp, the free-milling oxidized ores were successfully worked by wet crushing with stamps, followed by plate amalgamation. Several arrastras operated successfully on these ores for many years. As the silver content of the mill feed increased, with increased depth, modifications became necessary. In some mills, various concentrating devices were used to treat the tailings from the amalgamating plates, in others, the ore was subjected to a preliminary roast, either with or without chloridization. These modifications were not fully effective, and the plate amalgamation process gradually came into disuse.

During the eighties and early nineties, pan amalgamation, preceded or followed by concentration, was used to the virtual exclusion of all other methods throughout the Silver City region. In the Dewey mill of the Trade Dollar Consolidated Mining and Milling Co. the ore was crushed in four 5-stamp batteries to pass a 30-mesh screen, classified, and concentrated by Frue vanners. Under normal operating conditions 63 per cent of the silver content and 83 per cent of the gold content of the ore was recovered in the concentrate. The tailings from the vanners then passed to thickening cones, thence to the amalgamating pans in which they were reground with mercury in the presence of copper sulfate, salt, and a small amount of lye. It is interesting to note that this order of vanner and amalgamating pan is the reverse of the usual installation. The bullion ultimately recovered from the amalgam was equivalent to 28.5 per cent of the silver content of the mill feed and 11.5 per cent of the gold content. The ore treated contained 0.15 to 0.5 ounce of native gold per ton, and 20 to 50 ounces silver as native metal or argentite and naumannite, accompanied by less than one per cent of chalcopyrite in a quartz gangue. The total recovery from this ore was 91.5 percent of the silver and 94.5 per cent of the gold. At De Lamar prior to 1897, crushing by stamps was followed by pan amalgamation without concentration. The process recovered from 71 to 83 per cent of the value of the precious metals from quartzose ore whose average content was 0.85 ounces native gold and 16.5 ounces silver, chiefly as argentite and naumannite, per ton. It was not effective for ores with clayey gangue. At the mill of the Addie Consolidated Mining Co., the metallurgical process differed somewhat from that at Dewey. A small amount of concentrate was recovered from Frue vanners. The tailings from the vanners passed to Wheeler pans for regrinding and thence to a settling tank. The sands from the settler were then re-concentrated by a Deister slime table. The recovery effect is not known.

Cyanidation was first employed in the silver City region in 1897. In that year a small experimental plant was operated by the Poorman Gold Minds, Ltd., but the process did not replace pan amalgamation in their mill. The same year the Pelatan-Clerici cyanidation process was installed in the mill at De Lamar, and, after considerable modification, operated successfully. Repeated modification was necessary and the installation soon lost most of its resemblance to the original patented process. In 1905 the mill was wholly rebuilt, and its flow sheet again revised. ("Geology and Metalliferous Resources of the Region About Silver City, Idaho" by Arthur M. Piper and Francis B. Laney, Idaho Bureau of Mines and Geology Bulletin, No. 11, December, 1926, University of Idaho, Moscow, Idaho, Pg. 59-60.)

The historical record is filled with accounts of mill operations. Many mentions can be found regarding quantities of ore being processed. Pertinent to this study, mercury needs in the district are mentioned as well as mercury importation. A doctorial thesis could be undertaken in any of the deliverables requested utilizing the printed historic record. A smattering of newspaper articles from just the 1865-7 era exemplifies this point.

Owyhee Avalanche: September 9, 1865
Bullion Assayed

It has been our aim for some time to give our readers, as nearly as possible, a correct account, from time to time, of the bullion taken from the different mines in this county, but in endeavoring to do so, we have met with many obstacles, which it is next to impossible to overcome. There is so much of the Owyhee bullion sold to merchants and other parties doing business here, who send it away by private means, that to give a list of amounts sent by Express would not be giving one dollar in ten;…However, we occasionally get an item in that line which speaks for itself, as for example: we called on our friend Chittenden, the assayer, the other evening, and in conversation learned that on Monday, the 28th, he assayed eighty eight pounds of bullion; that on Thursday, 31st ult., he assayed two lots, one of 25 lbs. and the other of 4 lbs.; that on Friday, 1st. inst., he assayed one hundred pounds---making a total of two hundred and twenty pounds of bullion, which will probably approximate fifteen thousand dollars in value. This, it will be remembered, is only the business of one assay office, in a little more than one week. We were also informed that the Revenue Tax collected on bullion assayed by Mr. Chittenden, during the last two weeks, amounted to about one hundred dollars in coin. At the time we called, he had a large amount---probably one hundred pounds—on hand for assay, which when superadded to the above, will give nearly one third more to the amount mentioned.

Owyhee Avalanche: March 31, 1866

Valuable and Interesting Owyhee Statistics

Owyhee, I.T. March 18th, 1866

Hon. E. J. Curtis, Chairman of the Committee on Mint Statistics

Sir:

Not long since, I received a circular from the Committee of which you are Chairman, soliciting of me such information relative to the mineral wealth and resources of this county, as might come within my knowledge and observation, to be given as an inducement to Congress in favor of the establishment of an United States Branch Mint at Boise City. Feeling the necessity of such an institution, in common with the entire business population of this Territory, I cheerfully and respectfully submit the following report:

Morning Star Mill—8 stamps

Number of days running time………………..426

Number of tons ore reduced ………………..7369 ¼

Number of ledges of ore taken………………7

Amount of bullion up to March 9, 1866….$1,127,617.39

More, Fogus, & Co., Proprietors

Minear Mill—5 stamps

Number of days running time…………………136

Number of tons ore reduced…………………1,101 3/10

Number of ledges of ore taken……………………1

Amount bullion, up to March 9, 1866………$172,860.16

More, Fogus & Co., Renters

This mill has been rented by More, Fogus & Co. since September 10th, 1865, and working "Oro Fino" ore.

Jackson Mill—5 stamps

Number of days running time……………….36

Number of tons ore reduced……………….431 ¼

Number of ledges ore taken…………………..1

Amount bullion, up to March 9, 1866…….$48,084.19

More, Fogus & Co., Renters

This mill has been rented by More, Fogus & Co. since October 10th, 1865 and working "Oro Fino" ore.

Vass Mill—4 stamps

Number of days running time……………….73

Number of tons ore reduced………………..124

Number of ledges ore taken…………………8

Amount of bullion, up to Feb. 1, 1866…….$15,194

Vass & Co., Proprietors

Minear Mill—5 stamps

The following is the report of the above named mill from the time it first started up to the time More, Fogus & Co. rented it: during which time it was engaged in prospecting ore from the Morning Star, Roxbury, Allison, Whisky, New York, Caledonia, Home Ticket, Ophir of Idaho, Ladd & Reed, Golden Eagle, Oro Fino, Eureka, Silver Legion, Whisky Gulch, and Badger ledges.

Number of days running time……………….150
Number of tons ore reduced……………….1400
Number of ledges ore taken…………………..18
Amount of bullion……………………….$100,00.00
P. Minear & Co., Proprietors

In addition to the above, but which I am unable to give returns at present, are the Ainsworth Mill of ten stamps, running time about one hundred days, working ore from the Oro Fino Extension, Poorman, Trook & Jennings and Columbia ledges. Probable amount of bullion: $500,000.

O. S. N. Co., Proprietors

Shoenbar Mill………………….10 stamps
New York & Owyhee Mill…….20 stamps
Cosmos Mill……………………10 stamps
Lincoln Mill…………………….20 stamps
N. Y. & O. F. (Grenzeback's)…..10 stamps
Have all yielded more or less bullion but have not reported. Next season they will be in successful operation and will without doubt yield over $4,000,000 in bullion.

Recapitulation

Number of Mills……………………………………10
" of Stamps…………………………………102
" of Days Running Time…………………….820
" of Tons of Ore Reduced……………..10,336 1/8
" of Ledges Ore Taken……………………….31
Amount of Bullion…………………………..$1,463,755.74
Average Yield Per Ton…………………………..$142.58
Cost of transporting bullion to San Francisco at 8 %…$117,100.45
Cost of transporting coin from San Francisco to Owyhee at 4%…..$58,550.22
Total expense……………………………………….$175,650.67
It is difficult to estimate the amount of shipments of gold dust from this county during the past three years.

O. H. Purdy

Owyhee Avalanche: May 18, 1867
THE MORNING STAR MILL has steam up yesterday, trying the machinery for regular work on and after Monday. Ore will be hauled today to both this and Webfoot mill—the road being in passing condition.

Owyhee Avalanche: July 27, 1867
MILLS IN OPERATION

There are now in constant operation the Owyhee, Cosmos and Morning Star Mills and the Webfoot most of the time. The Owyhee will have its addition of six pans completed by the middle of next month, which will give constant employment to the mill's twenty stamps, which added to the others named will make over forty stamps nearly certain to be in continual action, besides as many more of which there is reasonable hope to believe will be supplied with ore and be stamping out bullion and making business before the year closes.

Owyhee Avalanche: July 27, 1867

THE "ENTERPRISE ARRASTRAR" below Ruby has been running day and night for several weeks—managed by Messrs. Cohn & Dockum. They are now receiving rock from the "Little Giant" ledge, lying parallel with and near to the Oro Fino.

Owyhee Avalanche: July 27, 1867

In Flint, the prospects are surely brightening. Mr. Chas Liebenau has just made a very successful run of Leviathan ore in Black's Mill. Of course the loss in working was considerable more than it should have been, but a point has been established in that it is proven that the ore can be worked with the machinery at hand at a large profit.

Owyhee Avalanche: July 27, 1867

CLEANING UP In Blue and Jacob's Gulches the placer miners are engaged in cleaning up the ground over which they have worked since the flow of water in the spring, and so far as we can learn with large pay. Very good wages can be made in either gulch by washing with sluices and even rockers, but the miners prefer to go after it with hydraulic power in the early part of the season and spend the latter part in cleaning up the bedrock and putting everything in the most advantageous shape for another season's operation.

Owyhee Avalanche: August 17, 1867

THE WHISKY We stated, a few weeks ago, that five and one-half tuns of ore from this mine yielded near a thousand dollars, and the statement should have been nearly fourteen hundred. Since the last crushing, the proprietors of the mine have timbered up the main shaft in solid style, and are now proceeding downwards with the purpose of giving the mine proper form and system, and make it pay greater profits in proportion to the labor bestowed upon it.

Owyhee Avalanche: August 24, 1867

The Webfoot Mill has been engaged for some time upon float rock gathered in the placer mines in the vicinity of the Oro Fino. A new pan has been received lately for this mill, and will be put in place ere long. This is in addition to those already in use.

Owyhee Avalanche: August 24, 1867

MR. J. S. TRASK has rented the Enterprise Arrastra—situated below Ruby—and is ready to rush ore on trial or by the ton, and will guarantee a true return in all cases. An amalgamating pan is attached to the works and the facilities are ample for a fair trial of silver or gold ores.

Owyhee Avalanche: September 14, 1867

ORO FINO …….Preparations are being made to run the mine and mill (or mills) all winter. They are laying in a large supply of wood, salt, quicksilver and chemicals, so that no impediment will be in the way.

Owyhee Avalanche: September 21, 1867

The Minear Mill is now engaged in crushing the ore from the Ida Elmore.

Owyhee Avalanche: September 21, 1867

THE OWYHEE COMPANY is making extensive improvements. Their smelting and retorting works have recently been improved and enlarged—six new pans have been added to the mill, a large space has been graded enlarging the quartz yard, a large and substantial building has been erected, the lower story of which is intended for a store room and the upper part as sleeping apartments for the employees. They are also erecting a new residence—the old one will be used for an office. Vast quantities of wood are being piled up, and altogether, everything wears the appearance of a healthy business.

Owyhee Avalanche: September 21, 1867

J. ROSS BROWNE is in the employ of the Government to collect statistics on the mineral resources of the Pacific States and Territories, and recently he was reported in Portland. Idaho is included in his territory and he will not visit it at all, but rely upon others to supply him with data for the required information.

Owyhee Avalanche: September 28, 1867

FLINT DISTRICT We are pleased to learn that our Flint neighbors regard their camp with increasing favor. From the many crushings made of ore at various times and under embarrassing circumstances in the present year, the quartz is fully ascertained to be of a high grade of richness. Boasting is necessary to even approximate a true yield, and this branch of reduction has not been very well performed owing to defects of one kind and another in the furnaces. However, each trial develops a fault and suggests improvements.

The Black Mill is now employed on Leviathan ore. The Iowa Mill is nearly completed…….. The mill is erected under the full direction of Mr. H. S. Jacobs, whose work will—we fully believe—bear the most critical mechanical examination. It will probably be completed within the next two weeks, and as it nears the finishing touch it shows quite differently from any other Owyhee mill; and also, all its parts and modes of operation look perfectly reasonable, and give assurance of this being a perfect success. We shall give it a more extended and detailed notice when it commences practical duty.

Owyhee Avalanche: November 2, 1867

IOWA MILL We were present last Wednesday at the starting of the Iowa's Co. new mill in Flint. The machinery worked admirably, and the cleaning process as far as is yet known gives every evidence of being a success. Altogether the mill is a splendid piece of mechanism, and reflects great credit on Mr. Jacobs, the chief Superintendent and constructor. The crushing process, machinery, and in fact every thing about the mill is entirely different from anything of the kind that we have ever seen; but our crowded column prevent our giving anything like a description of it this week. We shall note its working and give further details hereafter.

Owyhee Avalanche: November 9, 1867

NORTH STAR This famous mine, also known as the Golden Chariot, is yielding ore of almost unexampled richness. ………A large force is employed at the mine taking out ore enough to keep two mills at work—the Cosmos and Minear. There is considerable silver in the ore but it is chiefly valuable on account of its gold bearing qualities.

Owyhee Avalanche: November 9, 1867

ALLISON We understand that the Owyhee Mill will soon commence crushing ore from the Allison mine, which is at present yielding large quantities of good pay rock.

Owyhee Avalanche: November 9, 1867

ENCOURAGING The Lincoln Mill will be at work in a few days crushing ore from the Ida Elmore mine. The mill has been purchased by Wilson & Co., and is now undergoing some necessary repairs.

Owyhee Avalanche: November 30, 1867

Nine quartz mills are in operation nearly all the time, several of which will run all winter.

Owyhee Avalanche: November 30, 1867

NEW CONCENTRATOR Mr. Richards, of the Knickerbocker Co., has invented and is experimenting with a machine for the concentration and saving of sulphurets from tailings. We have not seen it in operation, but from trials already made, Mr. Richards is confident that he has struck the "right thing" at last. He is making some slight alterations, and when he gets it to running again we will give a full description.

Owyhee Avalanche: November 30, 1867

THE LINCOLN MILL J. M. Wilson, Esq., started the Lincoln Mill on Tuesday. It really seems good to hear it thumping away once more. It is now crushing ore from the Ida Elmore, and will continue to do so all winter. Mr. Wilson had made numerous repairs on the mill, and everything works to a charm. About 20 tuns per day are being crushed. Ten of the twenty stamps only are at work at present, there not being pan capacity enough for them all The works are driven by a splendid engine, and the furnace is the best we have seen in the territory, only requiring about four cords of wood per day. A splendid office is situated near the mill in which Mr. Caldwell Wright, a very efficient and clever gentleman, attends to the business.

Owyhee Avalanche: November 30, 1867

TREASURE SHIPMENT FOR NOVEMBER Wells, Fargo & Co. have shipped below by the Railroad stage from this place, during the month of November, $70,000 in gold and silver bullion. This is quite a nice little sum, and is exclusive of large amounts carried away by private parties.

Owyhee Avalanche: December 28, 1867

PAST, PRESENT AND FUTURE Next Wednesday is the beginning of 1868. The past has been an eventful year in the history of Owyhee. One year ago the prospect was dark and gloomy, work was suspended on nearly all the mines and not a mill was running; now a large number of mines are being worked and nine mills are in operation nearly all the time. Large amounts of bullion are being shipped to the mints. There is no excitement, business is lively, people are cheerful, and labor is in good demand. In taking an impartial view of matters and things during the past, we are led to the conclusion that the dark days of Owyhee are over; its progress for the better during the last six months being almost unrivaled in the history of mining camps. One of the most noticeable and commendable features of which is that most of the mines now worked are paying all expenditures, besides affording handsome profits to their owners. If improvement be as great in '68 as it has been in'67 our mines will be unrivaled by any in the world.

Owyhee Avalanche: December 28, 1867

TREASURE SHIPMENT Wells, Fargo & Co.'s shipment of bullion from this place to San Francisco during the present month, December, amounts to $105,000, all the product of Owyhee, being an increase of $35,000 over that of last month, and nearly twelve times as much as was shipped from here in December, '66, which was only $9,386. These figures speak for themselves. Next month the shipment will probably foot up $120,000 and keep increasing, till a year hence, when we are confident our mines will produce a million dollars per month.

Piper and Laney. Page 57

OUTPUT OF THE PRECIOUS METALS—PRODUCTION BY YEARS

The gross output of gold and silver from Owyhee County may be ascertained with reasonable accuracy, and, since the Silver City region embraces all the important producers, its output is essentially that of the county. The available data have been tabulated below. The figures from the years prior to 1890 are based in part upon the reported production from some of the mines, and, in part or in whole, upon estimates; they are, therefore, subject to some uncertainty. Gerry (17: p.395) has recently estimated that Owyhee County during the period of 1863-1923, produced gold valued at $21,674,700 (1,048,515 fine ounces) and 24,529,712 ounces of silver. These estimates differ slightly from the totals reached by the writer, but it is impossible to reconcile this difference without knowledge of the source of Gerry's data. It will be noted that the ratio of silver to gold varies greatly from year to year, reaching a minimum of 1.3 in 1887 and a maximum of 143.9 in 1920. This extreme variation is due to the great annual range of production from a large number of ore bodies, whose maximum and minimum gold-silver ratios are even more unequal than the extremes of the annual ratios. In the absence of complete tonnage and production records for each individual mine, it is useless to attempt to prove or disprove that the gold to silver ratio varies systematically from place to place over the region, or from one level to another, in any give mine.

Deliverable # 2: Determine through historic records, documents or writings the main process for separating the gold and silver form the mercury in the Silver City area.

It is worthwhile to invest in a copy of The Owyhee County Historical Society's, Outpost Journal #17 of May 1986, containing a superior article by Linda L. Morton titled "Stamp Mills in Owyhee County". Ms. Morton quotes The Owyhee Avalanche of June 5, 1875: "The ore as it comes from the mine is dumped on the yard, whence it is moved by descent to the [stamp] battery floor. The rock, or heavy portions of it, are put through the rock breaker…prior to its being pulverized at the [stamp] battery. From the latter it descends to the settling tanks, the pulp being subsequently taken there from and conveyed to the amalgamating pans. In the pans it further undergoes the grinding process which lasts several hours. Then the pans are charged with a sufficient amount of quicksilver to take up the precious metal. This operation continues until all the metal is taken up in the amalgam when the material is removed into the larger pans, called settlers. The amalgam is collected in the bottom of these, drawn off with syphons [sic] and conveyed to the strainers. By the straining process, the amalgam is left behind and ready for re-use…the dry amalgam usually contains in bullion an amount equal to about one-fifth of its weight. The separation of the bullion is affected by means of the retorting process…the quicksilver is evaporated and passes through a small pipe into a vessel of water on the outside…the bullion is ready to go into the hands of the assayer, who converts it into bars and ascertains its value…" (Outpost 17, p. 24).

Deliverable # 3: Determine through historic records, documents, or writings the priority of mercury recovery after separation from the gold and silver.

The presumption today is that mills wanted to recover all the mercury they could. That saved the cost of getting mercury to the Owyhees and prolonged the milling operation during dwindling supplies, especially in winter. However, an e-mail comment by Will Meyerriecks tells the probable truth of the matter: "if you spent $1 on Hg to get, say, $5 in gold/silver, then wouldn't it be worthwhile?" (1-11-06)

Deliverable # 4: Determine through historic records, documents or writings if final gold and silver recovery from the amalgam utilized a retorting process.

"In a mill, retorts were as fundamental to Hg use as was the use of Hg itself. See my Metals Prices in the appendix of Drills And Mills... would you throw away something as valuable as Hg if you could save it, after retorting? I think not." (Meyerriecks, 11 January 2006 email)

A current mine owner, who asked not to be identified in this report, stated that his father operated a retort. It was as easy as dropping the exhaust tube from the retort into a tub of water to condense and recover mercury.

Respected Silver City author, Julia C. Welch, transmitted in a recent e-mail that as a child (she was born in 1911), she often accompanied her father on visits to mines and mills.

"I think the mills around Silver that I knew about used mercury; the Potosi (I remember seeing a wash tub full of mercury); the Trade Dollar or Blaine up Long Gulch (my father explained the process of milling to us there when it was running);he also said that ore which had "free gold" could use mercury. This is what the quartz found on War Eagle and some on Florida had. But the mines in the DeLamar group had gold and silver in combinations with other minerals and had to use a different process involving a chemical called aqua regia. I guess that is the cyanide process used by the later Canadians. I would think that the Wagontown recovery mills also had to use some such chemical. Maybe not, since it had been used at the DeLamar mills. If other mines used anything but mercury I didn't hear about it." (Julia Welch, 25 July 2005)

Owyhee Avalanche: September 21, 1867

THE OWYHEE COMPANY is making extensive improvements. Their smelting and retorting works have recently been improved and enlarged—six new pans have been added to the mill, a large space has been graded enlarging the quartz yard, a large and substantial building has been erected, the lower story of which is intended for a store room and the upper part as sleeping apartments for the employees. They are also erecting a new residence—the old one will be used for an office. Vast quantities of wood are being piled up, and altogether, everything wears the appearance of a healthy business.

Deliverable # 5: Determine through historic records, documents, or writings the overall use, misuse, wasting, spilling, storage and/or dumping of mercury that occurred in the Jordan Creek watershed near Silver City.

During the 1930's, dredging of the Jordan Creek deposits immediately down stream from Wagontown produced on the floors of the dredge, "more mercury than they could deal with." (A Reliable Source that preferred not to be identified, 9-12-05). Purportedly, the mercury was accumulated from the gravel deposit.

"My brother and I dug a small shaft at the site of a retort from the earliest mining period. Dad showed us where to dig. He built a rocker for us to separate out the rocks and gravel. We sluiced the material in the bottom of the rocker. We also found mercury in the old tailings area of the mill. We would dip it up with spoons."

"Dad made a retort (about one gallon) to clean up the mercury we found. I still have a small bar of silver that we smelted from this project. We produced two mercury bottles of mercury which we sold to miners still operating in the Owyhees" (The same reluctant Source, 9-12-05).

"Brian Brunzell cleaned up the old De Lamar mill. He found and recovered a lot of mercury." (The same reluctant Source, 9-12-05)

Other quotes that add to the general knowledge of the early milling activity in the region:

Owyhee Avalanche: Oct. 28, 1865

Took a peep into the office of the Morning Star mill on Thursday, and saw eighteen bricks of bullion—six large and twelve small ones, the latter mostly gold. A partial clean up had just been made, and seventeen hundred pounds of amalgam obtained. Couldn't somebody give us a bullion item from the Ainsworth mill?

Owyhee Avalanche: October 28, 1865

During the past ten days eighteen teams have reached Sinker Creek, all laden with machinery and stores for Mr. Grenzeback's new quartz mill. Three more are on the way with the remainder. The main building is up and will be shingled the coming week. When finished it will cover a space forty five by sixty feet. At present only ten stamps will be put in, but the mill is of twenty stamp capacity. The Frieberg process with ovens and Varney pans will be used.

Owyhee Avalanche: October 21, 1865

A Visit to the Cinnabar District

On Sunday last, ….we made a visit to the great Cinnabar district of Owyhee. …and finally arriving at the Great Quicksilver mines that will probably some day surpass the celebrated New Almaden of California in wealth—which we found to be situated on the head of the north fork of Castle Creek, …It is about ten miles distant from Ruby City, on the southeastern slope of this range of mountains…a good road can be graded round the mountain at comparatively small cost, by which …the quicksilver used by mills and placer claims in this vicinity another season, will probably be supplied.

Owyhee Avalanche: September 9, 1865

A Visit to the Owyhee Cinnabar District

…The Cinnabar is confined to a rolling hill on either side of which they have never succeeded in finding any of the valuable ore. There are three tunnels now being run, one is in one hundred and ten feet, another about thirty eight feet, and a third near twenty five.

These tunnels are six feet high, and about four wide, and are certainly beautiful. Out of the longest tunnel they have taken something like seventy-five tons of very rich ore, or cinnabar which if it were worked, would more than pay for all the labor performed in the district. As I never saw a quicksilver ledge before, I confess that I cannot give the description I could if it were quartz. Quite unlike quartz, the precious ore is to be found in pockets, or as the cinnabar miners would say "pots". As far as the work has developed, these pots are situated about eight or ten inches apart.

Owyhee Avalanche: November 25, 1865

Mr. John Parks informs us that, since our last issue, he has run up twenty bars of bullion from the Morning Star Mill. These bars were of the average value of $1700 and were shipped Thursday morning.

Owyhee Avalanche: February 10, 1866

New York and Owyhee Mill

As this mill is fully completed and running, it is proper that it should receive a fitting notice before being placed on the regular list.

The officers of the Company arrived here in the latter end of July, selected a site, and broke ground for the mill on the 6th of August, and laid the corner stone on the 29th of the same month. The building is 69/71 feet, and has a Scriptural foundation—machinery and all being placed on solid bedrock. It has twenty stamps, with twelve pulp tanks, ten of Wheeler's pans, with proper concentrators. Wednesday was a gala day at the mill and office.

Will Meyerriecks, in Drills and Mills, shows this data in a table on page 248.
US Average Mercury Price--1850 to 1900

$100 per flask in 1850
$38 to $44 per flask from 1862 to 1869
Then the price began to rise to $103 per flask in 1874
Dropping to $30 per flask by 1878
$30 to $50 price range per flask from 1878 to 1900

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Appendix D. Data Sources and Related Information

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Table D-1. Data sources for Jordan Creek Subbasin Assessment.

Water Body	Source	Data Type	When Collected
Cow Creek	BLM	In-stream Water Temperature data	2000
Cow Creek	BLM	In-stream Water Temperature data	2003
Cow Creek	BLM	In-stream Water Temperature data	2003
Cow Creek	BLM	In-stream Water Temperature data	2003
Cow Creek	BURP	Biological-Habitat	1998
Soda Creek	BURP	Biological-Habitat	1996
Soda Creek (DRY)	BURP	Biological-Habitat	2003
Soda Creek (DRY)	BURP	Biological-Habitat	2003
Spring Creek	IDA-SCC	Personal Observations	2005
Spring Creek	IDEQ	Personal Observations	2005
Rock Creek	BURP Site 1998BIOB011	Biological-Habitat	1998
Rock Creek	BURP Site 1998BIOB012	Biological-Habitat	1998
Rock Creek	BURP Site 2003BIOA010	Biological-Habitat	2003
Rock Creek	BLM	In-stream Water Temperature data	2004
Rock Creek	Bahls	Periphyton Analysis	2004
Louisa Creek	BLM	In-stream Water Temperature data	2001
Louse Creek	Ingham	Flow Data	2005
Louse Creek	BURP Site 1998BIOB09	Louse Creek	1998
Louse Creek	Lester and Robinson	Biological-Habitat-Chemical 1992-199	5
Louse Creek	Pfiefer	Biological-Habitat-Chemical 2003	
Louse Creek	KDMC	Biological-Habitat-Chemical 2005	
Louse Creek	IDEQ	Water Quality Metal Analysis	2005
Louse Creek	Hill	Biological-Habitat-Chemical 1972	
Louse Creek	BLM	In-stream Water Temperature data	2004
Upper Jordan Creek	CH2MHill	Biological-Habitat-Chemical	Various Years to 1992
Upper Jordan Creek	BURP Site 2003BIOA045	Biological-Habitat	2003
Upper Jordan Creek	BURP Site 2003BIOA039	Biological-Habitat	2003
Upper Jordan Creek	Bahls	Periphyton Analysis	2004
Upper Jordan Creek	Pfiefer	Biological-Habitat-Chemical	2003
Upper Jordan Creek	EPA	Soil-Sediment	1998
Upper Jordan Creek	Dai and Ingham	Statistical Analysis of Fish Tissue Results	2005
Upper Jordan Creek	USGS	Discharge	1993-1996
Lower Jordan Creek	USGS	Discharge	1945 to 2003
Lower Jordan Creek	BLM	In-stream Water Temperature data	2004
Lower Jordan Creek	IDEQ	In-stream Water Temperature data	2005
Lower Jordan Creek	Dai and Ingham	Statistical Analysis of Fish Tissue Results	2005

Table D-2. Equation Values for Region 7. Estimating Monthly Streamflow Statistics in Ungaged Sites in Idaho (Hortness and Berenbrock, 2001).

Variables	Estimating Equation	Area	Mean Elevation	Basin Relief	Slope >30%	Precipitation	Forested	Ave. Basin Slope	Main Channel Slope
Qa	8.37E-01	0.963			2.52		0.646	-3.44	
October									
Q80	2.27E+02						0.432		-1.09
Q50	5.77E+02						0.523		-1.27
Q20	1.56E+03						0.568		-1.43
November									
Q80	5.28E+02						0.503		-1.26
Q50	9.89E+02						0.568		-1.36
Q20	1.71E+03						0.594		-1.42
December									
Q80	5.97E+02						0.507		-1.26
Q50	1.02E+03						0.565		-1.35
Q20	1.14E+03						0.606		-1.29
January									
Q80	1.16E+03		-0.526		0.209		0.485		-1.31
Q50	5.82E+03		-1.55		0.468		0.548		-1.41
Q20	1.27E+05		-3.85		1.02		0.705		-1.49
February									
Q80	3.49E+03		-1.13		0.488		0.47		-1.47
Q50	5.18E+04		-3.06		0.939		0.537		-1.53
Q20	3.05E+05		-4.06		1.21		0.515		-1.56
March									
Q80	4.10E-01	0.922	-1.75		0.354		0.537		
Q50	1.58E+00	1	-2.97		0.684		0.546		
Q20	6.34E+00	1.04	-3.59		0.82		0.47		
April									
Q80	1.17E+04				2.8		0.795	-3.34	-1.52
Q50	9.86E+03				2.01		0.746	-2.12	-1.55
Q20	7.66E+03				1.02		0.57	-0.607	-1.57
May									
Q80	1.28E+01					1.9	0.817		-1.48
Q50	1.38E+01					2.13	0.862		-1.49
Q20	1.91E+01					2.26	0.699		-1.43
June									
Q80	5.47E+01					1.21	0.775		-1.46
Q50	3.59E+01					1.65	0.844		-1.53
Q20	4.31E+01					1.9	0.739		-1.55
July									
Q80	2.66E+02					0.617	0.587		-1.46
Q50	2.43E+02					0.464	0.698		-1.53
Q20	2.85E+02					0.876	0.734		-1.55
August									
Q80	1.34E+02						0.465		-1.03
Q50	4.80E+02						0.571		-1.28
Q20	9.86E+02						0.648		-1.39

Variables	Estimating Equation	Area	Mean Elevation	Basin Relief	Slope >30%	Precipitation	Forested	Ave. Basin Slope	Main Channel Slope
September									
Q80	1.10E+02						0.469		-0.992
Q50	3.98E+02						0.53		-1.23
Q20	9.48E+02						0.547		-1.36

Table D-3 Q80, Q50 and Q20 for selected watersheds.

Louse Creek															
Watershed Characteristics															
Area (mi)2	21.5			October	November	December	January	February March		April	May	June	July	August	September
Mean Elv in 1000s	5.7		Q80	3.19	3.86	4.43	3.76	2.9	4.6	1.4	40.2	17.8	6.60	2.91	2.97
Basin Relief in	3.1		Q50	4.30	5.36	5.76	4.0	3.4	5.5	5.5	101	42.5	3.76	4.02	3.76
% Slope >30% +	8		Q20	5.82	7.38	10.3	5.6	5	8.6	20.1 164 70.6			17.0	6.05	4.76
Precipitation	25														
% Forested + 1%	35		Qa	1.6											
Avg Basin Slope	17.5														
Main Channel	204.8														
Lower Jordan															
Watershed Characteristics															
Area (mi)2	494.0			October	November	December	January	February March		April	May	June	July	August	September
Mean Elv in 1000s	5.7		Q80	14.34	21.86	24.93	19.74	15.98	28.84	2.37	242.0	106.9	49.93	11.17	10.52
Basin Relief in	3.9		Q50	24.12	33.60	35.62	18.26	12.97	31.96	13.47 588 269.3			27.88	21.56	19.36
% Slope >30% +	3.1		Q20	41.76	50.1	53.4	14.61	15.66	55.13	90.6	1066	540.9	126.3	36.06	30.76
Precipitation	25.9														
% Forested + 1%	9		Qa	4.83											
Avg Basin Slope	11.8														
Main Channel	30.1														
Spring Creek															
Watershed Characteristics															
Area (mi)2	13.2			October	November	December	January	February March		April	May	June	July	August	September
Mean Elv in 1000s	5.5		Q80	2.44	2.81	3.19	2.04	1.09	0.43	0.15	6.8	4.5	3.43	1.97	1.93
Basin Relief in	1.3		Q50	3.00	3.57	3.84 1.27		0.53	0.27	0.70	14	7.8	1.68	2.51 2.50	
% Slope >30% +	1.2		Q20	4.08	4.8	5.9	0.50	0.51	0.40	4.5	30	15.2	5.9	3.39	3.34
Precipitation	16														
% Forested + 1%	3		Qa	0.09											
Avg Basin Slope	5.5														
Main Channel	98.9														

Table D-3 Cont. Q80, Q50 and Q20 for selected watersheds.

Rock Creek														
Watershed Characteristics														
Area (mi)2	44.3		October	November	December	January	February	March	April	May	June	July	August	September
Mean Elv in 1000s	5.7	Q80	4.80	6.18	7.07 4.43		2.35	3.86	0.36	40.7	21.3	9.88	4.16 4.14	
Basin Relief in	2.9	Q50	6.84	8.78	9.41	3.16	1.36	2.83	1.93 96	46.2		5.74	6.28	5.83
% Slope >30% +	1.5	Q20	9.93	12.4	15.8	1.77	1.28	3.79	11.2 158	77.5		23.5	9.68	7.89
Precipitation	20													
% Forested + 1%	21	Qa	0.63											
Avg Basin Slope	7.5													
Main Channel	115.1													

Cow Creek														
Watershed Characteristics														
Area (mi)2	64.9		October	November	December	January	February	March	April	May	June	July	August	September
Mean Elv in 1000s	5.2	Q80	2.49	2.88	3.26 2.44		1.6	2.02	0.03	9.73	5.6	4.03	1.96 1.91	
Basin Relief in	1.2	Q50	3.05	3.62	3.90 1.84		1.11	1.84	0.29	20.6	10.5	1.85	2.51 2.52	
% Slope >30% +	2	Q20	4.20	4.89	5.84 1.06		1.32	3.30	4.7	49.0	22.8	6.99	3.34 3.42	
Precipitation	20													
% Forested + 1%	2	Qa	0.05											
Avg Basin Slope	13.5													
Main Channel	82.6													

Soda Creek														
Watershed Characteristics														
Area (mi)2	22.5		October	November	December	January	February	March	April	May	June	July	August	September
Mean Elv in 1000s	5.2	Q80	2.06	2.31	2.61 1.94		1.25	0.76	0.02	7.51	4.32	3.12	1.64 1.61	
Basin Relief in	2.0	Q50	2.44	2.86	3.08 1.43		0.84	0.63	0.22	15.9	8.07	1.41	2.01 2.03	
% Slope >30% +	2	Q20	3.27	3.82	4.66 0.81		0.99	1.08	3.6	38.2	17.4	5.33	2.62 2.70	
Precipitation	20													
% Forested + 1%	2	Qa	0.02											
Avg Basin Slope	13.3													
Main Channel	98.4													

Table D-3 cont. Q80, Q50 and Q20 for selected watersheds.

Louisa Creek														
Watershed Characteristics														
Area (mi)2	8.7		October	November	December	January	February	March	April	May	June	July	August	September
Mean Elv in 1000s	5.8	Q80	5.80	7.73	8.88 6.58		4.35	1.91	0.21	64.6	32.7	12.9	5.24 5.27	
Basin Relief in	0.8	Q50	8.70	11.4	12.2	6.17	3.99	1.69	1.89 158 74.5			8.14	8.32	7.51
% Slope >30% +	4	Q20	12.77	16.3	21.6 6.47		4.70	2.23	19.5	228	113	34.2	13.5 10.1	
Precipitation	20													
% Forested + 1%	51	Qa	0.06											
Avg Basin Slope	23													
Main Channel	137.3													
Jordan above														
Watershed Characteristics														
Area (mi)2	47.2		October	November	December	January	February	March	April	May	June	July	August	September
Mean Elv in 1000s	6.2	Q80	6.91 9.43		10.79	8.52	6.4	5.3	2.0	100.9	45.1	18.50	5.86	5.75
Basin Relief in	3.1	Q50	10.47 13.83		14.77	7.9	5.5	5.2 9.1		250	110.2	10.59	9.62	8.79
% Slope >30% + 1%	5.2	Q20	16.04 19.86		24.3	7.2	7	7.9	44.7	420	197.9	47.7	15.36	12.45
Precipitation	25													
% Forested + 1%	20	Qa	1.4											
Avg Basin Slope	14.9													
Main Channel Slope	80.7													
Jordan ab USGS at Delamar														
Watershed Characteristics														
Area (mi)2	36.0		October	November	December	January	February	March	April	May	June	July	August	September
Mean Elv in 1000s	6.2	Q80	6.84 9.33		10.70	9.07	7.4	6.0	5.6	110.1	48.4	18.32	5.95	5.89
Basin Relief in	2.7	Q50	10.44	13.83	14.78 9.5		7.9	6.8	19.8	278	120.6	10.87	9.78 8.85	
% Slope >30% + 1%	8	Q20	15.84 19.87		25.0	11.6	11	10.4	64.2	439	206.0	49.6	15.82	12.34
Precipitation	25		1.12	2.47	15.1 13.9		38.4	54.7	107	164	46.4	5.89	0.83 0.51	
% Forested + 1%	31	Qa	3.4											
Avg Basin Slope	15.9													
Main Channel Slope	96.9													

Table D-3 cont. Q80, Q50 and Q20 for selected watersheds.

Jordan ab Boulder Creek															
Watershed Characteristics															
Area (mi)2	128.0			October	November	December	January	February	March	April	May	June	July	August	September
Mean Elv in 1000s	5.8	Q80		5.66 7.48		8.56	6.90	5.2	14.7	1.5	50.3	26.3	12.32	4.85	4.79
Basin Relief in	3.4	Q50		8.29	10.77 11.52 6.7			5.0	17.1	7.0	118	57.6	7.21	7.60	7.01
% Slope >30% + 1%	5.1	Q20		12.33	15.30 19.2 7.0			6.5	27.8	33.4	195	97.4	29.5	11.89	9.69
Precipitation 20															
% Forested + 1%	20	Qa		3.8											
Avg Basin Slope	14.5														
Main Channel	97.0														

Jordan w/ Boulder															
Watershed Characteristics															
Area (mi)2	494.0			October	November	December	January	February	March	April	May	June	July	August	September
Mean Elv in 1000s	5.7	Q80		14.34	21.86	24.93 19.74		16.0	28.8	2.4	242.0	106.9	49.93	11.17 10.52	
Basin Relief in	3.9	Q50		24.12 33.60		35.62	18.3	13.0	32.0	13.5	588	269.3	27.88	21.56	19.36
% Slope >30% +	3.1	Q20		41.76 50.15		53.4	14.6	16	55.1	91	1066	540.9	126.3	36.06	30.76
Precipitation	25.9														
% Forested + 1%	9	Qa		4.8											
Avg Basin Slope	11.8														
Main Channel	30.1														

USGS 13177985 JORDAN CR AT DE LAMAR MINE NR JORDAN VALLEY OR

Top of Form
Bottom of Form

LOCATION
Latitude 43°01'25.95", Longitude 116°51'16.22" NAD83
Owyhee County, Idaho , Hydrologic Unit 17050108
DESCRIPTION
AVAILABLE DATA:

Data Type	Begin Date	End Date	Count
Peak streamflow	1994-04-19	1996-05-14	3
Daily Data			
Discharge, cubic feet per second	1993-10-01	1996-09-30	1096
Daily Statistics			
Discharge, cubic feet per second	1993-10-01	1996-09-30	1096
Monthly Statistics			
Discharge, cubic feet per second	1993-10	1996-09	
Annual Statistics			
Discharge, cubic feet per second	1994	1996	
Field/Lab water-quality samples	1996-01-18	1996-01-18	1

OPERATION:
Record for this site is maintained by the USGS Idaho Water Science Center
Email questions about this site to Idaho NWISWeb Data Inquiries

LOCATION
Latitude 42°54'45", Longitude 116°59'40" NAD83
Owyhee County, Idaho , Hydrologic Unit 17050108
DESCRIPTION
Drainage area: 467 square miles; Contributing drainage area
467 square miles,
Datum of gage: 4,450 feet above sea level NGVD29.
AVAILABLE DATA:

Data Type	Begin Date	End Date	Count
Peak streamflow	1946-04-19	2004-03-24	26
Daily Data			
Discharge, cubic feet per second	1945-10-01	2004-06-30	9335
Daily Statistics			
Discharge, cubic feet per second	1945-10-01	2004-06-30	9335
Monthly Statistics			
Discharge, cubic feet per second	1945-10 2	004-06	
Annual Statistics			
Discharge, cubic feet per second	1946 2	004	
Field/Lab water-quality samples	1967-11-15	1967-11-15	1

OPERATION:
Record for this site is maintained by the USGS Idaho Water Science Center
Email questions about this site to Idaho NWISWeb Data Inquiries
ADDITIONAL INFORMATION
LOCATION.--Lat 42° 54`45", long 116° 59`40", in SW1/4 NW1/4 SE1/4 sec.12, T.6 S., R.6 W. (Boise Meridian), Owyhee County, Hydrologic Unit 17050108, 300 ft above Lone Tree Creek, 5 miles southeast of Jordan Valley, Oregon and at mile 52.5.

DRAINAGE AREA.--

PERIOD OF RECORD.--Oct. 12, 1945 to Jan. 13, 1953 at site about 2.0 mi upstream. April 24, 1955 to Jan. 31, 1965 at site about 4 mi upstream. Feb. 4 to Oct. 9, 1965 at temporary site 300 ft downstream; Aug. 31, 1965 to Oct. 20, 1971 at site 3.6 mi upstream. Reestablished Nov. 15, 2002 at current location.

GAGE.--Elevation of gage is 4,450 ft above NGVD of 1929.

REMARKS.--Diversions upstream from station for irrigation.

Table D-4. Diatom association metrics used by the State of Montana to evaluate biological integrity in mountain streams: references, range of values, expected response to increasing impairment or natural stress, and criteria for rating levels of biological integrity. The lowest rating for any one metric is the rating for that site.

Biological Integrity/	No. of Species	Diversity Index[2]	Pollution	Siltation	Disturbance	% Dominant	% Abnormal
Impairment or Stress/	Counted[1]	(Shannon)	Index[3] Index	[4] Index	[5] Species	[6] Valves	[7]
Use Support							
Excellent/None >29		>2.99	>2.50	<20.0	<25.0	<25.0	0
Full Support							
Good/Minor 20-29		2.00-2.99	2.01-2.50	20.0-39.9	25.0-49.9	25.0-49.9	>0.0, <3.0
Full Support							
Fair/Moderate 19-10		1.00-1.99	1.50-2.00	40.0-59.9	50.0-74.9	50.0-74.9	3.0-9.9
Partial Support							
Poor/Severe <10		<1.00	<1.50	>59.9	>74.9	>74.9	>9.9
Nonsupport							
References	Bahls 1979	Bahls 1979	Bahls 1993	Bahls 1993	Barbour	Barbour	McFarland
	Bahls 1993				et al. 1999	et al. 1999	et al. 1997
Range of Values	0-100+	0.00-5.00+	1.00-3.00	0.0-90.0+	0.0-100.0	~5.0-100.0	0.0-30.0+
Expected Response	Decrease[8]	Decrease[8]	Decrease	Increase	Increase	Increase	Increase

1 Based on a proportional count of 400 cells (800 valves)

2 Base 2 [bits] (Weber 1973)

3 Composite numeric expression of the pollution tolerances assigned by Lange-Bertalot (1979) to the common diatom species

4 Sum of the percent abundances of all species in the genera Navicula, Nitzschia and Surirella

5 Percent abundance of Achnanthidium minutissimum (synonym: Achnanthes minutissima)

6 Percent abundance of the species with the largest number of valves in the proportional count

7 Valves with an irregular outline or with abnormal ornamentation, or both

8 Species richness and diversity may increase somewhat in mountain streams in response to slight to moderate increases in nutrients or sediment

Table D-5. Relative abundance of cells and ordinal rank by biovolume of diatoms (Division Bacillariophyta) and genera of non-diatom algae in periphyton samples collected from streams in the Jordan Creek watershed in 2003.1

Taxa	Upper Rock Cr.	Split Upper Rock Cr.	Jordan Cr. ab Jacob Gl.	Jordan Cr. ab Louse cr.	Flint Cr.	Williams Cr. WCACG
Cyanophyta						
Calothrix	c/6	f/3	r/6			
Dichothrix		o/9				
Merismopedia						r/5
Nostoc	c/7	f/5				
Oscillatoria			o/4	o/7		o/3
Phormidium						
Rhodophyta						
Audouinella					o/5	
Chlorophyta						
Ankistrodesmus						
Bulbochaete	c/4	o/12				
Chaetophora	c/3	a/2		o/6		
Cladophora				c/3		o/2
Cosmarium					r/6	r/4
Gloeocystis		o/11		o/10		
Mougeotia	c/5		r/5	c/4	c/3	
Oedogonium	o/8	c/6	c/3	f/2	c/2	
Pediastrum		o/8		r/8		
Pleurotaenium						
Rhizoclonium						
Scenedesmus	r/11	o/10	r/7	o/9		
Spirogyra	f/2	f/4		c/5		
Ulothrix	o/9				o/4	
Zygnema		o/7				
Chrysophyta						
unknown filament	o/10		c/2			
Bacillariophyta a/1		a/1	a/1	a/1	f/1	d/1
No. Non-Diatom Genera	10	11	6	9	5	4

1 d = dominant; a = abundant; f = frequent; c = common; o = occasional; r = rare

2 Split sample analyzed by Mr. Erich Weber of PhycoLogic.

Table D-6. Percent abundance of major diatom species[1] and values of selected diatom association metrics for periphyton samples collected from stations in the Jordan Creek watershed, 2003. Underlined values indicate minor stress; bold values indicate moderate stress; underlined and bold values indicate severe stress; all other values indicate no stress and full support of aquatic life uses when compared to biocriteria (thresholds). Shaded cells indicate notable values for diatom indicator species and metrics.

Species/Metric	PTC2	Upper Rock Cr.	Split Upper Rock Cr.	Jordan Cr. ab Jacob Gl.	Jordan Cr. ab Louse cr.	Flint Cr.	Williams Cr.
Achnanthidium minutissimum	3	0.70	0.61	15.01	19.11	1.78	0.65
Cocconeis placentula	3	1.75	1.58		0.48	12.76	5.54
Fragilaria capucina	2	2.21	5.83	6.09	12.14	0.55	
Melosira varians	2		0.85	0.84	8.89	1.66	54.67
Navicula capitatoradiata	2	0.82				6.99	0.65
Navicula reichardtiana	2				0.96	2.22	7.50
Nitzschia acicularis	2			9.44	0.24	0.33	
Nitzschia dissipata	3	0.23	0.73	4.51	0.48	5.77	2.61
Nitzschia fonticola 3		5.83	5.59	0.60		0.22	
Nitzschia inconspicua	2	5.24	9.11		0.84	0.33	
Nitzschia lacuum	3	4.43	0.24				
Nitzschia palea	1	1.17	0.49	17.10	3.37	9.43	1.52
Pseudostaurosira brevistriata	3	25.64	10.69	0.52	1.20		
Rhoicosphenia abbreviata	3	1.17	0.12		1.20	5.44	1.30
Rhopalodia gibba	2	0.35	2.92		5.89	0.22	
Staurosira construens	3	13.05	17.01			0.22	0.22
Staurosirella pinnata	3	4.55	7.29	0.10			
Synedra rumpens	2	2.10		17.42	1.44	1.00	0.43
Synedra ulna	2	1.05	0.61	6.93	10.34	3.11	0.22
Number of Species Counted		60	71	48	66	71	48
Shannon Species Diversity		4.38	4.78	3.92	4.59	5.07	3.07
Pollution Index		2.65	2.57	2.10	2.29	2.29	2.12
Siltation Index		23.89	29.16	41.24	16.71	44.17	31.63
Disturbance Index		0.70	0.61	15.01	19.11	1.78	0.65
Percent Dominant Species		25.64	17.01	17.42	19.11	12.76	54.67
Percent Abnormal Cells		0.12	0.00	1.99	0.00	0.00	0.11
Percent Rhopalodiales		4.66	8.99	0.00	8.41	0.44	0.00
Similarity Index3			63.51		43.35		

1A major diatom species accounts for 5.0% or more of the cells at one or more stations in a sample set.
2 Pollution Tolerance Class (Lange-Bertalot 1979): 1 = most tolerant; 2 = tolerant; 3 = sensitive to organic pollution.
3 Percent Community Similarity (Whittaker 1952) when compared to the diatom assemblage at the next upstream station on the same stream.
4 Split sample analyzed by Mr. Erich Weber of PhycoLogic.

Table D-7. Modal categories for selected ecological attributes of diatom species in the Jordan Creek watershed, 2003. Modal categories that represent somewhat inferior water quality when compared to the best site(s) in the sample set are given in bold letters. Modal categories that represent significantly inferior water quality when compared to the best site(s) in the sample set are in shaded cells.

Ecological Attribute	Upper	Split Upper	Jordan Cr.	Jordan Cr.	Flint Cr.	Williams Cr.
	Rock Cr.	Rock Cr.	ab Jacob Gl.	ab Louse cr.		WCACG
Motility[1] not		not	not	not	not	not
motile		motile	motile	motile motile		motile
pH[2] alkaliphilous		alkaliphilous circumneutral		circumneutral	alkaliphilous alkaliphilous	
Salinity[2] fresh		fresh	fresh	fresh fresh		fresh
Nitrogen Uptake[2] autotrophs		autotrophs	autotrophs	autotrophs autotrophs		heterotrophs
	(low organics)	(low organics)	(high organics)	(high organics)	(high organics)	
Oxygen Demand[2] continuously		continuously	low	moderate	moderate	moderate
high		high				
Saprobity[2] beta-meso-		beta-meso-	beta-meso-	beta-meso-	beta-meso-	alpha-meso-
saprobous		saprobous	saprobous	saprobous saprobous		saprobous
Trophic State[2] variable		meso-	variable	variable	eutraphentic	eutraphentic
		eutraphentic				

1 Dr. R. Jan Stevenson, Michigan State University, digital communication.

2 Van Dam et al. 1994

3 Split sample analyzed by Mr. Erich Weber of PhycoLogic.

Table D-8. 2003 DEQ Macroinvertebrate Data Analysis

DEQ 2003								
			Below Mine				above mine	
Stream TROUT	CREEK	ROCK CREEK	JORDAN CREEK	FLINT CREEK	JOSEPHINE CREEK	ROCK CREEK	JORDAN CREEK	WILLIAMS CREEK
Site 2003SBOIA00	7	2003SBOIA010	2003SBOIA039	2003SBOIA04 0	2003SBOIA0 41	2003SBOIA0 42	2003SBOIA0 45	2003SBOIA046
Date 07-15-	2003	07-17-2003	09-09-2003	09-09-2003	09-10-2003	09-10-2003	09-11-2003	09-11-2003
Percent Subsampled	8.33	21.88	25.00	20.83	16.67	100.00	20.83	31.25
EcoAnalysts Sample ID	1	2	3	4	5	6	7	8
Abundance Measures								
Corrected Abundance	6720.00	2435.81	2176.00	2592.00	3210.00	451.00	2692.80	1760.00
EPT Abundance	2256.00	329.04	1008.00	1080.00	1026.00	207.00	1440.00	806.40
Dominance Measures								
1st Dominant Taxon	Hydropsyche sp.	Cladotanytarsus sp.	Tanytarsus sp. Acari		Pisidium sp.	Tricorythodes sp.	Rhithrogena sp.	Optioservus sp.
1st Dominant Abundance	804.00 488.99		564.00	667.20	900.00	148.00	441.60	448.00
2nd Dominant Taxon	Sphaeriidae	Acari	Tricorythodes sp.	Brachycentrus americanus	Tricorythodes sp.	Hyalella sp.	Hydropsyche sp.	Zaitzevia sp.
2nd Dominant Abundance	708.00 301.62		408.00	350.40	696.00	75.00	297.60	259.20
3rd Dominant Taxon	Micropsectra sp.	Parametriocnemus sp.	Paraleptophlebia sp.	Optioservus sp.	Hyalella sp.	Leptophlebiidae	Micropsectra sp.	Brachycentrus americanus
3rd Dominant Abundance	624.00 164.52		356.00	216.00	354.00	35.00	288.00	137.60
% 1 Dominant Taxon	11.96	20.08	25.92	25.74	28.04	32.82	16.40	25.45
% 2 Dominant Taxa	22.50	32.46	44.67	39.26	49.72	49.45	27.45	40.18
% 3 Dominant Taxa	31.79	39.21	61.03	47.59	60.75	57.21	38.15	48.00
% 4 Dominant Taxa			66.9%				48.3%	
% 5 Dominant Taxa			70.0%				55.1%	
Richness Measures								
Species Richness 58.00		48.00	42.00	50.00	41.00 41.00		46.00	50.00
EPT Richness	18.00	10.00	10.00	19.00	8.00	9.00	21.00	22.00
Ephemeroptera Richness	6.00 4.00		5.00	8.00	3.00	4.00	10.00	8.00
Plecoptera Richness	4.00	2.00	1.00	5.00	0.00	0.00	5.00	4.00
Trichoptera Richness	8.00	4.00	4.00	6.00	5.00	5.00	6.00	10.00
Chironomidae Richness	23.00 17.00		13.00	16.00	11.00	12.00	18.00	11.00
Oligochaeta Richness	1.00	4.00	3.00	3.00	2.00	4.00	0.00	3.00

Table D-8 cont. 2003 DEQ Macroinvertebrate Data Analysis

Non-Chiro. Non-Olig. Richness	34.00	27.00	26.00	31.00	28.00	25.00	28.00	36.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
Community Composition								
% Ephemeroptera	9.11	8.07	38.60	13.89	24.49	41.02	25.49	10.36
% Plecoptera	7.86	1.88	0.18	6.30	0.00	0.00	14.80	10.36
% Trichoptera	16.61	3.56	7.54	21.48	7.48	4.88	13.19	25.09
% EPT	33.57	13.51	46.32	41.67	31.96	45.90	53.48	45.82
% Coleoptera	5.00	7.88	2.02	8.89	2.99	2.22	5.53	40.73
% Diptera	44.11	53.85	35.11	15.93	4.86	13.53	30.84	9.45
% Oligochaeta	1.61	5.44	2.02	3.33	2.06	4.21	0.00	1.64
% Baetidae	6.25	0.75	0.18	0.74	2.06	0.44	1.78	3.09
% Brachycentridae	0.36	0.00	0.00	13.52	0.00	0.00	1.07	12.55
% Chironomidae	41.61	47.47	33.27	12.78	3.93	12.42	27.99	8.55
% Ephemerellidae	0.00	0.00	2.94	2.59	0.00	0.00	5.17	0.55
% Hydropsychidae	12.86	2.25	0.00	3.33	0.56	0.00	11.05	6.91
% Odonata	1.07	0.56	3.68	0.00	4.11	6.65	0.00	0.18
% Perlidae	0.00	0.00	0.00	0.93	0.00	0.00	5.88	0.73
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Simuliidae	1.43	0.00	0.00	0.19	0.37	0.00	0.00	0.36

Table D-8 cont. 2003 DEQ Macroinvertebrate Data Analysis

Stream TRO	UT CREEK	ROCK CREEK	JORDAN CREEK	FLINT CREEK	JOSEPHINE CREEK	ROCK CREEK	JORDAN CREEK	WILLIAMS CREEK
Site 2003SBOIA0	07	2003SBOIA010	2003SBOIA03 9	2003SBOIA040	2003SBOIA041	2003SBOIA042	2003SBOIA045	2003SBOIA046
Date 07-15-	2003	07-17-2003	09-09-2003	09-09-2003	09-10-2003	09-10-2003	09-11-2003	09-11-2003
Percent Subsampled	8.33	21.88	25.00	20.83	16.67	100.00	20.83	31.25
EcoAnalysts Sample ID	1	2	3	4	5	6	7	8
Functional Group Composition								
% Filterers	36.25	5.44	26.29	18.33	29.35	2.66	12.66	17.45
% Gatherers	32.68	54.03	42.83	19.26	43.18	73.17	30.30	26.55
% Predators	5.89	29.27	13.24	35.37	10.09	14.41	27.27	7.82
% Scrapers	6.25	8.44	9.19	18.15	14.95	5.76	21.57	35.82
% Shredders	17.68	1.50	6.25	8.15	0.56	2.22	7.84	12.18
% Piercer-Herbivores	0.89	0.94	0.00	0.00	0.56	0.22	0.00	0.18
% Unclassified	0.36	0.38	2.21	0.74	1.31	1.55	0.36	0.00
Filterer Richness	7.00	2.00	2.00	4.00	5.00	2.00	3.00	6.00
Gatherer Richness	21.00	22.00	15.00	20.00	13.00	16.00	18.00	18.00
Predator Richness	11.00	13.00	11.00	10.00	10.00	10.00	11.00	10.00
Scraper Richness	7.00	4.00	9.00	8.00	7.00	5.00	7.00	7.00
Shredder Richness	9.00	4.00	3.00	6.00	2.00	5.00	6.00	8.00
Piercer-Herbivore Richness	1.00 2.00		0.00	0.00	2.00	1.00	0.00	1.00
Unclassified 2.00		1.00	2.00	2.00	2.00	2.00	1.00	0.00
Diversity/Evenness Measures								
Shannon-Weaver H' (log 10)	1.44 1.32		1.11	1.29	1.09	1.10	1.29	1.23
Shannon-Weaver H' (log 2)	4.79 4.37		3.68	4.30	3.62	3.67	4.29	4.07
Shannon-Weaver H' (log e)	3.32 3.03		2.55	2.98	2.51	2.54	2.97	2.82
Margalef's Richness	6.47	6.03	5.33	6.23	4.95	6.55	5.70	6.56
Pielou's J'	0.82	0.78	0.68	0.76	0.68	0.68	0.78	0.72
Simpson's Heterogeneity	0.94	0.92	0.86	0.90	0.85	0.85	0.92	0.89
Biotic Indices								
% Indiv. w/ HBI Value	99.46	93.25	96.88	97.04	96.45	97.34	97.86	100.00
Hilsenhoff Biotic Index	5.28	5.92	4.64	4.20	5.83	5.78	3.64	3.81
% Indiv. w/ MTI Value	80.89	69.23	72.06	81.30	47.29	65.19	75.76	79.27
Metals Tolerance Index	3.21	3.72	3.47	4.06	3.78	4.00	3.48	3.77
% Indiv. w/ FSBI Value	35.36	20.08	40.26	46.11	24.49	36.36	58.29	85.09
Fine Sediment Biotic Index	77.00 34.00		26.00	87.00	23.00	17.00	108.00	116.00

FSBI - average	1.33	0.71	0.62	1.74	0.56	0.41	2.35	2.32
FSBI - weighted average	4.25	2.89	3.16	5.04	3.95	3.85	5.20	4.46
% Indiv. w/ TPM Value	67.68	30.96	57.17	51.11	41.12	55.43	72.01	89.64
Temp. Pref. Metric - average	2.71 1.63		1.05	2.36	1.20	0.66	3.87	3.02
TPM - weighted average	3.46	3.84	2.47	4.28	2.14	2.07	5.24	3.90
DEQ MBI	4.77	3.90	4.06	4.73	3.73	3.75	5.06	5.09
Karr BIBI Metrics								
Long-Lived Taxa Richness	6.00 5.00		3.00	5.00	3.00	4.00	7.00	8.00
Clinger Richness	32.00	21.00	23.00	28.00	21.00	17.00	26.00	32.00
% Clingers	70.89	59.66	70.04	81.11	47.29	47.89	84.85	90.73
Intolerant Taxa Richness	10.00	5.00	7.00	14.00	4.00	4.00	16.00	16.00
% Tolerant taxa	0.01	2.16	1.52	0.87	3.62	31.21	0.00	0.68
UIN 520-1		520-2	520-3	520-4	520-5	520-6	520-7	520-8

Table D-9 Kinross Delmar Mine 1999 Macroinvertebrate Data

Kinross-Delamar				
Stream	Jordan Creek	Jordan Creek	Jordan Creek	Jordan Creek
Site B1		B1	B1	B2
Rep 1		2	3	1
Date 08-12-	1999	08-12-1999	08-12-1999	08-12-1999
Percent Subsampled	100.00	100.00	100.00	73.53
Abundance Measures				
Corrected abundance	189.00	306.00	175.00	779.28
EPT abundance	38.00	103.00	50.00	59.84
Dominance Measures				
1st dominant taxon	Orthocladius Complex	Sweltsa sp.	Sweltsa sp.	Orthocladius Complex
1st Dominant Abundance	36.00	84.00	36.00	269.30
2nd dominant taxon	Orthocladius sp.	Orthocladius Complex	Orthocladius Complex	Orthocladius sp.
2nd Dominant Abundance	23.00	38.00	36.00	201.30
3rd dominant taxon	Optioservus sp.	Potthastia gaedii gr.	Orthocladius sp.	Eukiefferiella claripennis gr.
3rd Dominant Abundance	20.00	33.00	18.00	81.60
% 1 dominant taxon	19.05	27.45	20.57	34.55
% 2 dominant taxa	31.22	39.87	41.14	60.38
% 3 dominant taxa	41.80	50.65	51.43	70.86
Richness Measures				
species richness	34.00	34.00	28.00	31.00
EPT richness	10.00	12.00	11.00	8.00
Ephemeroptera richness	2.00	3.00	2.00	3.00
Plecoptera richness	3.00	5.00	6.00	3.00
Trichoptera richness	5.00	4.00	3.00	2.00
Rhyacophila richness	0.00	0.00	0.00	0.00
Community Composition				
% Ephemeroptera	2.12	1.31	1.71	3.14
% Plecoptera	11.64	30.72	24.57	3.84
% Trichoptera	6.35	1.63	2.29	0.70
% EPT	20.11	33.66	28.57	7.68
% Coleoptera	15.34	7.52	10.86	7.85
% Diptera	58.73	55.88	53.71	79.58
% Oligochaetae	0.00	0.00	0.00	0.00
% Baetidae	0.00	0.00	0.00	0.17
% Brachycentridae	3.17	0.00	0.57	0.17
% Chironomidae	51.32	50.33	49.71	77.49
% Ephemerellidae	2.12	0.98	1.14	2.97
% Hydropsychidae	2.12	0.00	0.57	0.52
% Odonata	0.00	0.00	0.00	0.00
% Perlidae	1.59	0.65	1.14	0.17
% Pteronarcyidae	0.00	0.00	0.00	0.00
% Simuliidae	0.00	0.00	0.00	0.00

Table D-9 cont. Kinross Delmar Mine 1999 Macroinvertebrate Data

Functional Group Composition				
% filterers	4.76	0.00	1.14	0.70
% gatherers	49.21	41.18	53.71	79.23
% predators	24.87	40.20	30.86	9.25
% scrapers	2.12	1.96	1.14	0.17
% shredders	7.41	11.76	6.29	3.14
filterer richness	2.00	0.00	2.00	2.00
gatherer richness	13.00	14.00	11.00	17.00
predator richness	11.00	10.00	6.00	6.00
scraper richness	3.00	4.00	1.00	1.00
shredder richness	3.00	4.00	4.00	3.00
Diversity/Evenness Measures				
Shannon-Weaver H' (log 10)	1.26	1.13	1.13	0.90
Shannon-Weaver H' (log 2)	4.20	3.75	3.77	3.00
Shannon-Weaver H' (log e)	2.91	2.60	2.61	2.08
Hilsenhoff Biotic Index	4.46	3.24	3.97	5.61
Margalef's Richness	6.30	5.77	5.23	4.51
Metals Tolerance Index	3.10	2.87	2.21	2.26
Pielou's J'	0.82	0.74	0.78	0.61
Simpson's Heterogeneity	0.92	0.88	0.89	0.80
Karr BIBI Metrics				
Long-Lived taxa richness	8.00	4.00	5.00	4.00
Clinger richness	12.00	11.00	13.00	12.00
Intolerant taxa richness	1.00	3.00	2.00	2.00
% Tolerant taxa	19.05	10.78	18.29	8.60
Montana DEQ Metrics				
MT Biotic Index	4.46	3.24	3.97	5.61
C-Gatherers + C- Filterers	53.97	41.18	54.86	79.93
% Scraper + %Shredder	9.52	13.73	7.43	3.32
% univoltine	49.74	43.14	43.43	65.79
% multivoltine	17.99	18.63	20.00	20.94
% semivoltine	17.99	8.17	12.57	7.68
% Hydropsychinae	2.12	0.00	0.57	0.00
UIN 8-160		8-161	8-162	8-163

Table D-9 cont. Kinross Delmar Mine 1999 Macroinvertebrate Data

Stream	Jordan Creek	Jordan Creek	Jordan Creek	Jordan Creek	Jordan Creek
Site B2		B2	B3	B3	B3
Rep 2		3	1	2	3
Date 08-12-	1999	08-12-1999	08-12-1999	08-12-1999	08-12-1999
Percent Subsampled	56.82	100.00	100.00	100.00	100.00
Abundance Measures					
Corrected abundance	1047.20	152.00	537.00	466.00	338.00
EPT abundance	128.48	22.00	315.00	249.00	136.00
Dominance Measures					
1st dominant taxon	Orthocladius sp.	Orthocladius Complex	Rhithrogena sp.	Rhithrogena sp.	Micropsectra sp.
1st Dominant Abundance	285.10 43.00		102.00	101.00	86.00
2nd dominant taxon	Orthocladius Complex	Orthocladius sp.	Drunella doddsi	Polypedilum sp.	Rhithrogena sp.
2nd Dominant Abundance	257.00 38.00		100.00	69.00	54.00
3rd dominant taxon	Acari	Antocha sp.	Micropsectra sp.	Sweltsa sp.	Polypedilum sp.
3rd Dominant Abundance	80.96 7.00		77.00	35.00	45.00
% 1 dominant taxon	27.23	28.29	18.99	21.67	25.44
% 2 dominant taxa	51.76	53.29	37.62	36.48	41.42
% 3 dominant taxa	59.50	57.89	51.96	43.99	54.73
Richness Measures					
species richness	33.00	25.00	38.00	42.00	35.00
EPT richness	12.00	9.00	15.00	21.00	15.00
Ephemeroptera richness	3.00 6.00		7.00	9.00	6.00
Plecoptera richness	5.00	1.00	4.00	6.00	5.00
Trichoptera richness	4.00	2.00	4.00	6.00	4.00
Rhyacophila richness	0.00	0.00	1.00	0.00	0.00
Community Composition					
% Ephemeroptera	5.55	9.21	47.67	36.91	23.67
% Plecoptera	5.55	3.95	3.54	8.58	4.73
% Trichoptera	1.18	1.32	7.45	7.94	11.83
% EPT	12.27	14.47	58.66	53.43	40.24
% Coleoptera	12.27	5.26	3.54	4.94	2.37
% Diptera	67.73	78.95	36.87	38.84	55.03
% Oligochaetae	0.00	0.00	0.00	0.00	0.30
% Baetidae	0.17	0.00	8.01	3.43	3.25
% Brachycentridae	0.34	0.00	0.00	0.43	0.00
% Chironomidae	64.71	74.34	34.45	36.91	53.25
% Ephemerellidae	5.38	4.61	20.11	7.94	3.25
% Hydropsychidae	0.50	0.00	7.08	5.15	10.95
% Odonata	0.00	0.00	0.00	0.00	0.00
% Perlidae	0.84	0.00	1.49	0.21	0.59
% Pteronarcyidae	0.00	0.00	0.00	0.00	0.00
% Simuliidae	0.00	0.00	0.00	0.00	0.00

Table D-9 cont. Kinross Delmar Mine 1999 Macroinvertebrate Data

Functional Group Composition					
% filterers	0.50	0.00	7.45	5.36	10.95
% gatherers	70.08	75.66	31.84	28.11	42.60
% predators	13.61	7.24	6.52	12.02	7.99
% scrapers	0.34	0.66	1.30	3.22	1.18
% shredders	4.87	4.61	11.36	15.88	14.50
filterer richness	1.00	0.00	3.00	2.00	2.00
gatherer richness	15.00	12.00	13.00	16.00	13.00
predator richness	7.00	3.00	10.00	7.00	8.00
scraper richness	1.00	1.00	4.00	4.00	2.00
shredder richness	5.00	3.00	3.00	5.00	4.00
Diversity/Evenness Measures					
Shannon-Weaver H' (log 10)	1.03 1.05		1.12	1.25	1.14
Shannon-Weaver H' (log 2)	3.41 3.50		3.72	4.15	3.77
Shannon-Weaver H' (log e)	2.37 2.42		2.58	2.88	2.62
Hilsenhoff Biotic Index	5.16	4.81	2.88	2.99	3.55
Margalef's Richness	4.60	4.78	5.89	6.67	5.84
Metals Tolerance Index	2.64	2.51	2.36	2.46	2.52
Pielou's J'	0.68	0.75	0.71	0.77	0.74
Simpson's Heterogeneity	0.85 0.85		0.89	0.91	0.88
Karr BIBI Metrics					
Long-Lived taxa richness	6.00 2.00		4.00	4.00	4.00
Clinger richness	14.00	7.00	16.00	18.00	15.00
Intolerant taxa richness	2.00	1.00	1.00	3.00	2.00
% Tolerant taxa	11.08	7.24	12.66	10.30	7.10
Montana DEQ Metrics					
MT Biotic Index	5.16	4.81	2.88	2.99	3.55
C-Gatherers + C-Filterers	70.59 75.66		39.29	33.48	53.55
% Scraper + %Shredder	5.21 5.26		12.66	19.10	15.68
% univoltine	61.34	71.05	46.93	44.21	34.91
% multivoltine	19.66	17.76	26.07	17.60	33.14
% semivoltine	12.61	5.26	5.21	5.36	3.25
% Hydropsychinae	0.00	0.00	6.33	5.15	8.88
UIN 8-164		8-165	8-166	8-167	8-168

Table D-9 cont. Kinross Delmar Mine 1999 Macroinvertebrate Data

Stream	Jordan Creek	Jordan Creek	Jordan Creek	Jordan Creek	Jordan Creek	Jordan Creek	Jordan Creek
Site	B4	B4	B4	B5	B5	B5	B6
Rep	1	2	3	1	2	3	1
Date	08-12-1999	08-12-1999	08-12-1999	08-11-1999	08-11-1999	08-11-1999	08-11-1999
Percent Subsampled	93.46	100.00	69.93	100.00	100.00	23.31	100.00
Abundance Measures							
Corrected abundance	520.02	374.00	726.44	302.00	497.00	1973.40	270.00
EPT abundance	258.94	219.00	286.00	246.00	400.00	1162.59	143.00
Dominance Measures							
1st dominant taxon	Micropsectra sp.	Rhithrogena sp.	Micropsectra sp.	Rhithrogena sp.	Rhithrogena sp.	Rhithrogena sp.	Rhithrogena sp.
1st Dominant Abundance	169.10	116.00	208.80	90.00	227.00	403.30	71.00
2nd dominant taxon	Rhithrogena sp.	Micropsectra sp.	Rhithrogena sp.	Baetis tricaudatus	Baetis tricaudatus	Polypedilum sp.	Baetis tricaudatus
2nd Dominant Abundance	149.80	72.00	137.30	46.00	67.00	313.20	24.00
3rd dominant taxon	Sweltsa sp.	Polypedilum sp.	Polypedilum sp.	Drunella doddsi	Polypedilum sp.	Micropsectra sp.	Antocha sp.
3rd Dominant Abundance	43.87	35.00	71.50	42.00	34.00	283.10	19.00
% 1 dominant taxon	32.51	31.02	28.74	29.80	45.67	20.43	26.30
% 2 dominant taxa	61.32	50.27	47.64	45.03	59.15	36.30	35.19
% 3 dominant taxa	69.75	59.63	57.48	58.94	66.00	50.65	42.22
Richness Measures							
species richness	32.00	30.00	44.00	26.00	35.00	27.00	33.00
EPT richness	12.00	12.00	21.00	12.00	17.00	12.00	13.00
Ephemeroptera richness	3.00	4.00	9.00	5.00	8.00	6.00	6.00
Plecoptera richness	4.00	4.00	6.00	2.00	3.00	3.00	3.00
Trichoptera richness	5.00	4.00	6.00	5.00	6.00	3.00	4.00
Rhyacophila richness	1.00	0.00	0.00	0.00	0.00	0.00	1.00
Community Composition							
% Ephemeroptera	37.45	44.12	28.35	59.60	68.01	38.91	43.70
% Plecoptera	9.67	6.95	6.50	8.28	6.04	8.48	3.70
% Trichoptera	2.67	7.49	4.53	13.58	6.44	11.52	5.56
% EPT	49.79	58.56	39.37	81.46	80.48	58.91	52.96
% Coleoptera	4.73	4.01	4.13	3.97	1.61	1.74	6.30
% Diptera	44.65	36.63	54.72	12.58	16.10	38.04	37.78
% Oligochaetae	0.00	0.00	0.20	0.00	0.00	0.00	0.00
% Baetidae	5.35	7.49	5.71	15.23	13.48	11.09	9.26
% Brachycentridae	0.21	0.27	0.20	0.99	0.20	0.00	0.00
% Chironomidae	41.77	33.69	48.82	10.93	13.08	36.52	25.19
% Ephemerellidae	3.29	5.61	2.17	14.24	7.04	6.96	7.41
% Hydropsychidae	1.23	6.68	3.35	11.26	5.03	10.65	2.59

% Odonata	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Perlidae	0.82	2.94	0.98	0.99	1.81	1.09	0.00
% Pteronarcyidae	0.00 0.00		0.00	0.00	0.00	0.00	0.37
% Simuliidae	0.62	1.07	0.20	0.99	0.00	0.87	4.81

Table D-9 cont. Kinross Delmar Mine 1999 Macroinvertebrate Data

Functional Group Composition							
% filterers	2.67	8.02	3.54	12.91	5.23	11.52	7.41
% gatherers	46.50	34.22	48.82	26.49	21.13	33.04	38.52
% predators	11.52	6.15	9.65	10.60	9.86	9.35	7.78
% scrapers	0.62	1.07	1.57	1.66	0.80	1.74	2.22
% shredders	3.91	11.76	12.20	3.64	7.44	16.74	5.93
filterer richness	3.00	3.00	3.00	3.00	2.00	2.00	2.00
gatherer richness	14.00	11.00	17.00	10.00	12.00	9.00	16.00
predator richness	9.00	8.00	9.00	5.00	9.00	5.00	4.00
scraper richness	1.00	3.00	4.00	3.00	2.00	4.00	3.00
shredder richness	1.00	2.00	5.00	1.00	3.00	3.00	3.00
Diversity/Evenness Measures							
Shannon-Weaver H' (log 10)	0.93 1.02		1.16	0.99	0.92	1.04	1.21
Shannon-Weaver H' (log 2)	3.10 3.40		3.84	3.29	3.07	3.44	4.01
Shannon-Weaver H' (log e)	2.15 2.36		2.66	2.28	2.12	2.38	2.78
Hilsenhoff Biotic Index	2.53	2.72	3.21	2.26	1.89	3.14	2.75
Margalef's Richness	4.96	4.90	6.53	4.38	5.48	3.43	5.72
Metals Tolerance Index	1.87 2.55		2.26	2.47	2.59	2.76	2.87
Pielou's J'	0.62	0.69	0.70	0.70	0.60	0.72	0.79
Simpson's Heterogeneity	0.80 0.84		0.86	0.85	0.76	0.88	0.90
Karr BIBI Metrics							
Long-Lived taxa richness	4.00 4.00		4.00	3.00	4.00	3.00	4.00
Clinger richness	16.00	14.00	19.00	14.00	14.00	12.00	15.00
Intolerant taxa richness	1.00 2.00		2.00	2.00	2.00	2.00	1.00
% Tolerant taxa	10.00	12.30	7.43	20.86	17.10	3.29	18.15
Montana DEQ Metrics							
MT Biotic Index	2.53	2.72	3.21	2.26	1.89	3.14	2.75
C-Gatherers + C-Filterers	49.18 42.25		52.36	39.40	26.36	44.57	45.93
% Scraper + %Shredder	4.53 12.83		13.78	5.30	8.25	18.48	8.15
% univoltine	37.04	40.91	32.48	48.01	57.34	34.13	47.41
% multivoltine	42.59	33.42	42.91	23.51	20.72	29.57	34.07
% semivoltine	5.56	6.95	6.10	4.64	3.42	2.83	8.15
% Hydropsychinae	1.23	6.68	2.76	11.26	5.03	10.65	2.59
UIN	8-169	8-170	8-171	8-172 8-173		8-174 8-175	

Table D-9 cont. Kinross Delmar Mine 1999 Macroinvertebrate Data

Stream	Jordan Creek	Jordan Creek	Jordan Creek	Jordan Creek	Jordan Creek	Jordan Creek	Jordan Creek
Site	B6	B6	B7	B7	B7	B8	B8
Rep	2	3	1	2	3	1	2
Date	08-11-1999	08-11-1999	08-11-1999	08-11-1999	08-11-1999	08-11-1999	08-11-1999
Percent Subsampled	76.92	100.00	100.00	66.67	66.67	100.00	100.00
Abundance Measures							
Corrected abundance	683.80	257.00	408.77	836.50	826.50	110.00	139.00
EPT abundance	481.00	181.00	30.00	300.00	351.00	72.00	84.00
Dominance Measures							
1st dominant taxon	Rhithrogena sp.	Rhithrogena sp.	Polypedilum sp.	Polypedilum sp.	Polypedilum sp.	Rhithrogena sp.	Rhithrogena sp.
1st Dominant Abundance	149.50	49.00	134.80	304.00	234.00	27.00	27.00
2nd dominant taxon	Hydropsyche sp.	Baetis tricaudatus	Cladotanytarsus sp.	Hydropsyche sp.	Hydropsyche sp.	Hydropsyche sp.	Polypedilum sp.
2nd Dominant Abundance	109.20	37.00	122.00	73.50	166.50	17.00	26.00
3rd dominant taxon	Baetis tricaudatus	Sweltsa sp.	Tanytarsus sp.	Rhithrogena sp.	Optioservus sp.	Polypedilum sp.	Hydropsyche sp.
3rd Dominant Abundance	102.70	22.00	25.68	60.00	78.00	17.00	25.00
% 1 dominant taxon	21.86	19.07	32.98	36.34	28.31	24.55	19.42
% 2 dominant taxa	37.83	33.46	62.82	45.13	48.46	40.00	38.13
% 3 dominant taxa	52.85	42.02	69.10	52.30	57.89	55.45	56.12
Richness Measures							
species richness	35.00	39.00	32.00	47.00	41.00	24.00	33.00
EPT richness	18.00	20.00	15.00	19.00	19.00	10.00	13.00
Ephemeroptera richness	8.00	9.00	6.00	7.00	7.00	4.00	5.00
Plecoptera richness	5.00	5.00	1.00	5.00	5.00	2.00	4.00
Trichoptera richness	5.00	6.00	8.00	7.00	7.00	4.00	4.00
Rhyacophila richness	2.00	1.00	0.00	0.00	1.00	0.00	0.00
Community Composition							
% Ephemeroptera	47.34	47.86	2.20	14.35	12.89	38.18	33.09
% Plecoptera	5.70	11.67	1.22	5.38	5.26	2.73	3.60
% Trichoptera	17.30	10.89	3.91	16.14	24.32	24.55	23.74
% EPT	70.34	70.43	7.34	35.86	42.47	65.45	60.43
% Coleoptera	2.85	2.72	10.76	10.94	13.97	2.73	2.16
% Diptera	26.43	22.96	81.65	51.05	40.47	29.09	35.97
% Oligochaetae	0.00	0.00	0.24	0.18	0.00	0.00	1.44
% Baetidae	15.02	14.79	0.49	2.51	5.63	0.00	0.00
% Brachycentridae	0.38	0.00	0.98	1.08	0.73	0.00	0.00
% Chironomidae	20.91	15.18	81.41	48.71	37.39	27.27	31.65
% Ephemerellidae	10.08	7.39	0.73	3.77	2.18	5.45	12.23

% Hydropsychidae	15.97	7.39	0.73	8.79	20.15 15.45 17.99
% Odonata	0.00	0.00	0.00	0.00	0.00 0.00 0.00
% Perlidae	1.14	1.56	0.00	1.08	0.36 0.00 1.44
% Pteronarcyidae	0.00	0.00	0.00	0.90	1.45 0.00 0.00
% Simuliidae	3.42	1.17	0.00	0.18	1.27 0.91 0.72

Table D-9 cont. Kinross Delmar Mine 1999 Macroinvertebrate Data

Functional Group Composition							
% filterers	19.77	8.56	7.02	11.30	23.41	17.27	20.86
% gatherers	27.19	28.79	13.67	19.61	17.42	10.00	15.83
% predators	5.32	16.73	4.80	6.63	6.35	6.36	3.60
% scrapers	1.52	3.50	3.58	6.81	1.81	3.64	4.32
% shredders	13.69	8.17	33.99	37.54	30.67	24.55	24.46
filterer richness	3.00	2.00	2.00	5.00	4.00	3.00	4.00
gatherer richness	12.00	13.00	12.00	17.00	12.00	7.00	13.00
predator richness	10.00	8.00	5.00	8.00	8.00	4.00	4.00
scraper richness	4.00	6.00	4.00	5.00	3.00	3.00	2.00
shredder richness	2.00	4.00	3.00	3.00	5.00	3.00	4.00
Diversity/Evenness Measures							
Shannon-Weaver H' (log 10)	1.09 1.26		0.92	1.16	1.12	1.08	1.15
Shannon-Weaver H' (log 2)	3.63 4.19		3.06	3.86	3.73	3.60	3.84
Shannon-Weaver H' (log e)	2.52 2.91		2.12	2.67	2.59	2.49	2.66
Hilsenhoff Biotic Index	3.11 2.60		5.67	4.46	4.63	3.30	3.34
Margalef's Richness	5.21	6.85	5.16	6.84	5.95	4.89	6.48
Metals Tolerance Index	3.16 2.82		3.40	3.27	3.67	2.83	2.76
Pielou's J'	0.71	0.79	0.61	0.69	0.70	0.78	0.76
Simpson's Heterogeneity	0.88 0.92		0.79	0.84	0.86	0.88	0.89
Karr BIBI Metrics							
Long-Lived taxa richness	4.00 5.00		3.00	6.00	5.00	2.00	2.00
Clinger richness	17.00	17.00	13.00	22.00	21.00	15.00	16.00
Intolerant taxa richness	3.00 3.00		1.00	1.00	1.00	1.00	1.00
% Tolerant taxa	14.19	21.01	11.01	10.16	14.76	5.45	2.16
Montana DEQ Metrics							
MT Biotic Index	3.11	2.60	5.67	4.46	4.63	3.30	3.34
C-Gatherers + C-Filterers	46.96 37.35		20.69	30.90	40.83	27.27	36.69
% Scraper + %Shredder	15.21 11.67		37.57	44.35	32.49	28.18	28.78
% univoltine	36.69	39.30	48.99	25.70	15.97	46.36	42.45
% multivoltine	28.71	28.40	2.85	10.34	14.16	10.00	10.07
% semivoltine	3.99	5.45	10.76	12.91	15.79	2.73	3.60
% Hydropsychinae	15.97	7.39	0.73	8.79	20.15	15.45	17.99
UIN 8-176		8-177	8-178	8-179	8-180	8-181	8-182

Table D-9 cont. Kinross Delmar Mine 1999 Macroinvertebrate Data

Stream	Jordan Creek	Jordan Creek	Jordan Creek	Jordan Creek	Louse Creek	Louse Creek	Louse Creek
Site	B8	B11	B11	B11	B9	B9	B9
Rep	3	1	2	3	1	2	3
Date	08-11-1999	08-11-1999	08-11-1999	08-11-1999	08-11-1999	08-11-1999	08-11-1999
Percent Subsampled	100.00	93.46	100.00	100.00	93.46	100.00	100.00
Abundance Measures							
Corrected abundance	146.00	524.30	287.00	286.00	459.03	166.00	424.00
EPT abundance	93.00	233.26	170.00	227.00	202.23	63.00	220.00
Dominance Measures							
1st dominant taxon	Hydropsyche sp.	Lepidostoma sp.	Lepidostoma sp.	Lepidostoma sp.	Micropsectra sp.	Micropsectra sp.	Baetis tricaudatus
1st Dominant Abundance	27.00	79.18	107.00	168.00	113.40	38.00	92.00
2nd dominant taxon	Polypedilum sp.	Hydropsyche sp.	Hydropsyche sp.	Hydropsyche sp.	Optioservus sp.	Optioservus sp.	Micropsectra sp.
2nd Dominant Abundance	25.00	70.62	26.00	32.00	73.83	31.00	63.00
3rd dominant taxon	Nixe sp.	Polypedilum sp.	Polypedilum sp.	Polypedilum sp.	Rhithrogena sp.	Agapetus sp.	Simulium sp.
3rd Dominant Abundance	13.00	56.71	25.00	16.00	56.71	26.00	56.00
% 1 dominant taxon	18.49	15.10	37.28	58.74	24.71	22.89	21.70
% 2 dominant taxa	35.62	28.57	46.34	69.93	40.79	41.57	36.56
% 3 dominant taxa	44.52	39.39	55.05	75.52	53.15	57.23	49.76
Richness Measures							
species richness	26.00	45.00	46.00	33.00	30.00	23.00	39.00
EPT richness	18.00	18.00	15.00	12.00	13.00	10.00	19.00
Ephemeroptera richness	6.00	7.00	10.00	5.00	5.00	4.00	5.00
Plecoptera richness	5.00	4.00	1.00	4.00	3.00	2.00	5.00
Trichoptera richness	7.00	7.00	4.00	3.00	5.00	4.00	9.00
Rhyacophila richness	1.00	0.00	0.00	0.00	1.00	1.00	1.00
Community Composition							
% Ephemeroptera	23.29	4.90	4.53	2.45	24.48	13.25	34.91
% Plecoptera	8.22	8.16	6.27	6.29	3.26	1.81	3.77
% Trichoptera	32.19	31.43	48.43	70.63	16.32	22.89	13.21
% EPT	63.70	44.49	59.23	79.37	44.06	37.95	51.89
% Coleoptera	4.79	0.41	1.05	1.05	17.02	21.69	10.85
% Diptera	25.34	54.29	37.98	18.18	30.77	30.12	34.91
% Oligochaetae	0.00	0.00	0.00	0.00	6.06	4.82	0.94
% Baetidae	0.00	1.63	0.70	0.00	6.76	0.00	21.70
% Brachycentridae	0.00	0.20	0.00	0.00	0.47	0.00	1.18
% Chironomidae	23.29	53.47	35.54	16.08	29.14	27.11	21.23
% Ephemerellidae	3.42	0.20	1.39	1.05	0.00	0.60	1.89

% Hydropsychidae	18.49	13.47	9.06	11.19	0.00	0.00	3.54
% Odonata	0.00	0.61	0.70	1.05	0.00	0.00	0.00
% Perlidae	0.68	0.61	0.00	0.35	0.93	1.20	1.18
% Pteronarcyidae	0.00	0.41	0.00	0.35	0.00	0.00	0.24
% Simuliidae	0.00	0.41	0.70	0.00	0.70	1.20	13.21

Table D-9 cont. Kinross Delmar Mine 1999 Macroinvertebrate Data

Functional Group Composition							
% filterers	18.49	33.06	16.38	14.69	1.17	1.20	18.16
% gatherers	9.59	16.53	11.15	5.94	42.66	34.94	43.40
% predators	15.75 11.02		12.20 8.39		5.13	10.24	4.01
% scrapers	6.16	0.61	1.39	0.35	11.89	18.67	5.66
% shredders	23.97	33.47	54.01	65.73	2.56	0.00	4.25
filterer richness	1.00	4.00	5.00	3.00	2.00	1.00	5.00
gatherer richness	4.00	14.00	16.00	7.00	12.00	6.00	14.00
predator richness	7.00	11.00	10.00	7.00	7.00	8.00	7.00
scraper richness	4.00	3.00	4.00	1.00	2.00	2.00	3.00
shredder richness	3.00	5.00	5.00	6.00	2.00	0.00	4.00
Diversity/Evenness Measures							
Shannon-Weaver H' (log 10)	1.18 1.21		1.15	0.77	1.07	1.04	1.14
Shannon-Weaver H' (log 2)	3.91 4.02		3.82	2.57	3.55	3.47	3.79
Shannon-Weaver H' (log e)	2.71 2.79		2.65	1.78	2.46	2.40	2.63
Hilsenhoff Biotic Index	3.65 4.42		3.49	2.39	3.11	2.93	3.46
Margalef's Richness	5.02 7.03		7.95	5.66	4.73	4.30	6.28
Metals Tolerance Index	3.15 2.58		2.54	2.08	2.52	2.61	3.44
Pielou's J'	0.83	0.73	0.69	0.51	0.72	0.77	0.72
Simpson's Heterogeneity	0.91 0.91		0.84	0.64	0.87	0.87	0.89
Karr BIBI Metrics							
Long-Lived taxa richness	4.00 4.00		3.00	4.00	4.00	4.00	6.00
Clinger richness	17.00	20.00	18.00	16.00	16.00	11.00	21.00
Intolerant taxa richness	2.00 1.00		1.00	1.00	0.00	2.00	1.00
% Tolerant taxa	10.96	5.91	7.32	3.50	24.18	27.71	33.73
Montana DEQ Metrics							
MT Biotic Index	3.65	4.42	3.49	2.39	3.11	2.93	3.46
C-Gatherers + C-Filterers	28.08 49.59		27.53	20.63	43.82	36.14	61.56
% Scraper + %Shredder	30.14 34.08		55.40	66.08	14.45	18.67	9.91
% univoltine	36.30	36.53	58.89	70.98	29.60	35.54	22.17
% multivoltine	7.53	33.47	17.42	7.34	36.60	30.72	55.19
% semivoltine	6.16	1.63	1.74	2.45	18.88	24.10	12.74
% Hydropsychinae	18.49 13.47		9.06 11.19		0.00	0.00	3.54
UIN	8-183 8-184		8-185	8-186 8-187		8-188	8-189

Table D-9 cont. Kinross Delmar Mine 1999 Macroinvertebrate Data

Stream Louse	Creek	Louse Creek	Louse Creek
Site	B10 B10 B10		
Rep	1 2 3		
Date	08-11-1999 08-11-	1999 08-11-	1999
Percent Subsampled	83.33	56.82	100.00
Abundance Measures			
Corrected abundance	618.00 952.16 369.00		
EPT abundance	138.00 105.60 166.00		
Dominance Measures			
1st dominant taxon	Simulium sp.	Simulium sp.	Optioservus sp.
1st Dominant Abundance	258.00	765.60	85.00
2nd dominant taxon	Micropsectra sp.	Baetis tricaudatus	Agapetus sp.
2nd Dominant Abundance	98.40	61.60	52.00
3rd dominant taxon	Baetis tricaudatus	Micropsectra sp.	Baetis tricaudatus
3rd Dominant Abundance	75.60	22.88	40.00
% 1 dominant taxon	41.75	80.41	23.04
% 2 dominant taxa	57.67	86.88	37.13
% 3 dominant taxa	69.90	89.28	47.97
Richness Measures			
species richness	35.00 20.00 37.00		
EPT richness	15.00 7.00 20.00		
Ephemeroptera richness	4.00 3.00 4.00		
Plecoptera richness	4.00 2.00 5.00		
Trichoptera richness	7.00	2.00	11.00
Rhyacophila richness	1.00 0.00 1.00		
Community Composition			
% Ephemeroptera	16.12 8.50 17.07		
% Plecoptera	2.72 0.92 5.69		
% Trichoptera	3.50	1.66	22.22
% EPT	22.33 11.09 44.99		
% Coleoptera	5.44	1.85	24.66
% Diptera	67.57 85.95 26.02		
% Oligochaetae	2.14 0.74 0.27		
% Baetidae	12.23 6.47 10.84		
% Brachycentridae	0.39 0.55 2.17		
% Chironomidae	25.05 5.36 20.60		
% Ephemerellidae	0.58 0.55 0.00		
% Hydropsychidae	1.75 1.11 2.44		
% Odonata	0.00 0.00 0.00		
% Perlidae	1.36 0.55 1.90		
% Pteronarcyidae	0.00 0.00 0.00		
% Simuliidae	41.75	80.41	4.34
Functional Group Composition			
% filterers	43.88	82.07	8.67
% gatherers	39.22 12.38 33.06		
% predators	5.05 0.92 9.76		
% scrapers	0.58	0.00	14.91
% shredders	2.52 0.74 2.71		
filterer richness	4.00 3.00 4.00		

Table D-9 cont. Kinross Delmar Mine 1999 Macroinvertebrate Data

gatherer richness	14.00	9.00	12.00
predator richness	7.00	3.00	7.00
scraper richness	2.00	0.00	2.00
shredder richness	4.00	2.00	6.00
Diversity/Evenness Measures			
Shannon-Weaver H' (log 10)	0.93	0.41	1.20
Shannon-Weaver H' (log 2)	3.09	1.38	3.98
Shannon-Weaver H' (log e)	2.14	0.95	2.76
Hilsenhoff Biotic Index	4.40	4.78	3.38
Margalef's Richness	5.29	2.77	6.09
Metals Tolerance Index	4.05	4.79	3.92
Pielou's J'	0.60	0.32	0.76
Simpson's Heterogeneity	0.78	0.35	0.90
Karr BIBI Metrics			
Long-Lived taxa richness	5.00	2.00	5.00
Clinger richness	16.00	10.00	19.00
Intolerant taxa richness	1.00	1.00	0.00
% Tolerant taxa	16.50	4.94	39.84
Montana DEQ Metrics			
MT Biotic Index	4.40	4.78	3.38
C-Gatherers + C- Filterers	83.11	94.45	41.73
% Scraper + %Shredder	3.11	0.74	17.62
% univoltine	12.23	5.18	33.60
% multivoltine	74.17	90.20	29.81
% semivoltine	7.38	2.40	27.37
% Hydropsychinae	1.75	1.11	2.17
UIN 8-190		8-191	8-192

Other Reports available from KDMC include the following:

Benthic Macroinvertebrate Bioassessment and Monitoring for Jordan Creek LAT Site, Area (B11) 2001-2008, prepared by Michael D. Bilger, M.S. for EcoAnalysts

2004 Benthic Macroinvertebrate Bioassessment and Monitoring Report-Louse Creek and Jordan Creek-Kinross-DeLamar Mining Company, prepared by Brett D. Marshall, February 2005 for EcoAnalysts

2003 Benthic Macroinvertebrate Bioassessment and Monitoring Report-Louse Creek and Jordan Creek-Kinross-DeLamar Mining Company, prepared by John J. Pfeiffer, January 2004 for EcoAnalysts

BUGS Metrics Report

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BURPID	STREAM	ECOREGION
1998SBOIB009	LOUSE CREEK	SNAKE RIVER BASIN/HIGH DESERT

DateMeas	HUC	Total Abundance	Low Abundance	Taxa Richness	% Domnce Top Taxa	% Domnce Top 3
6/15/1998	17050108	150		26	23.33333	43.33333
% Domnce Top 5	**% Scrapers**	**% EPT**	**Sum EPT Taxa**	**HBI**	**H'**	**% Ephem**
58	16	67.33334	18	5.885906	1.344277	50.66667
% Plec	**% Trich**	**Count Ephem Taxa**	**Count Plec Taxa**	**Count Trich Taxa**	**Sum Obligate CWB**	**Sum Obligate CWB**
2	14.66667	11	2	5	0	0
% Obligate CWB	**Number Clinger Taxa**	**Number Long Lived**	**% Clingers**	**% Long Lived**	**# Elmidae Taxa**	**# Predator Taxa**
0	14	1	32.66667	2.666667	1	6
% Elmidae	**% Predator**	**# Scrapers Taxa**	**SMI**	**TPI**	**SumTPITaxa**	
0.6666667	6.666667	5	66.225372	10.243333	3	

Figure D-1. Louse Creek BURP data.

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BURPID	STREAM	ECOREGION
1998SBOIB011	ROCK CREEK (LOWER)	SNAKE RIVER BASIN/HIGH DESERT

DateMeas	HUC	Total Abundance	Low Abundance	Taxa Richness	% Domnce Top Taxa	% Domnce Top 3
6/17/1998	17050108	379		28	42.48021	69.65699
% Domnce Top 5	**% Scrapers**	**% EPT**	**Sum EPT Taxa**	**HBI**	**H'**	**% Ephem**
82.8496	32.71768	47.4934	19	6.296399	1.293195	42.74406
% Plec	**% Trich**	**Count Ephem Taxa**	**Count Plec Taxa**	**Count Trich Taxa**	**Sum Obligate CWB**	**Sum Obligate CWB**
1.055409	3.693931	9	3	7	0	0
% Obligate CWB	**Number Clinger Taxa**	**Number Long Lived**	**% Clingers**	**% Long Lived**	**# Elmidae Taxa**	**# Predator Taxa**
0	16	1	44.85488	13.45646	2	6
% Elmidae	**% Predator**	**# Scrapers Taxa**	**SMI**	**TPI**	**SumTPITaxa**	
3.957784	2.110818	6	65.043701	0	0	

Figure D-2. Lower Rock Creek BURP data.

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BURPID	STREAM	ECOREGION
1998SBOIB012	ROCK CREEK (UPPER)	SNAKE RIVER BASIN/HIGH DESERT

DateMeas	HUC	Total Abundance	Low Abundance	Taxa Richness	% Domnce Top Taxa	% Domnce Top 3
6/17/1998	17050108	385		27	41.2987	71.68831

% Domnce Top 5	% Scrapers	% EPT	Sum EPT Taxa	HBI	H'	% Ephem
83.37663	17.92208	51.68831	16	6.784	1.261815	43.37663

% Plec	% Trich	Count Ephem Taxa	Count Plec Taxa	Count Trich Taxa	Sum Obligate CWB	Sum Obligate CWB
0	8.311688	10	0	6	0	0

% Obligate CWB	Number Clinger Taxa	Number Long Lived	% Clingers	% Long Lived	# Elmidae Taxa	# Predator Taxa
0	9	1	29.61039	9.350649	1	3

% Elmidae	% Predator	# Scrapers Taxa	SMI	TPI	SumTPITaxa
0.5194805	3.116883	5	52.998589	10.47	1

Figure D-3. Upper Rock Creek BURP data.

Appendix E. Supporting Data for TMDL Analysis

Table E-1. Total mercury, Dissolved mercury and Methyl mercury Water Quality Results for the Jordan Creek Watershed. DEQ 2005.

Station	Description	Total Mercury ng/l	Dissolved Mercury ng/l	Methyl Mercury ng/l	Methyl Mercury %
JC-2005-01 Jo	rdan near Stateline	19.9 9.17	2.06		10.3
JC-2005-02	Jordan Below Boulder Cr.	31.4 13.3	1.92		6.1
JC-2005-08	Jordan Below Placer Tailings	13.3 5.23	0.74		5.5
JC-2005-09	Jordan Below Delamar Mine	35.3 19.5	1.23		3.5
JC-2005-10	Jordan Below Blue Gulch	57.9 8.28	0.64		1.1
JC-2005-11	Jordan Below Silver City	92.7 89.5	2.14		2.3

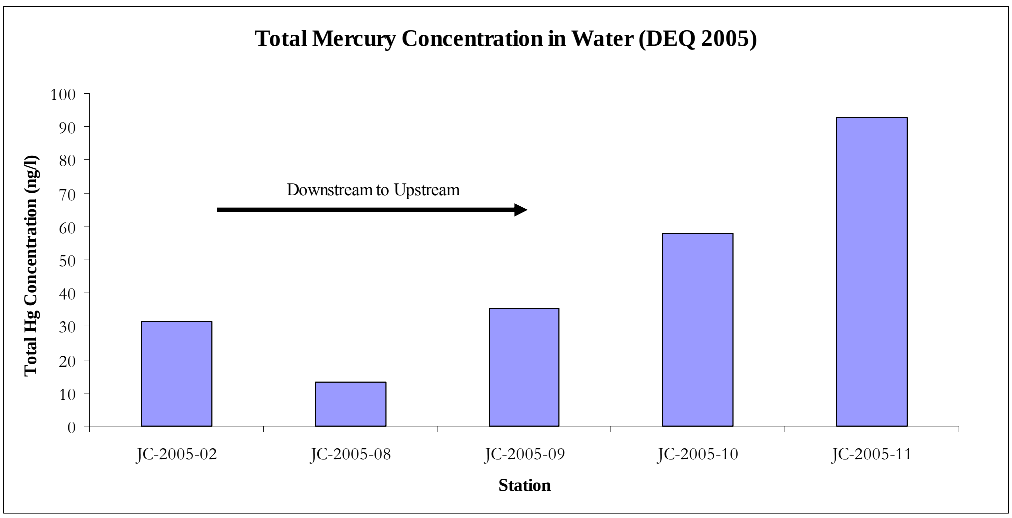

Figure E-1. Total Mercury Concentration Upper Jordan Creek Watershed. DEQ 2005.

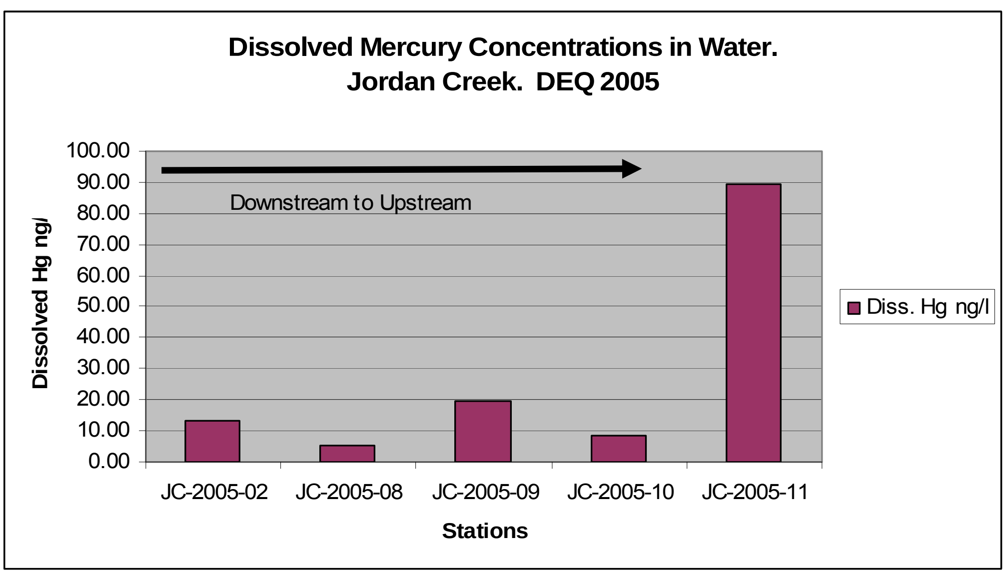

Figure E-2. Dissolved Mercury Concentrations Upper Jordan Creek Watershed. DEQ 2005.

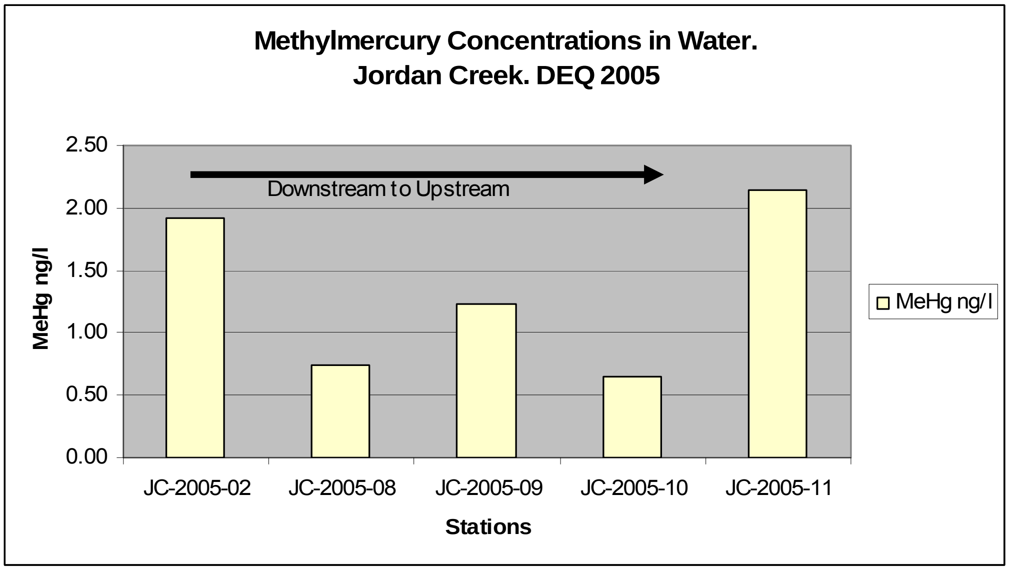

Figure E-3. Methyl Mercury Concentration Upper Jordan Creek Watershed. DEQ 2005.

Table E-2. Total mercury, Dissolved mercury and Methylmercury Water Quality Results for Louse Creek, Flint Creek, East Fork, Boulder/Rock Creek and Williams Creek. DEQ 2005.

Station	Description	Total mercury ng/l	Dissolved mercury ng/l	Methyl mercury ng/l	Methyl Mercury %
LC-2005-07	Louse Creek near Confluence with Jordan Creek	1.40	0.78	0.10	7.4
FC-2005-06	East Fork Upstream of Flint Creek	0.76	0.50	0.052	6.8
FC-2005-05	Flint Creek below Mines	1.22	0.84	0.28	23
BC-2005-04	Rock Creek below Triangle Reservoir	1.24	1.98	[a]a 0.24	19
WC-2005-13	Williams Creek 2 miles Upstream of Jordan Creek	1.80	1.06	0.21	12

Table E-3. Total Mercury and Methyl Mercury Results for Stream Sediments in Jordan Creek. DEQ 2005.

Station	Description	Total Mercury ng/g	Methyl Mercury ng/g	Methyl Mercury %
JC-2005-01	Jordan near Stateline	4260	11.5	0.27
JC-2005-02	Jordan Below Boulder Cr.	2046	4.80	0.23
JC-2005-08	Jordan Below Placer Tailings	1292	0.40	0.03
JC-2005-09	Jordan Below Delamar Mine	1385	31.9	2.3
JC-2005-10	Jordan Below Blue Gulch	1235	6.65	0.54
JC-2005-11	Jordan Below Silver City	948	1.37	0.14

a Dissolved Fraction Greater than Total mercury Concentration was noted as a possible concern by Brooks Rand Laboratory

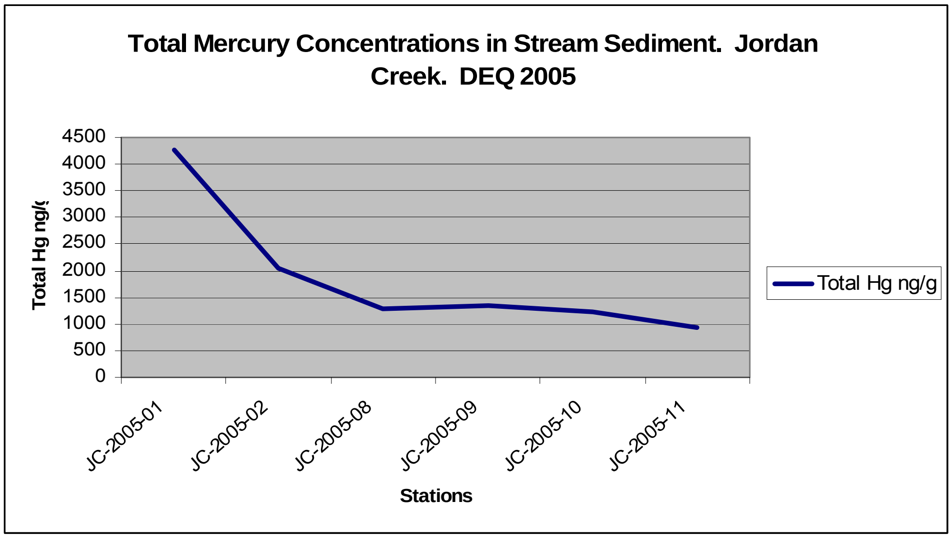

Figure E-4. Total mercury Concentrations in Stream Sediments. Jordan Creek. DEQ 2005

Table E-4. Total Mercury and Methyl Mercury Results for Stream Sediments in the Non-Jordan Creek Sites. DEQ 2005.

Station	Description	Total Mercury ng/g	Methyl Mercury ng/g	Methyl Mercury %
LC-2005-07	Louse Creek near Confluence with Jordan Creek	16.4 0.23		1.4
FC-2005-06	East Creek Upstream of Flint Creek	3.19 0.30		9.5
FC-2005-05	Flint Creek below Mines	13.8 0.98		7.1
BC-2005-04	Rock Creek below Triangle Reservoir	12.1 0.24		2.0
WC-2005-13 Willi	ams Creek 2 miles Upstream of Jordan Creek	5.24 0.029		0.55

Table E-5. Measured Water Column Total Mercury Concentration, Measured Flow and Estimated Daily Load.

Site	Station ID Number	Flow (cfs)	Measured Concentrations (µg/l)	Estimated Mercury Load (mg/day)
Jordan Near State Line	JC-2005-01	0.7 0.	0199	34.1a
Jordan Below Boulder Cr.	JC-2005-02	9.9 0.	0314	760.67
Jordan Below Placer Tailings	JC-2005-08	0.1(est) 0.	0133	3.25b
Jordan Below Delamar Mine	JC-2005-09	0.5 0.	0353	43.2
Jordan Below Blue Gulch	JC-2005-10	0.4 0.	0579	56.7
Jordan Below Silver City	JC-2005-11	0.6 0.	0927	136.1

a Overall Reduction in Load from JC-2005-01 and JC-2005-02 Associated with Irrigation Water Withdrawals. b Area between JC-2005-08 and JC-2005-09 is low gradient alluvial depositional area and is suspected to act as a sink for mercury attached. est – estimated.

Appendix F. Distribution List

NAME ORG	ANIZATION	LOCATION
Jim Hyslop	Owyhee Historical Society	Nampa
Steve Smith	Kinross Delamar Mine	Jordan Valley, OR
Tom Hook		Murphy
Mike Hanley		Jordan Valley, OR
Tom Gluch		Jordan Valley, OR
Dennis Stanford		Jordan Valley, OR
Doug Burgess		Homedale
Vern Kirshner		Jordan Valley, OR
Elias Jaca		Nampa
Forest and Nancy Fretwell		Jordan Valley
Duane Lafayette	Idaho Association of Soil Conservation Districts	Bruneau
John and Lorna Steiner		Oreana
Rich Bennett		Jordan Valley OR
Jennifer Martin	Owyhee Watershed Council	Ontario, OR
	U.S. Bureau of Land Management	Marsing

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Appendix G. Public Comments

Public involvement in the development of this TMDL has included the following events:

September 2005	The first informational meeting was held at the Pleasant Valley School. This was the first meeting informing stakeholders and interested parties of on-going and future activity for the Jordan Creek Watershed Subbasin Assessment and Total Maximum Daily Load. At this meeting, solicitations for nominations for membership for the Jordan Creek Watershed Advisory Group were requested. It was explained that the duties of the Watershed Advisory Group is to assist the Department of Environmental Quality in developing the Jordan Creek Watershed Subbasin Assessment and Total Maximum Daily Load.
November 2005	A meeting was held in Marsing, Idaho to update potential Watershed Advisory Group participants on monitoring results from the previous summer's monitoring effort. A preliminary assessment of impaired water bodies was discussed along with a detailed analysis of the results from the fish tissue mercury analysis.
February 2006	A meeting was held at the Pleasant Valley School. A formal recognition of Jordan Creek Watershed Advisory Group was acknowledged by the Department of Environmental Quality at this meeting.
September 2006	A meeting was held at the Pleasant Valley School. The members were provided with drafts of the mercury and Potential Natural Vegetation temperature TMDLs.
December 2006	A meeting was held at the NRCS Office in Marsing. At the meeting, Kinross Delamar Mine presented their official comment letter (below). This letter was also signed by several of the WAG members. The group also voted to send the document out for public comment with the letter included in the document.
April 30-July 7, 2007	The draft document posted for public comment. Comments and responses are provided below.

Kinross Delamar Mine Comment Letter

KINROSS

Kinross DeLamar Mining Co.
PO Box 52
Jordan Valley, OR 97910
Tel: 208 583 2511
Fax: 208 583 2516

December 4, 2006

Craig Shepard
Regional Manager
Idaho Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706

Re: comments on the initial draft TMDL for WAG review

Dear Mr. Shepard,

Kinross DeLamar Mining Company (KDMC) owns the DeLamar and adjacent Stone Cabin Mines that are located in the upper Jordan Creek watershed that are in the final closure and reclamation stage. Due to this location, KDMC will be directly affected by the proposed Jordan Creek Total Maximum Daily Loads (TMDLs), and therefore has a representative on the Watershed Advisory Group (WAG). The level of effort put forth by the Idaho Department of Environmental Quality (IDEQ) to collect the field data, conduct research, and produce this draft document is exceptional. As a WAG member, the opportunity to review the preliminary draft TMDL document is appreciated and the following comments are offered.

1. General Comment. Acknowledging that a broad range of scientific and technical information has been incorporated, the preliminary draft TMDL document is very long and complex. Much more time, discussion, and in-depth explanation of these TMDLs are needed for WAG member(s) to be able to understand the reasoning, implications, and the range of potential future affects on residents of the Jordan Creek watershed. Also, the WAG has not had sufficient time to provide meaningful input into this TMDL as required by state law. IDEQ should not rush to complete these TMDLs to meet internal deadlines to the detriment of local residents and businesses.

2. Cow Creek. There is a reference to the estimated daily average discharge from Cow Creek of 0.9 cfs (412 gpm) on pg. xxiii, and another reference to Cow Creek discharge of 0.05 cfs (22.9 gpm) on pg. 64. In reality, this creek is thought to be dry for much of the year making both of these estimates suspect. If Cow Creek flows are below 1 cfs, we question the applicability of any standards, consistent with state law. Also, even assuming the standards do apply, the presumption that cold water aquatic life is an appropriate and attainable use does not appear supportable. Accordingly, consistent with state law, IDEQ should first consider whether they are applying an attainable standard, and if not, modify the standard prior to development of this TMDL.

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Overall, we suggest that IDEQ first consider reclassification of beneficial uses for ephemeral and intermittent streams (to something more representative than cold water aquatic life) prior to proceeding with the TMDL.

Further, IDEQ is also proposing a Potential Natural Vegetation (PNV) TMDL for temperature for Cow Creek and other similar drainages. We suggest that IDEQ carefully consider guidance from both the recent Rapanos v. US Supreme Court decision that clearly infers that intermittent streams are not regulated under the CWA; and HCR 64 where the Idaho legislature directed IDEQ not to regulate beyond federal requirements. Considering this guidance, is it really appropriate to create further regulation on intermittent or ephemeral streams such as Cow Creek and others? If PNV TMDLs are created for intermittent and ephemeral streams, should area ranchers expect to see new grazing restrictions, fencing requirements, or other restrictions?

√3. Background mercury (Hg) concentration in soils. From a previous WAG meeting, our understanding is that soil sampling to determine a background concentration for mercury (Hg) in soils yielded results much lower than (10%) of the "normal" range. Considering that the headwaters area of Jordan Creek includes Cinnebar Mountain, obviously getting this name due to presence of massive mercury sulfide deposits, the reasonable expectation is that soils in upper Jordan Creek watershed would potentially be much higher in Hg than the "normal" range. If IDEQs 2005 data cited in the preliminary draft TMDL do not reflect background values within or higher than the "normal" range, it should be considered highly suspect and not used. These data are used in the analysis discussed on page 137 to develop the Regression Analysis in Table 49. In Table 49, what appears to represent background Hg in soils is presented as ug/l. Background Hg in soils is commonly presented in ug/kg. From a brief review of the literature, 10 - 100 ug/kg is commonly used as a range of background concentration for Hg in soils around the world. Considering the geologic setting of upper Jordan Creek, it is not unreasonable to assume a background Hg concentration in soils substantially higher than 100 ug/kg. Using the Flint Creek data as an example, the reported Hg concentration of 0.00084 appears much to low. Use of an unrealistically low soil background concentration results in an under-estimate of background Hg discharged to in Jordan Creek waters and fish. This topic requires further clarification by IDEQ as to the raw data values, sample locations, number of samples used to determine average background Hg concentration in soils and water, and an explanation as to how this data is sufficient to extrapolate across an entire drainage.

√4. IDEQ is advocating on page 139 that KDMC will be required to conduct storm water monitoring "using more stringent detection limits"; i.e., methods that are often referred to as "white suit and gloves" methods and laboratories. These methods are costly, potentially unreliable, and impractical. KDMC currently

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uses industry standard, EPA approved methods with a mercury detection limit of 0.0001 mg/l (0.1parts per trillion). Since IDEQ has concluded that KDMC is not a significant source of pollutants to Jordan and Louse Creeks, there is no apparent need to use the "white suit" methods. We suggest that the reference to using more stringent detection limits ("white suit and gloves") on page 139 be removed from the document.

√5. Since the Idaho criteria and this TMDL are not based on concentrations of mercury in water (but fish tissue concentration), it is unclear how loading estimates will achieve compliance with standards. Likewise is there some correlation between the loading allocation and mercury in fish? Does IDEQ have good quality data to demonstrate that (x%) of methyl mercury in water or loading equals (y%) methyl mercury in fish? The same scenario is true for the comparison of mercury concentration in stream sediment to methyl mercury in fish. We believe that until IDEQ definitively addresses these issues that the TMDL appears flawed.

√6. KDMC releases storm water by authorization of an NPDES Storm Water Multi-Sector General Permit initiated in 2000 (MSGP 2000). This permit is scheduled to be re-issued in 2006 (MSGP 2006) with many more stringent modifications. The proposed MSGP 2006 does not allow coverage if a TMDL allocates a zero load (WLA) for a permitted facility. We are concerned that an IDEQ allocation to KDMC based on background conditions in a different drainage, may be a de facto zero allocation. IDEQ has concluded on page 132 and elsewhere, that data collected by IDEQ and KDMC indicates that the mine is not a contributing factor for criteria not being met. Clearly, the interaction between the MSGP 2006 and the TMDL will be complex. To help avoid unforeseen consequences, we suggest that IDEQ make a concise statement that KDMC is not a significant source of mercury, no allocation to KDMC is necessary at this time, and that compliance with BMPs in the MSGP 2006 will constitute compliance with the TMDL.

√7. In the preliminary draft TMDL it is noted that based on a programmatic interpretation by two IDEQ staffers, they conclude that since fish tissue for Hg is exceeded in Jordan Creek, then aquatic life use is impaired. However, IDEQ concludes in other parts of the document that Jordan Creek fisheries are fully supported. Benthic macro-invertebrate data collected over a number of years and presented in the document clearly indicate that aquatic life has not impaired in Jordan Creek. As the long-term benthic data seems much more compelling than a programmatic interpretation, the interpretation appears flawed and should be removed.

8. IDEQ recognizes in the TMDL for smaller streams such as Louse Creek that certain bottom dwelling fish like dace and sculpin exceed fish tissue criteria, but it is not problematic because these fish are non-edible. IDEQ should

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consider that because of Jordan Creek's size and limited accessibility, fish consumption may be negligible. Has IDEQ conducted any type of a survey to determine the amount of fish, if any, that are consumed from Jordan Creek?

9. IDEQ appears to have concluded that based on the presence of red-band trout in Jordan Creek and some of the surrounding streams, then all of the watershed should be protected as a cold water aquatic life beneficial use. We question this interpretation, especially considering known water temperatures for lower Jordan Creek and extended dry conditions for many of the smaller sub-drainages. IDEQ is aware of the ephemeral and intermittent flow regimes in many of the smaller tributaries. Naturally low flows or dry stream channels over many months of the year, as well as naturally higher water temperatures in the mid and lower reaches of Jordan Creek make many of these areas unreasonable for a cold water aquatic life beneficial use designation. We request IDEQ to not make blanket designation for cold water aquatic life beneficial use in areas where there is no data to support it, or where visual and anecdotal information could be collected to make a more reasonable determination. Again we believe IDEQ should evaluate whether the appropriate designated uses are attainable and if not, a change in beneficial use classification and standards should precede development of the TMDL, consistent with state law requirements.

We appreciate the opportunity to comment on this preliminary draft and look forward to continuing this working relationship with IDEQ. The level of effort that has went in to this preliminary draft, thus far, is commendable.

Sincerely,

[signature]

Steve Smith
Project Manager (Acting) and Jordan Creek WAG Member
Kinross DeLamar Mining Company

Cc: file

OTHER WATERSHED ADVISORY GROUP (WAG) SIGNATURES

Print Name	Signature
ELIAS JACA	Elias Jaca
Dennis L Stanford	Dennis L Stanford

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Response to Comments

<table>
<tr><th>Comment</th><th>Response</th></tr>
<tr><td>State of Oregon:</td><td></td></tr>
<tr><td>The EPA chronic/continuous mercury concentration (CCC) should be listed as 0.91ug/l total mercury or 0.77 ug/l total dissolved mercury in the water column and apply only to the total recoverable mercury fraction, not to reactive or methylated mercury (Hg^{2+}), the form of mercury most directly associated with bioaccumulation within the food chain.</td><td>The commenter is correct, EPA's 1995 chronic aquatic life criterion for mercury applies to total recoverable (0.91 µg/l) or dissolved (0.77 µg/l) mercury in the water column. While this includes the fraction that may be methylated, it is not specific to methylmercury. The document has been corrected to make this clear.</td></tr>
<tr><td>The document compares back-calculated water column concentrations (4.0 ng/L methylmercury and 0.29 ug/L total mercury as a worst case scenario, derived from the fish tissue criterion) to the EPA chronic mercury criterion for fresh water systems to identify the protective nature of the calculated water column concentrations. The EPA criteria is footnoted as follows:

This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the food chain because sufficient data were not available when the criterion was derived.

Thus, while back-calculated water column concentrations may be appropriate to identify direct exposure concerns for aquatic life, they cannot be assumed to account for or be protective of food-chain related bioaccumulation.</td><td>The back calculation to water column is based on a conservative bioaccumulation factor (BAF) and conservative fraction of methylmercury to illustrate that the fish tissue criterion of 0.3 mg/l is very likely to be more protective, that is require lower mercury levels in the water, than EPA's 1995 aquatic life chronic criterion would allow. This will not necessarily always be true. If the BAF in Jordan Creek trout is greater than the 5th percentile trophic level 3 BAF of 74,000, or the fraction of total mercury that is methylmercury is more than 1.4%, than the fish tissue criterion could only be met with lower total mercury levels in the water than is stated in the example given.

We agree that EPA's current (last revised in 1995) aquatic life criteria do not take into account food-chain related exposure for aquatic life. Although Idaho's fish tissue criterion does take into account bioaccumulation of mercury, it is not the intent of our comparison to say the fish tissue criterion has been judged by EPA to be protective of food-chain related bioaccumulation in aquatic life. The purpose of our back-calculation from fish tissue to water column mercury levels is simply to show that the fish tissue criterion results in far lower water column mercury in most conditions, including those in lower Jordan Creek, than EPA's aquatic life water column criteria. In that sense Idaho's fish tissue criterion is more stringent (protective) than and is thus preferred to EPA's aquatic life criteria for developing the Jordan Creek TMDL.</td></tr>
<tr><td>The document bases target reductions on stream characteristics specific to higher gradient, non-eutrophic stream conditions. Relative methyl-mercury production is cited at 1.4% worst case scenario (generally in the 2-8% range) of total mercury. While this relative conversion may apply accurately to the stream conditions occurring in the upper watershed, it cannot necessarily be used to calculate methylmercury concentrations in the lower watershed due to greater sedimentation, deposition and instream</td><td>The TMDL is based on meeting the fish tissue criterion of 0.3 mg/kg methylmercury. In doing so, no assumption is made about the fraction of methylmercury to total mercury in Jordan Creek or the rate of bioaccumulation of mercury. The example back calculation to water column concentrations is simply to illustrate the strong likelihood that meeting the fish tissue criterion will also result in meeting EPA's 1995 aquatic life water column criteria.

If bioaccumulation is higher or the fraction of</td></tr>
</table>

Comment	Response
processing of organic matter. In cold, fast moving waters with little organic matter content, lower mercury methylation rates are generally observed. Warmer, nutrient rich waters with higher organic content and algal growth generally have greater mercury methylation rates. Higher proportions of methylmercury, if occurring in the lower watershed will increase the level of concern associated with bioaccumulation of mercury. The EPA chronic criterion has not been identified as being protective of this condition (bioaccumulation).	methylmercury to total mercury greater than used in the example calculation, then meeting the fish tissue criterion will be even more difficult and would drive lower water column mercury levels. Such may well be the case in the lower watershed, particularly outside Idaho and the scope of the Jordan Creek TMDL. We agree that EPA has no recommended aquatic life criterion that accounts for mercury bioaccumulation through the food chain.
A linear relationship between total mercury and methylmercury production can only be assumed if physical characteristics are static within the watershed area under assessment. If physical conditions (slope, water temperature, dissolved oxygen, level of eutrophication, etc.) differ substantially throughout the watershed, assumption of a linear relationship is not necessarily valid and critical conditions should be identified in order to project a protective water quality reduction target. Occurrence of these complicating processes is evident in the data plotted in the following two graphics, Figures 1 and 2 (data provided by H. Rueda, EPA) While sediment mercury concentrations are observed to increase inversely with slope (slope decreases with distance traveled downstream) due to greater sedimentation and selective accumulation of fine sediments with higher relative surface area, water column mercury concentrations are observed to decrease proportionally with slope probably due to the decrease in turbulence and lower overall water sediment contact occurring in the slower moving waters. The TMDL identifies that stream reaches in upper Jordan Creek have little fine sediment accumulation (p 114), suggesting that greater deposition is occurring in the lower Jordan Creek watershed (OR). Increased deposition in downstream areas is most likely the result of lower gradients, shallower slopes. In addition to associated mercury, fine materials that deposit in the lower reaches also carry organic material that will degrade with warmer water temperatures and lead to a decrease in dissolved oxygen. Greater algal growth is also possible in slower moving waters. Algal respiration and degradation processes commonly result in lower dissolved oxygen concentrations, especially at the sediment-water interface. Both processes have the potential to contribute to greater methylmercury production and greater exposure potential for resident fish than observed in the upstream reaches.	We agree that in reality BAFs and mercury methylation rates are not static. However, as a practical matter in development of mercury TMDLs it is typical that static but conservative point estimates are made of these factors, thus a constant linear relation assumed. EPA's states in their January 2009 Hg Implementation Guidance *"The uncertainty associated with differential bioaccumulation of methylmercury across sites within a state or tribal jurisdiction will be embedded in the state or tribal water-based criterion.* ***Reducing such uncertainty is one of the primary reasons EPA chose to express its national recommended criterion for methylmercury as a tissue concentration rather than as a water concentration."*** *[Emphasis added]* In other words, EPA believes, and DEQ agrees, that a fish tissue criterion is more likely to be broadly protective under varying conditions of bioaccumulation and mercury methylation than is a water column criterion. We are aware of the inverse relation between sediment mercury and water column mercury the commenter points out. Undoubtedly there is greater deposition of fine sediment, and thus greater sediment bound mercury in lower gradient reaches of Jordan Creek, while at the same lower water column concentrations of mercury occur due to downstream dilution. There are also transport and lag time differences for sediment versus water that likely contribute to this pattern. We also agree that there is potential for greater Hg methylation and bioaccumulation of mercury in the lower watershed. If elevated sediment bound mercury or greater methylation does in fact result in higher fish tissue mercury levels in lower Jordan Creek, our fish tissue based TMDL would reflect that in greater reductions in mercury loading. That may be an imperfect solution

Comment	Response
	but at present there are no sediment criteria on which to base a TMDL for mercury.
The lack of co-variance in mercury concentrations within the watershed is acknowledged in the draft TMDL (page 161). Fish tissue methylmercury concentration is proposed as an 'integrator' of complicating factors. Similar to the differences in methylmercury production discussed above, a linear relationship between water column methylmercury and fish tissue concentrations cannot be assumed. Accumulation of mercury in fish tissue is influenced by water temperature, feeding habits, time periods spent in a single location, percent body fat, metabolic processes and a number of other water quality and habitat parameters. Due to this complexity, a reduction in total mercury in sediments or water column in upstream reaches cannot necessarily be assumed to result in a proportional reduction in fish tissue mercury throughout all locations of the stream reach, as observed in Figure 1 and 2. Total mercury reductions must be coupled with measures designed to realize improvements in dissolved oxygen and organic decomposition in areas prone to eutrophic conditions in order to improve the chance that related decreases in fish tissue concentrations will be realized. A critical step in reducing fish tissue mercury is reducing the opportunity for methylation to occur. This step is as important as reducing mercury loading in many cases, especially where legacy mercury sources are present and transport has occurred throughout the stream system.	A linear relationship is assumed in any BAF that is not periodically re-evaluated and recalculated as conditions change in a watershed. More expensive modeling approaches, which have the potential to be dynamic given periodic update of input variables, were beyond Idaho's means. We agree that bioaccumulation of mercury is very complicated and reflects a myriad of factors. This notwithstanding, we believe it would be a mistake to write a TMDL that targets controlling methylation rates and bioaccumulation factors rather than reduction in sources of mercury. To do so would in our opinion miss-apportion responsibility for cleanup. We do believe methylation and bioaccumulation factors should be looked at in TMDL implementation, as possible interim control measures, but not until source allocations for mercury have been set and not as a substitute for reduction in mercury loading. We also recognize that a situation such as Jordan Creek where much of the loading is legacy mining related is particularly difficult to deal with in a TMDL. The complex biogeochemical cycle of mercury compounds the difficulty. We note that cleanup of sediment contaminated by past activities is a matter of remediation that is apart from control of current activities in the watershed and suggest that it is more properly the scope of CERCLA than it is the Clean Water Act. This suggests to us a TMDL is not the best or ultimate tool for fixing legacy loading problems. None-the-less, when implementing the Jordan Creek TMDL it will be important to look at cleanup of in stream sediment deposits in addition to reducing source loads.
Critical conditions for methylmercury production generally occur most often in the lower watersheds of surface water systems where the level of diversion, deposition, nutrient loading, and water temperatures increase and slope and dissolved oxygen concentrations are commonly observed to decrease. Protective water quality targets should therefore be evaluated specific to lower watershed conditions in most cases. The identification of critical conditions in the Jordan Creek watershed should be inclusive of and protective of downstream conditions, including those occurring in the watershed in Oregon, and TMDL goals and allocations should be constructed such that water quality achieved at the state line is protective of the designated uses of both states. Fish tissue methylmercury concentrations are observed to increase substantially with distance	We agree that there is potential for greater mercury methylation in the lower Jordan Creek watershed, particularly beyond Idaho's borders, and conditions downstream in Oregon may be worse for mercury bioaccumulation in fish tissue. In fact the TMDL targets fish tissue mercury levels at the state line, not just because it is the limit of Idaho's jurisdiction, but also because it is the location or greatest fish tissue mercury within Idaho, thus the critical condition for our TMDL. Idaho DEQ would have liked to have worked with Oregon DEQ on a joint TMDL but without engagement and cooperation and from the State of Oregon we could not write a TMDL for Oregon waters. As written the TMDL makes no assumption or accounting about what takes place in Oregon. The only assertion is that the planned reductions will result in meeting the fish

Comment	Response
downstream, and fish tissue mercury concentrations in Oregon are substantially greater than those observed in the Idaho stream segments. Given this relationship, mercury reductions and targets identified specific to Idaho fish tissue concentrations cannot be assumed to be protective of human health or aquatic life uses in the Oregon portion of the watershed. While the Idaho TMDL should not be responsible for water quality concerns (eutrophication, excessive nutrient loading, etc.) occurring in the Oregon segments of Jordan Creek, downstream water quality influences and system characteristics should be considered in determining critical conditions and appropriate water quality targets. Given the substantial difference in upstream to downstream water quality, physical (stream) conditions and increased sediment and fish tissue mercury concentrations observed between the Idaho and Oregon segments of Jordan Creek, it is not clear that the draft TMDL allocations are protective of Oregon designated uses.	tissue criterion at the state line, with a margin of safety. We do know that there are patterns of water use in Oregon – diversions and off-stream storage of irrigation water – that may exacerbate the loading of mercury coming from Idaho. That was beyond our analysis. Thus we acknowledge there is uncertainty whether the Jordan Creek mercury load reductions will meet fish tissue criteria after the water of Jordan Creek enters Oregon
Specific Comments:	
Table 13 (page 50) The table would benefit from a more detailed explanation of the derivation of the listed figures.	The BAF's are taken from the national default values given by EPA in Appendix A to "Water Quality Criterion for the Protection of Human Health: Methylmercury Final" EPA-823-R-01-001. 1.4% of total mercury as methyl mercury is the grand median from rivers stated in comments of James Hurley, reviewer of Appendix A of EPA's 2001methylmercury criterion document. Five percent of total mercury as methyl mercury is the midpoint of the range of 2-8% for both sediment and water measured in NAWQA Basins in the western US as reported by D. Krabenhoft of the USGS in March 2003 briefing to Congress. The ratio may be higher in select watersheds and in reservoirs in particular, but as explained in the TMDL, a higher fraction of methyl mercury to total mercury makes translation of methylmercury fish tissue to an equivalent water column total mercury concentration lower, that is, even more stringent.
Page 111 Data collected in the Lower Jordan River channel (1/2 mile from the Oregon border) showed instream diversions, stagnant pools, warm water temperatures (p 111) and very high potential for eutrophic conditions to occur. These conditions are indicative of a high potential for methylmercury production. Fish tissue concentrations available for this site are from very small fish only and will almost certainly exhibit lower methylmercury concentrations than older larger fish.	DEQ collected fish samples to the best of its ability. The Jordan Creek fishery is occupied by small fish. DEQ has noted the comment regarding diversions near the Oregon border. We have recommended listing for flow and habitat alteration in the next Integrated Report.

Comment	Response
Section 3.1, Jordan Creek and Mercury (page 121-122) The statement that Louse Creek "did not have mercury loadings sufficient to cause elevated concentrations of methylmercury in fish tissue (page 120)" is not reflective of the available data. Sculpin and dace sampled in Louse Creek exhibit tissue concentrations of approximately 0.5 mg/kg, well in exceedance of the 0.3 mg/kg fish tissue criterion identified by the TMDL.	Sculpin and dace are not fish that have been identified as species caught and eaten in Idaho by the fishing public. Exceedance of DEQs fish tissue criterion is based on a weighted trophic level approach. Louse Creek was delisted in the 2008 Integrated Report
Section 3.1, Point Sources (page 121-122) The TMDL document lists "higher" water quality concentrations of mercury for Jordan Creek sampled below Silver City as 0.093 ug/L and 0.089 ug/L (total and dissolved respectively). The detection limit for mercury monitoring at the Kinross-Delamar mine site is listed as 0.1 ug/L. This detection limit is higher than the elevated concentrations that are used in the document to identify the location below Silver City as a "continuing source of mercury". The statement that "water quality data … has indicated that the mine is not currently discharging any pollutants that can be shown to exceed criteria in Jordan Creek" is difficult to justify using the 0.1 ug/L detection limit data.	DEQ has noted your comment and revised language in the document.
Evaluation of Sources of Current Mercury Loadings (page 123, paragraph 2) The statement that "the levels [of mercury] found in sediments don't appear to be the cause of what is found in the water column above" is not consistent with the observed trend of higher fish tissue and higher sediment mercury concentrations upstream to downstream in Jordan Creek (Figures 1 and 2 in general comment section).	DEQ has noted your comment.
Design Conditions, Mercury, final paragraph (page 140) The assumption that total mercury reductions will produce a commensurate reduction in methylmercury production and fish tissue methylmercury concentrations is not supported by the available data and current understanding of the science as discussed in more detail in the general comments section.	While the assumption of a proportional response is a simplifying one, it is no different from the assumption made when a one time static BAF is developed. A linear relationship is assumed in any BAF that is not periodically re-evaluated and recalculated as conditions change in a watershed. We agree that bioaccumulation of mercury is very complicated and reflects a myriad of factors. And while there are certainly lag times in transport of mercury, and variation in methylation rates we have no data to indicate how these factors may change with decrease in future loading. More expensive modeling approaches, which have the potential to be dynamic given periodic update of input variables, were beyond Idaho's means. Given limited data our best estimate is that the response of fish tissue will be commensurate to changes in watershed mercury loading. The margin of safety in the TMDL target, future monitoring, and periodic revision of the TMDL are our best means of

Comment	Response
	addressing any shortcoming in this simplifying assumption. See also response to comment on "Protection of Human Health" below.
Current Mercury Load associated with Permitted Facilities (page 162) The document states that additional mercury monitoring will not be required for implementation of the TMDL. In the absence of data collection/monitoring, how will compliance be identified in the waste load allocation for the Kinross-Delamar discharge?	Kinross Delamar is not expected to have a numeric wasteload allocation for their Multi Sector Industrial Stormwater Permit, but rather will be required to continue implementing appropriate BMPs and conduct monitoring, which they already have been doing under their current NPDES permit related to the mines facility closure plan. The TMDL has been revised to ensure this is clear.
Allocations, Table 72 (page 171) The table identifies the load allocation for "Upstream of JC-2005-01" as 12.49 mg/day. This value is 2.6 times greater than the estimated load (a 166% increase). Reductions or no-net-increase loading is required of all other sources, including background calculated for other stream sections. Some justification is needed for the identified allowable increase in background mercury loading for this segment.	These loading allocations have been removed from the final document because of the difficulty in replicating them, the numerous assumptions that went into developing them, and due to the fact that the mercury TMDL is based on reductions in fish tissue based on Idaho's fish tissue criterion. However, sources are described, and it is recommended that future work further elaborate on the impacts of airborne mercury deposition in the watershed, as well as studies to better pinpoint loading from legacy mining.
Environmental Protection Agency Comments:	**Response:**
Water quality standards. The water quality standards for temperature are discussed on pages 45 and 46, but only the cold water aquatic life criteria. Jordan Creek has salmonid spawning listed as a beneficial use, but the criteria relating to that use, and when they apply, are not presented here.	Yes Jordan Creek is designated in Idaho's Water Quality Standards for salmonid spawning as well as coldwater aquatic life. The failure to mention the spawning criteria is an oversight that has been corrected in the final TMDL. This will have no effect on the TMDL as there are no point sources of heat and so the goal will remain Potential Natural Vegetation.
Reservoir and other heat sources. Triangle Reservoir on Rock Creek may have an effect on the temperature on downstream, temperature impaired, sections of Jordan Creek. Even small reservoirs can have significant impacts to temperature many miles downstream. Currently these effects are not discussed in the TMDL.	Stream temperatures are likely affected by the presence of small reservoirs like Triangle; however, it is unknown whether the affect is a benefit or a detriment. Until further information can be gathered about Triangle Reservoir, it has not been included in the temperature TMDL at this time.
Louse Creek. Indications that Louse Creek is used for salmonid spawning are discussed on pages 79 through 81. BLM temperature data is not plotted in the TMDL. It would be informative to see what the stream temperatures are, especially if there is temperature data in or near the spawning season.	Louse Creek was not listed for temperature on the 1998 or later 303d lists and was apparently inadvertently included. It has been removed from the analysis.
Jordan Creek. Temperature data for Jordan Creek is not displayed in the TMDL. In the discussion of temperature data only the cold water aquatic life criteria are discussed, though Jordan Creek has salmonid spawning as a designated use. Temperature	Temperature data for Jordan Creek is extremely limited and was only gathered by BLM. Jordan Creek was listed by EPA as an addition to the 1998 303(d) list, but EPA did not provide temperature data to DEQ that showed the basis of the listing. A Potential

Comment	Response
data from the spawning season should be discussed, if it exists and it would be helpful to see the data displayed in graphs.	Natural Vegetation TMDL was developed.
Shade curves. A preferred approach to develop PNV temperature TMDLs is to use site or region specific shade curves, e.g. Willamette TMDL, Mattole TMDL, etc. We recognize that IDEQ resources may not allow these curves to be developed for each TMDL, which has lead IDEQ to use curves developed in other TMDLs. To improve the selection of shade curves, local information and literature (BLM, USFS, NRCS, etc.) on the type, height and density of local natural vegetation should be reviewed. This method of choosing a shade curve, rather than the current method of averaging numerous shade curves, often comprised of very different vegetation communities with very different underlying assumptions of PNV height and canopy density, may result in a more accurate estimate of natural shade for the specific watershed.	New shade curves have been developed recently for Idaho, and the temperature TMDL for Jordan Creek has been revised to include those curves.
Bankfull channel widths (p.5). The TMDL uses the Upper Snake Regional curve to estimate channel width. Examination of aerial photos suggests that current channel widths in Lower Jordan Creek exceed natural widths, very substantially in many locations. Given the departure between current and natural channel widths in some locations, we recommend that the document devote a more extensive section to discussing this problem, and its cause.	Available bankfull width data suggest that most streams in the analysis have existing widths similar to natural widths as predicted by the Upper Snake regional curve. The lowest stretch of Jordan Creek is an exception to that and was inadvertently missed in the temperature TMDL analysis. The TMDL has been revised to recognize excessive bankfull widths in the lowest stretch of Jordan Creek.
Averaging needed shade improvements (T. 1 – 6). Averaging of needed shade improvements for a watershed can completely mask very important areas of needed restoration. Problematic areas are ignored with the proposed averaging method if only the average conditions are used as an evaluation criterion for attainment of the PNV approach. This is not an accurate application of the PNV methodology because it does not ensure potential natural stream temperatures. Instead of averaging, we recommend describing the range of improvements needed, for example 10 - 50% increases are needed, depending on the reach. Providing a map showing reach specific values, as the TMDL does, is good. It seems reasonable to suggest that land managers initially target restoration in areas with greatest departure. However, it should be made clear, that to meet WQS, all areas which show any deviation from natural would need improvement in order to meet WQS.	This methodology is no longer employed in PNV-style temperature TMDLs. The Jordan Creek temperature TMDL has been revised to focus more attention on specific differences between existing shade and target shade.
Reaches excluded from TMDL. A number of stream reaches in Soda Creek and also some in Rock Creek and its tributaries were excluded from the TMDL analysis because flows are not perennial. Please	Segments of stream channel that have no evidence of water and riparian vegetation on the aerial photo were excluded from the analysis. These areas are known to be ephemeral or at least intermittent with very long dry

Comment	Response
explain when flow occurs in this reach, including intermittent flow, and whether temperature criteria are exceeded during this time. If temperature criteria are exceeded in these reaches or further downstream when there is flow, the TMDL should include allocations for these reaches.	time such that riparian plant communities do not develop. Including them is inappropriate, as no restoration will improve that situation. Furthermore, streams that naturally cease flowing during the summer do not contribute heat loads to downstream waters. Our water quality standards do limit the application of numeric criteria, such as temperature, to times of optimal flow in waters that are not perennial. DEQ has insufficient data either on temperature or flow to fully answer this question, and presumes these streams are at their Potential Natural Vegetation shade targets.
Discussion of deviations less than 30%. On p. 166 the document indicates that Jordan Creek with 18% shade improvement needed is in "reasonably good condition" and of a lower priority than other waterbodies. We find this description very counterproductive, clearly sending the message that restoration really isn't needed in these reaches. Such language should be deleted. As an alternative, it would be reasonable to suggest that restoration be prioritized based on departure from target conditions. However, as stated above, it should be clear that all reaches would need to meet PNV shade targets in order to meet WQS.	This language has been revised consistent with the revised temperature TMDL.
Effective shade targets were established for the Jordan Creek and its temperature listed tributaries only. Numerous tributaries feed Jordan Creek. Due to the cumulative effects of temperature increases, and the potential impacts of these tributaries on the temperature of Jordan Creek, PNV shade targets should be set for tributaries to ensure temperature standards will be met in Jordan Creek, unless it is shown that the tributary(s) are in a natural state.	Non-listed streams were not included in the temperature TMDL. If and when they become listed for temperature, they will be addressed in a new temperature TMDL. Flowing tributaries may indeed have an impact on summer temperatures, the critical season. It is DEQ's policy to not presume impairment, thus we do not normally develop TMDLs or load allocations for waters that are not currently listed as impaired and for which there is not data showing impairment.
Mercury TMDL/Protection of Aquatic Life	
Pages 49-51 of the Subbasin Assessment, state that the 0.3 mg/kg human health fish tissue criteria is also protective of aquatic life. The reason stated is that if 0.3 mg (methylmercury)/kg wet weight of fish tissue in upper trophic level species were back calculated to an equivalent water column concentration, using a range of national bioaccumulation factors (BAFs), these mercury levels would be lower than EPA's 2002 recommended chronic criterion (0.94ug/l total mercury or 0.77 ug/l total dissolved mercury in the water column). As the TMDL text states, the protectiveness of EPA's 2002 recommended chronic criterion is not considered by NOAA, USFWS or EPA to be protective of sensitive northwest aquatic species. The TMDL indicates that native redband trout are present in	Until EPA in consultation with NOAA and FWS agree on and put forth new criteria, DEQ is only able to rely on current criteria. Among the current criteria Idaho DEQ continues to believe the fish tissue criterion is as protective and likely more protective of aquatic life than is EPA's current 1995 aquatic life criteria for mercury. We also believe that the methylmercury fish tissue criterion will adequately protect aquatic-dependent life in Idaho when applied to the highest trophic level of fish. Whether it is protective enough is a judgment for EPA to work out with NOAA and FWS. The Jordan Creek TMDL cannot wait for resolution of this matter, but it can certainly be revised later as need be.

Comment	Response
many locations within the Jordan Creek watershed, so the protectiveness of the fish tissue methyl mercury criteria for these and other species is an issue. The fact that the range of back-calculated water column concentrations are typically less than this criteria, does not form an adequate basis to support the 0.3 mg/kg fish tissue criteria's protectiveness of aquatic life. We recognize that this is a difficult issue for both EPA and IDEQ, and EPA is currently gathering information on mercury and protection of aquatic life. We hope to work with IDEQ to resolve this issue prior to finalization of the Jordan Creek TMDL and other Idaho Mercury TMDLs.	
Protection of Human Health	
The TMDL sets allocations for reductions at six locations where sampling of fish tissue and water column values occurred in 2005. Reductions of total mercury in the water column at each site are proportional to the reductions needed to achieve average higher trophic level fish tissue concentrations of 0.24 mg/kg at that site. This would be an acceptable approach if there was a correlation between levels of mercury in the water column and those in fish tissue. This is not the case in Jordan Creek. Page 98 of the TMDL states that there is no statistically significant difference between mercury levels in fish at the sample sites in the 2005 IDEQ study. However, there is a clear trend in the water column levels of mercury in Jordan Creek. Mercury water column concentrations are very high in the upstream portion of the creek near Silver City and the areas of historic mining. Jordan Creek data for water column mercury and fish tissue mercury is plotted in the graph below. It shows a sharply declining trend in water column loading below the historic mining area. The historic mining area appears to still be the primary source of mercury to the Jordan/Owyhee system. There are probably secondary sources in the sediment throughout Jordan Creek and the Owyhee River below the Jordan Creek confluence, but the original source appears to be the Silver City historic mining area. This source area only receives a 59% reduction allocations in the TMDL, down to a water column level of 0.038 ug/l, which is approximately thirty times the background loading of mercury in the Jordan Creek system. The TMDL reductions required in this source area are not sufficient to attain the human health criteria downstream.	Despite poor correlations evident in the limited existing data DEQ believes fish tissue mercury levels are related to water column mercury levels and ultimately to source loadings. If this is not the case then there is no reason to expect mercury load reductions to improve fish tissue mercury levels and no purpose to a TMDL. Recent results reported from the METALLICUS study by Harris and others (2007 in PNAS) indicate a rapid response in fish tissue to addition of mercury to a watershed. While response to reductions in mercury will likely take longer due to storage in the watershed, there is strong reason to expect fish tissue mercury to fall with reductions in Hg loading. Time and money could provide a more sophisticated analysis of mercury routing through the watershed and food chain may be possible, but resources did not allow. While it may not be certain that the called for mercury reductions are sufficient, our best estimate with available information is that they will result in meeting fish tissue mercury criterion, with a 20% margin of safety, at the state line. If that proves to be untrue the TMDL can be revised. Because historic mercury loading is dispersed downstream in sediments throughout the Jordan Creek mainstem, we expect called for reductions in loading and subsequent improvement in fish tissue mercury levels to be a long term proposition.

Comment	Response
Without more conservative allocations applied to the upstream source area near Silver City, the reduction in water column levels or fish tissue concentrations at the state line are not likely to be attained and mercury will continue to be exported downstream and continue to supply mercury to the downstream sediments.	
IDEQ's recent study of water column mercury concentrations in Snake River tributaries noted that the Owyhee River near its mouth had elevated levels of mercury relative to other tributary systems (verbal communications Marti Bridges, April 25, 2007). The only known source of mercury loading in the Owyhee system is the Jordan Creek historic mining area. More stringent load allocations to this source area would likely be protective of downstream waters of the Snake River in Idaho, which are listed as impaired for mercury in fish tissue. A protective allocation for Jordan Creek's mining area could serve as one of the allocations for the Brownlee Reservoir mercury TMDL.	While historic mining, especially in Jordan Creek proper, is the primary source of anthropogenic mercury loading, significant loading from air deposition cannot be discounted. In fact, there are sizable regional sources from gold ore roasters in northern Nevada, and a cement kiln at Durkee, Oregon. The ore roasters in particular, likely have a significant influence on the Owyhee watershed outside Jordan Creek, and the cement kiln is likely a significant loader to Brownlee Reservoir. These possibilities are best explored in development of a mercury TMDL for Brownlee Reservoir.
Protection of Uses in Downstream Oregon Waters	
Sampling in Jordan Creek shows higher fish tissue concentrations of mercury in Oregon than upstream in Idaho (see the figure above). As there are no other known sources of mercury to Jordan Creek in Oregon, this is likely due to conditions more conducive to mercury methylation in these lower gradient, downstream reaches and Antelope Reservoir. In addition, the Owyhee River and Owyhee Reservoir are also listed as impaired due to elevated mercury levels in fish tissue. The TMDL does not discuss how downstream state standards in Oregon will be met. The allocations in IDEQ's Jordan Creek TMDL do not consider protection of human health in Oregon.	Fully addressing how upstream load allocations will affect downstream fish tissue concentrations and thus protection of human health in Oregon would require a lot more study and an interstate TMDL effort. The best Idaho can do on its own is to write a TMDL that meets criteria at the state line. To go beyond that would be overstepping our jurisdiction.
Because the allocations are based on the percent reductions required in fish tissue to meet the fish tissue criteria, using Idaho fish tissue concentrations will significantly underestimate the reduction needed to be protective of human health in Oregon. Though no fish tissue samples were collected in Oregon in 2005, when the data used in the TMDL was collected, there is extensive historic data. Average fish tissue concentrations are shown in the table above. Fish tissue mercury concentrations in Oregon are at least twice as high as those in Idaho reaches of Jordan Creek. IDEQ's comparison of their 2005 data with the earliest and most extensive of the historic datasets, a 1973 study by the University of Idaho, indicates that there is a correlation between current and historic Idaho datasets (Appendix H). For redband trout, the most commonly sampled species, the 2005	This would be useful information should Oregon and Idaho join forces in a cross-border TMDL. Had Oregon cooperated with Idaho in development of an interstate TMDL for Jordan Creek, mercury reduction allocations such as suggested may have resulted.

Comment	Response
fish tissue concentrations were higher than those recorded in 1973. As a result, we believe it is reasonable to assume that fish tissue levels in Oregon are currently as high, or higher, than they were historically. Given this information, our recommendation is to establish the load capacity and percent mercury reduction in Idaho's Jordan Creek TMDL at levels which will achieve Oregon's 0.3 mg/kg fish tissue criteria for mercury, and thereby control mercury sources in Idaho in a manner which will be protective of human health in both Idaho and the downstream state.	
Natural Background Allocations	
Table 69 on page 163 presents existing loadings including estimated natural background loads at each IDEQ 2005 sample site. Table 72 on page 171 gives allocations to sources at each of the sample sites. Many of the background loadings in Table 69 differ from those in Table 72. Most of these differences are slight, though puzzling, however the load allocation for background at JC-2005-01 (near the state line) is significantly higher than the estimated background loading.	DEQ agrees these loading estimates are confusing at best. The estimated background loads originally calculated in Tables 69 and 72 were based on data in Table 32 that incorrectly calculated background loads based on analysis of five DEQ 2005 sample sites that served as "reference" streams—streams that had not been impacted by historic mining and had low levels of mercury in fish tissue and water column mercury.The incorrect data was then plotted in Figure 37 and showed R^2=0.4961, an acceptable correlation. Upon correcting the data (the data was all there but had been transposed) the new R^2=0.35, a correlation DEQ does not find acceptable in light of the limited data set. The corrected Table 32, Figure 37 and Table 33 are included in this final document. DEQ staff were unable to replicate the work of the original TMDL author. In light of the poor correlation used to assign specific load estimates we have removed the analysis parsing out loads. Virtually all of the loading is either background along with air deposition, or legacy mercury loading that essentially functions together as non point source loading. The mercury TMDL is based on fish tissue reductions to achieve the water quality standard. Sources are discussed to the extent possible based on the information available. Developing a TMDL for legacy mining issues is not necessarily the best way to address the elevated mercury levels.
Point Sources	
Kinross Mine Stormwater. (pp. 121-122) The TMDL document lists "higher" water quality concentrations of mercury for Jordan Creek sampled below Silver City as 0.093 ug/L and 0.089 ug/L (total and dissolved respectively). The detection limit for mercury monitoring at the Kinross-Delamar mine site is listed as 0.1 ug/L. This detection limit is higher than the elevated concentrations that are used in the document	See Response to State of Oregon on same question.

Comment	Response
to identify the location below Silver City as a "continuing source of mercury". There have been two samples that have exceeded these high detection limits. The statement that "water quality data … has indicated that the mine is not currently discharging any pollutants that can be shown to exceed criteria in Jordan Creek" cannot be justified using the 0.1 ug/L detection limit data. **WLAs.** (Table 72; p. 163) The wasteload allocations, like the load allocations, are set at each of the six 2005 sample sites. The discharges points for the mine are not at these locations. It would be clearer and easier to understand and enforce if either a single (cumulative?) wasteload allocation for the stormwater permit is applied at the lowest discharge point or several allocations are established for multiple discharge points to Jordan Creek. The way this wasteload allocation is currently written it will be difficult to assess compliance and translate into permit limits.	
Sediment Assessment/ Sediment Data	
Appendix D The SMI data used to evaluate sediment impairment in Cow Creek, Soda Creek and Louse Creek is not shown in Appendix D with the macroinvertebrate data from other stream sampling sites. Also missing are: o 1998 DEQ BURP datasets for 2 sites on Rock Creek (1998SBOIB011 and 1998SBOIB012) o 1998 DEQ BURP dataset for 1 site on Louse Creek (1998SBOIB09) o 1996 Kinross Delamar macroinvertebrate datasets for 2 sites on Louse Creek. o 2003 Kinross Delamar macroinvertebrate datasets for 2 sites on Louse Creek Kinross Delamar datasets for macroinvertebrate sampling in Jordan Creek from 1988 through 1998 and 2000 though 2004.	Louse Creek was delisted and approved by EPA in the 2008 Integrated Report. DEQ does not have copies of raw data sets from KDMC for Louse Creek from 1996. Tables 25, 26 and 27 in the draft TMDL presented a synopsis of data from both KDMC and DEQ for Louse Creek. DEQ does not have copies of raw data from KDMC from 1988 through 1998. Nor did DEQ have readily available data from 2000 through 2004 from KDMC. We utilized data from DEQ in 1998 and 2003 as well as KDMC data from 2003 in order to make a more comparable comparison. Outside data and data older than five years is considered Tier 2 data and may be considered in TMDL development, but if newer data exists within the past five years (Tier 1) DEQ relies upon that data. DEQ has added copies of the data to Appendix D for two 1998 Rock Creek BURP sites. Appendix D references full reports by KDMC for Louse Creek as well as monitoring conducted by KDMC from 2001 through 2008 that we have recently become aware of.
Rock Creek (p. 68) Appendix D shows macroinvertebrate data from two 2003 BURP monitoring sites (2003SBIOIA010 and 2003SBOIA042). Why is only one of these sites discussed here? The data from site 2003SBOIA042 is not used in the TMDL, what is the reason for excluding it?	The data from 2003SBOIA042 was not available at the time the TMDL was written, so only site 2003SBOIA010 was used.
Louse Creek (p. 78) Appendix D shows macroinvertebrate data from six sites in Louse Creek	Louse Creek was delisted in the 2008 Integrated Report. It is DEQ policy in WBAG not to run other

Comment	Response
collected in 1999 by Kinross Delamar Mining Company. None of these datasets are used in the evaluation of sediment impairment. Why is the data excluded from consideration? One of these sites had an SMI of 1, indicating that there are sites that are impaired in Louse Creek, though the overall condition may be acceptable. Also the sites had much higher percentages for %3 dominant taxa, than the % 5 dominant taxa figures of the datasets used in the TMDL, indicating a significantly lower species diversity in the excluded data than in the data used in the TMDL. Other metrics in the excluded data also indicate a more impaired stream condition.	entities data through our metrics and process. It is our expectation that outside entities rely on their contractors to report findings.
Though macroinvertebrate indices for the 1998 DEQ sample collection are discussed on page 78, no SMI index is shown in the text. Why is this not calculated?	Louse Creek was delisted in the 2008 Integrated Report. An SMI was not calculated because the 1998 sample was outside the time frame for WBAGII metrics calculations (prior to July 1)
(p. 79) Table 26 Macroinvertebrate Indices, Louse Creek above Sullivan Gulch and below Sullivan Gulch, Kinross Delamar Mining Company 1996; What does “NA” mean in this table?	Louse Creek was delisted in the 2008 Integrated Report. NA meant not available.
(p.24) In the discussion of stream bank stability, results are cited from Kinross Delamar’s 1996 assessment but no data is given for the 2003 assessment. Was this parameter not assessed at that time?	Louse Creek was delisted in the 2008 Integrated Report.DEQ is unaware of stream bank stability being assessed in 2003 by KDMC.
Upper Jordan Creek (p.89-90) The text mentions macroinvertebrate data collected by Kinross Delamar Mining Company from 1988 though 2004. Appendix D shows macroinvertebrate data from 27 sites in Jordan Creek collected in 1999 by Kinross Delamar. The assessment of Upper Jordan Creek uses data collected in 1998 and 2003 only. Why are these the only data used?	DEQ typically only relies on data collected within five years of developing the TMDL. We also typically only utilize outside data that has summarized conclusions where the author has calculated their own metrics, as opposed to DEQ running the data through our metrics. While data may have been collected by Kinross Delamar during from 1988 through 2004, DEQ chose to use data that KDMC had for the same time frames that DEQ had data. Only complete data sets from KDMC as shown in the document and in Apppendix D at the time the TMDL was developed. More recent Kinross Delamar published documents with data are identified in theAppendix D.
Lower Jordan Creek. (p. 115) The canopy cover section mentions that additional information will be made available on canopy cover in Lower Jordan Creek by August 2006. Is this information included in the report?	This statement was an artifact of the draft TMDL and should have been deleted. The finalized Temperature TMDLs utilize current methodologies employed by Idaho DEQ for development of PNV TMDLs as outlined in our Handbook and supported by Region 10 EPA.
Recommendations for Delisting Louse Creek	
Metals The levels of aluminum shown in Table 30 on page 82 (310 ug/L to 380 ug/L) are roughly four times EPA’s current guidance value for chronic exposure in freshwater aquatic life protection (0.87 ug/L) [http://www.epa.gov/waterscience/criteria/nrwqc-	There is much uncertainty about toxic levels of aluminum. EPA, in its National Recommended Water Quality Criteria, notes: “There are three major reasons why the use of Water-

Comment	Response
2006.pdf].Though Idaho's water quality standards do not have a criteria for aluminum, these levels of aluminum in the water column raise concerns for aquatic life.	Effect Ratios might be appropriate. (1)The value of 87 micro-g/l is based on a toxicity test with the striped bass in water with pH= 6.5-6.6 and hardness <10 mg/L. Data in "Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virginia" (May 1994) indicate that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time. (2) In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide. (3) **EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 µg aluminum/L, when either total recoverable or dissolved is measured**. [emphasis added]" Louse Creek was delisted and approved by EPA in the 2008 Integrated Report.
In addition to this, the elevated concentrations of mercury found in a dace and a sculpin from the creek indicate there may be a problem with mercury, especially since the spatial range of sculpin tends to be limited. Levels of mercury in the water column and the sediments were low at the one site in Louse Creek where samples were taken so it is not certain that there is mercury impairment.	Louse Creek was delisted and approved by EPA in the 2008 Integrated Report.
More data is required to adequately assess metals impairment in Louse Creek.	Louse Creek was delisted and approved by EPA in 2008.
Lower Jordan Creek	
Sediment Without any data it is not possible to determine whether sediment impairment is not a problem in Lower Jordan Creek. It is likely that flow alterations may also impair this section of the stream, but there is no evidence that sediment is not also impairing the channel. More data is needed to assess conditions in Lower Jordan Creek and determine if the stream is no longer impaired due to excess sediment.	It is DEQ's position that sediment is not the actual source of impairment in Lower Jordan Creek, but rather it is flow and habitat alterations such as levees, irrigation diversions etc. Macroinvertebrate data has not beem collected because access has been denied. through private property. While it is true that sediment samples have levels of mercury within them, it is the methylation of mercury and its excessive bioaccumulation in fish tissue that would be the cause of impairment, not the quantity of sediment itself. In DEQ's efforts to sample sediment for its mercury content it was difficult to find fine sediment even in the lowest reaches of Jordan Creek within Idaho.

Comment	Response
Kinross –Delamar Mining Company Comments:	**Response:**
Current Stormwater Discharges	
The final TMDL needs to make clear the current that the best management practices (BMPs) and monitoring requirements required in the MSGP are adequate to address discharges in the subject TMDL because such discharges contribute de minimus (if any) loading of mercury to Jordan Creek above natural background conditions. Such a finding is consist with IDEQ's Implementation Guidelines for the Idaho Mercury Water Quality Criteria (April 2005), pp 8, 87, 94 and 102. See also the Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion (EPA August 2006) Chapter 6. As indicated in Exhibit A, the waste load allocation currently identified for KDMC's stormwater discharge in the subject TMDL substantially underestimates the likely actual mercury in sediment discharges in stormwater. This is supported by background soil samples taken at the Mine in the 1970's and the 1980's and the likely volume of runoff from the KDMC mine site calculated in the environmental impact statement (EIS) for the Mine prepared in 1994. (We assume IDEQ already has a copy of the EIS, but we would be happy to provide a copy to IDEQ if necessary.) A copy of background samples data base is attached as Exhibit B. KDMC believes these samples are representative of natural, (albeit mineralized) undisturbed conditions at the mine site. Based on this data, we are very concerned that IDEQ has substantially underestimated natural background contributions of mercury throughout the watershed to Jordan Creek. As you know, natural background conditions in surface water which exceed state criteria are not considered violation of standards and should not from the basis for water quality limited listings. See IDAPA 58.01.02.05.03 and 200.09. If IDEQ believes that it must quantify a numerical wasteload allocation for KDMC's current discharge, KDMC requests that IDEQ revise the allocation based on actual on soil samples taken at the mine.	DEQ has removed the loading analysis because of the difficulty in replicating the results. Numerous assumptions went into the analysis by the original TMDL author. We agree that the loading analysis offered a crude prediction and may have underestimated mercury in background. It is also possible it may have overestimated mercury loading. In light of the fact that the TMDL is written to meet Idaho's fish tissue criterion, and that KDMC's multi sector industrial stormwater permit is intended to apply appropriate measures and BMPs,along with monitoring. DEQ has specified in the TMDL that those measures necessary to protect water quality must be implemented in order to meet the intent of a waste load allocation. No numeric wasteload is provided, consistent with many MSGPs.
Background Mercury Concentrations in Soils.	
KDMC raised the concern in our December 7, 2006 letter and we continue to be concerned about IDEQ's attempts to establish background mercury runoff levels in the Jordan Creek watershed based upon soil concentrations in a different watershed, (Flint Creek). As demonstrated by soil samples taken by KDMC Mine our concerns were justified. Further, the TMDL makes no connection between current mercury runoff from soils to Jordan Creek and current conditions in the water body. To the extent there is datum which	DEQ has removed the original loading analysis. See response to KDMC above. The TMDL is written to meet Idaho's fish tissue criterion.

Comment	Response
identifies causes of mercury impairment to Jordan Creek it appears it comes from a number of discrete sources near Silver City as well as existing in stream sediment deposits. As noted above, KDMC is concerned IDEQ is establishing an artificial low number for the "background" in Jordan Creek without any supporting data which may require KDMC to undertake expensive monitoring or treatment in the future based on these low levels. We would recommend that background runoff of Hg sediments in Jordan Creek needs to accurately quantified based on representative soil samples in the watershed on an annual basis and as a daily load suggested in Exhibit A before the final TMDL is developed.	
Future Discharges:	
As noted, KDMC may decide to pursue additional discharge of treated ground water or other non-storm water discharges in the future. For example, EPA's recent General NPDES Permit Groundwater Remediation Discharge Facilities in Idaho could form the basis for KDMC to pursue future permitted discharge to more efficiently manage water at the Mine. As discussed in Exhibit A, based on pilot treatment system currently in place at the Mine, KDMC believes it can meet the current limit of 0.012 ug/l Hg. Based on an estimated annual average discharge rate of 350 gallons per minute, KDMC request that IDEQ proposed a future reserve for Hg discharge of 22.9 mg/day.	DEQ has included a waste load reserve for growth for mercury in the TMDL. This allocation is based on assuring compliance with downstream states standards by interpreting Idaho's narrative toxics criteria.

Appendix H: Analysis of Total Mercury Concentrations in Fish Samples

Analysis of Total Mercury Concentrations in Fish Samples from Jordan Creek and Non-Jordan Creek Sites

Prepared by:
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Idaho Department of Environmental Quality
Revised November 2009

Introduction

In the summer of 2005, Idaho DEQ initiated a fish tissue, stream sediment, and water column monitoring effort to document current mercury levels in the Jordan Creek Watershed (Ingham 2005). Fish collection and the tissue analysis had three main objectives; 1) assist in the evaluation of fish mercury levels compared to the newly established mercury criteria for the state of Idaho, 2) to assist in identifying the primary source of mercury, areas of methylation, and 3) determine if there is a correlation between total mercury (THg)/ methylmercury (MeHg) levels in fish as related to levels found in the stream sediment and/or water column.

Four fish groups were targeted as being desirably species to achieve the objectives: adult red band trout, adult suckers, sculpin and young of the year (YOY) red band trout. Unfortunately, not all fish target groups were collected as planned. At the two lower stations near the Idaho-Oregon state line no large fish were captured. These large fish were to represent the catchable-edible criteria outlined in the Jordan Creek Mercury Evaluation study (Ingham 2005). At some other stations YOY trout and/or sculpins were not found. These smaller non-catchable-edible fish were targeted as the representative group in identifying possible sources of mercury and methylmercury.

Fish tissue samples were collected in June 2005 at five Jordan Creek sites and three non-Jordan Creek sites (Figure 1). Numerous species were collected, including those determined to be representative of the catchable-edible criteria. Other species included suckers, dace, northern pick minnow, sculpin and YOY red band trout. These samples represented tissue collected in the watershed where historic mining could have had an impact on water quality, and at other sites where there was no historic mining activity.

For each site, adult fish were composited by random combinations of individual fish, with each composite consisting of 3 or 4 fish. Young of the year red band trout, sculpin and other nongame smaller fish were taken as whole body samples and composited. All fish were processed in a clean laboratory following Environmental Protection Agency (EPA) clean hands-dirty hands protocols (EPA Method 1669). A total of 56 samples were obtained for the entire monitoring event (Appendix B).

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[1] State of Idaho Department of Environmental Quality, Technical Services Section
[2] Project Manager, Jordan Creek Mercury Study, State of Idaho Department of Environmental Quality, Boise Regional Office

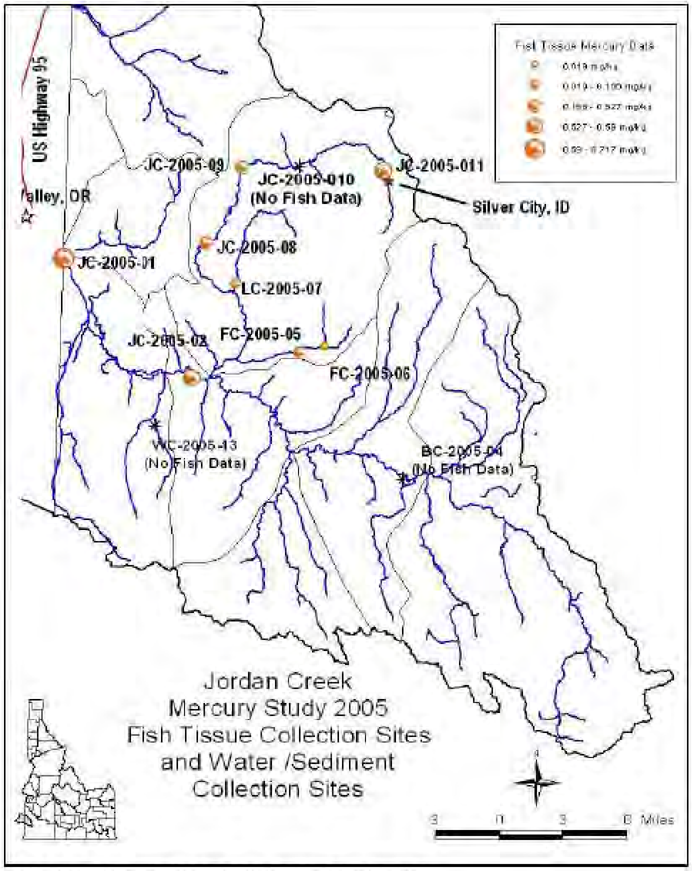

Figure 1. 2005 Jordan Creek Mercury Study.

Objectives of Data Analysis

Based on the laboratory data, this paper reports statistical analysis results to fulfill the following objectives:

1) to summarize statistics on fish total mercury concentrations (mg/kg) for each site (Figure 1);
2) to statistically test the difference in fish mercury concentrations in 1973 and in 2005;
3) to estimate total mercury levels in red band trout and suckers for Jordan Creek sites JC-2005-01 and JC-2005-02 (Ingham 2005).

Summary of Findings

We concluded from the analyses that:

1) Data from 2005 showed total mercury concentrations in Jordan Creek fish are significantly higher than those in the non-Jordan Creek fish. The average fish total mercury in Jordan Creek sites is 0.56 mg/kg with a 95% confidence interval (CI) of 0.51 and 0.61 mg/kg. For the three non-Jordan Creek sites, the average fish total mercury is 0.13 mg/kg and the 95% CI is 0.08 and 0.18.

2) There were fewer YOY fish in Jordan Creeks than in non-Jordan Creeks. Young of the year red band trout were found at only one Jordan Creek site (JC-2005-11). Total mercury in this whole body sample was 0.49 mg/kg. At the non-Jordan Creek sites the average total mercury concentration of seven YOY whole body composites was 0.03 mg/kg with a 95% CI of 0.02 and 0.04.

3) Total mercury concentrations in 2005 red band trout at Jordan Creek sites were significantly higher than in 1973 ($p < 0.001$) (Hill et al. 1973). However, no statistical difference was found in the fish mercury level between 2005 and 1973 for the non-Jordan Creek sites ($p = 0.60$). This analysis also showed variability in the 2005 composite red band trout samples were significantly lower than in the 1973 individual fish samples ($p < 0.01$). Compositing reduced the data variability by more than three times. This means, in order to achieve the same precision for the average fish mercury level in Jordan Creeks, compositing reduced the sample size requirement by nine times. Therefore, if a generic estimate (such as the mean fish mercury level) is of interest, compositing is recommended to obtain a more precise estimate and to reduce laboratory analytical costs.

4) Total mercury concentrations in Jordan Creek red band trout are predictable, provided the methylmercury concentrations of the water and the sediments are known. Fish weights-lengths are also good predictors for mercury levels in Jordan Creek. In the non-Jordan Creeks sites, fish sizes do not influence fish mercury levels significantly. Table 1 summarizes the estimated mean red band trout total mercury concentration using the three predictors. The 95% CI for each estimate is also included.

Table 1. Predicted Total Mercury Concentrations (mg/kg) in Jordan Creek Red Band Trout, 2005.

			JC-2005-01		*JC-2005-02*	
Predictor	R_{Adj}^2	***n***	***Mean***	***(95% CI)***	***Mean***	***(95% CI)***
Sediment MeHg (mg/l)	0.94	5	0.75	(0.61,0.90)	0.67	(0.54,0.80)
Water MeHg (mg/l)	0.51	7	0.73	(0.46,1.2)	0.70	(0.44,1.1)
Composite weight (g)	0.79	6	0.54	(0.38,0.75)	0.60	(0.45,0.79)

The above predictions are for red band trout of typical length of 11.3 inches in Jordan Creek site JC-2005-01 and 6.8 inches in site JC-2005-02. The sizes are the averages from the observed red band trout in 1973. All three models showed that total mercury concentrations at the two sites were greater than the 0.3 mg/kg fish consumption index (FCI). For this study, sediment methylmercury appeared to be the best predictor of red band trout mercury concentrations in Jordan Creek sites as indicated by a high R2 and narrow confidence intervals.

5) No statistical difference was found for the total mercury concentrations in Jordan Creek suckers. Using the observations from the 1973 study, the average mercury level in suckers was 0.82 mg/kg with 95% CI of 0.71 and 0.94, for JC-2005-01 and 0.74 mg/kg with 95% CI of 0.63 and 0.85 for JC-2005-02. Typical sucker lengths at the two sites were 9.4 inches and 5.8 inches, respectively.

Objective 1: Summary Statistics on Fish Total Mercury Concentrations by Site
Figure 2 is the box plot of total mercury concentrations in fish in 2005 by site. The box encloses the center 50% of the data (25% quantile to 75% quantile). The bar in the box is the median (50% quantile) of the data and the star is the average value of the data. Whiskers are 1.5 times the inter-quantile range (IQR), which is the 75% quantile - 25% quantile from the upper and lower sides of the box. Any observation beyond the whiskers is an extreme event in the data set.

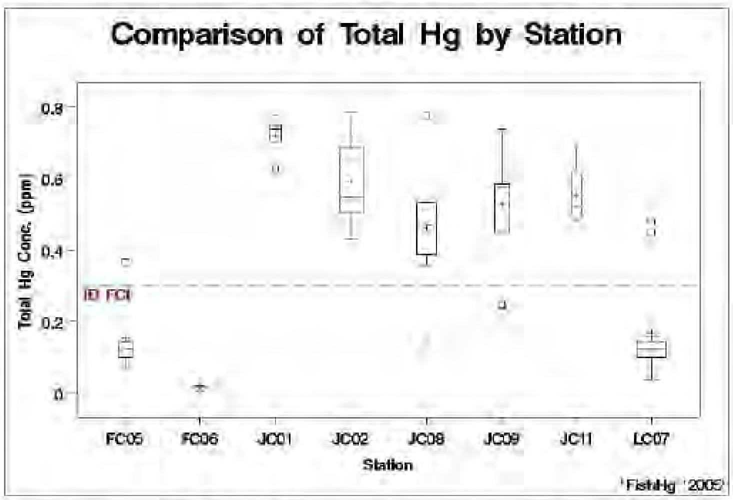

Figure 2. Comparison of Total Mercury Concentrations for all Species, 2005.

The dotted line in Figure 2 denotes the FCI for the State of Idaho, which is 0.3 mg/kg. Total mercury concentrations in fish from all Jordan Creek sites were above the FCI. For all sampled species, the average fish mercury level in Jordan Creeks in 2005 was 0.56 mg/kg with a 95% CI of 0.51 and 0.61. The highest observed fish mercury level was 0.72 mg/kg from JC-2005-01. However, no red band trout were caught at this site. Instead, the fish samples were mostly composite samples of dace, suckers, northern pike minnows and shiners. The lowest observed

Jordan Creek fish mercury concentration was 0.25 mg/kg from a red band trout composite sample at Jordan Creek site JC-2005-09.

For non-Jordan Creek total mercury levels in fish were less than the FCI. Out of the 18 red band trout and suckers samples from the three non-Jordan Creek sites, 17 samples had total mercury lower than 0.15 mg/kg. Total mercury concentration in one red band trout sample from Flint Creek was 0.37 mg/kg. However, this sample consisted of a fillet from a trout that was 12 inches in length and weighed 227 grams. The average fish length and weight for the Flint Creek site was 6.5 inches and 55 grams. Very likely the trout was not a resident, but had migrated from lower segments.

Figure 3 is the box plot of total mercury concentrations found in fish from the 1973 study (Hill et al. 1973). Generally, the same pattern of high mercury concentration in Jordan Creek fish and low mercury concentration in non-Jordan Creek fish was observed. However, comparing to Figure 2, two items are noted; First, the average fish mercury levels in Jordan Creek site JC-2005-08, site JC-2005-09, and site JC-2005-11 were lower in 1973. Secondly, the compositing process used in 2005 monitoring reduced the variation of the observed fish mercury levels remarkably. This is indicated by the different y-scale of the two figures and the range of the center 50% of the data. Compositing attenuated the variability caused by individual differences in fish and the influence from extreme fish samples with high or low mercury levels.

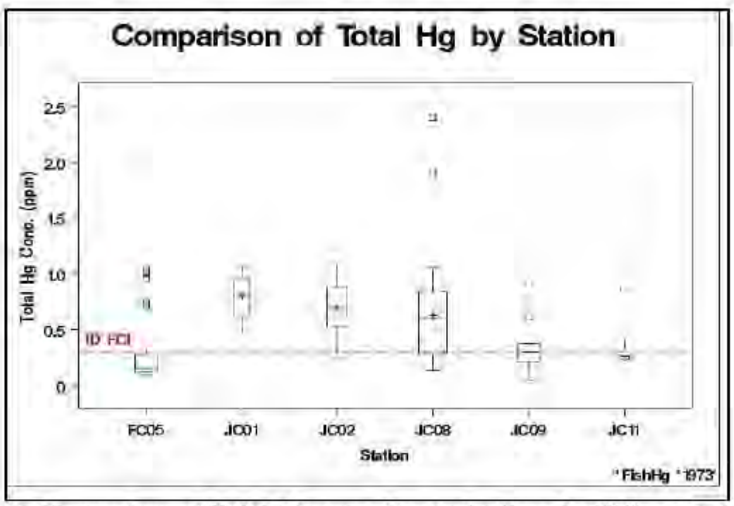

Figure 3. Comparison of Total Mercury Concentrations in all Species, 1973.

As red band trout and suckers are of primary interest, the box plots of these two species only, for 2005 and 1973, are shown in Figures 4 and 5. These plots show the general trend of red band trout and suckers mercury concentrations being high in Jordan Creek sites and low in non-Jordan Creek sites. Figures 3, 4 and 5 show that there were fewer red band trout and suckers samples in

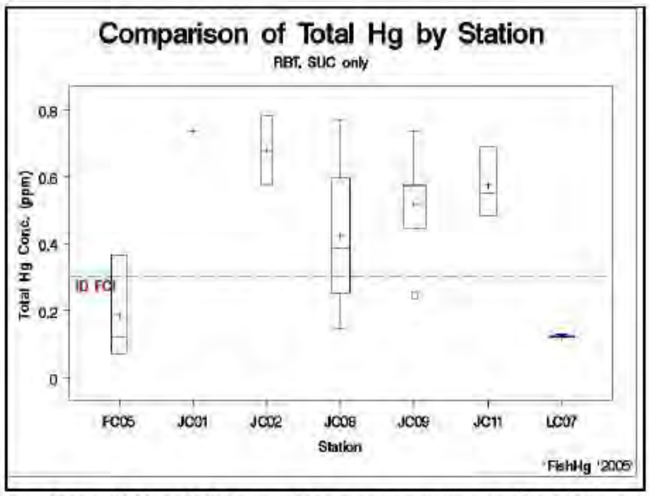

Figure 4. Box Plots of Total Mercury Concentrations in Red Band Trout and Suckers, 2005.

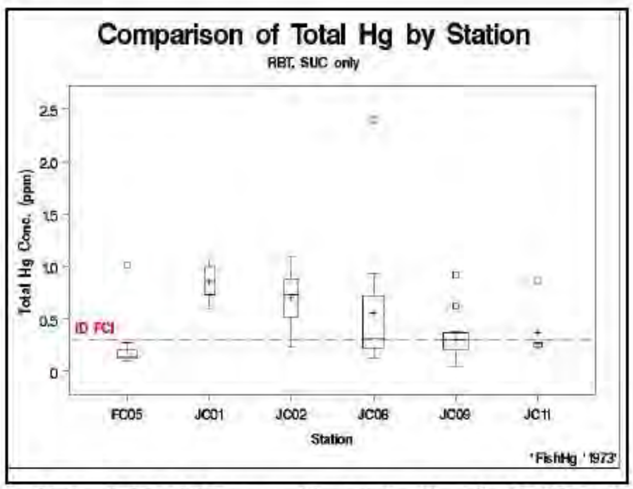

Figure 5. Box Plots of Total Mercury Concentrations in Red Band Trout and Suckers 1973.

Jordan Creek sites JC-2005-01 and JC-2005-02 as indicated by the narrowness of the boxes. In fact, no red band trout were found at these two sites, only suckers.

Objective 2: Results of statistical tests on the difference of total mercury concentrations in fish for 2005 and 1973

Two sample t-tests were used to compare total mercury concentrations in red band trout and suckers for the two time periods. Data were transformed using natural logarithm to meet the normality assumption of the test. The equal variance assumption was tested before applying the t-test. If an unequal variance was indicated, the t-test with unequal variance was applied. The F-test showed the equal variance assumption could not be used for comparisons at Jordan Creek sites ($p < 0.01$ for both red band trout and suckers). Compositing in 2005 reduced the variability of observed data. Therefore, the t-test with unequal variance was applied to compare red band trout and suckers mercury level at Jordan Creek sites. However, the equal variance assumption held for non-Jordan Creek site comparisons.

Table 2 summarizes the results of the t-test on the fish mercury concentrations in 1973 and in 2005. For Jordan Creek sites, significantly higher total mercury levels were found in 2005 red band trout than in 1973 ($p < 0.001$). For the non-Jordan Creek sites total mercury concentrations in red band trout did not differ significantly between 2005 and 1973. For suckers, no mercury level difference were found at Jordan Creek sites ($p = 0.30$). Comparison to total mercury concentrations in suckers for the non-Jordan Creek sites was not applicable due to the lack of samples.

Table 2. Summary of t-test results for total mercury concentrations in Jordan creek and non-Jordan creek red band trout and suckers in 1973 and 2005.

Hypothesis	***Red Band Trout***	***Suckers***
Jordan Creek		
H_0: $\ln(THg)_{1973} = \ln(THg)_{2005}$ H_A: $\ln(THg)_{1973} \neq \ln(THg)_{2005}$	p< 0.001 Therefore reject H0, there is a difference in Total Hg concentration in red band trout for 1973 and 2005 at significance level (α) of 0.05.	p=0.30 Therefore accept H0, there is no difference in Total Hg concentration in suckers for 1973 and 2005 at significance level (α) of 0.05.
Non-Jordan Creek		
H_0: $\ln(THg)_{1973} = \ln(THg)_{2005}$ H_A: $\ln(THg)_{1973} \neq \ln(THg)_{2005}$	p=0.60 Therefore accept H0, there is no difference in Total Hg concentration in red band trout for 1973 and 2005.	N/A. No suckers were sampled in LC-2005-07 for both years and no suckers were found in FC2005-05 in 2005.

Objective 3: Estimates of total mercury concentrations in red band trout and suckers of Jordan Creek site JC-2005-01 and JC-2005-02.

Both sites, JC-2005-01 and JC-2005-02, did not produce catchable-edible size fish during the electrical fishing effort in June 2005. However, it is desirable to know the mercury concentrations in red band trout and suckers at these locations. Therefore, various prediction models were tested using mercury levels in the stream sediments, the water column and fish.. Methylmercury in sediment (Model 1), methylmercury in water (Model 2), and composite fish weight (Model 3) were found to be good predictors. For each predictor, a model was developed. Residual plot and residual Q-Q plot were examined for adequacy of the model and normality assumptions. The adequacy and assumptions were satisfied for each developed model. The models and the goodness of fit (R_{adj}^2) for each are listed in Table 3. Observations (dots) and fitted models (lines) are shown in Figures 6, 7 and 8.

Table 3. Summary of Prediction Models for Red Band Trout, Total Mercury Concentrations for Jordan Creek Site JC-2005-01 and Site JC-2005-02.

Predictor	***Model #***	***Model***	R_{adj}^2
Sediment MeHg (mg/l)	1	$THg_{RBT} = 0.52 + 0.095 \ln(MeHg)_{Sedi}$	0.94
Water MeHg (mg/l)	2	$\ln(THg)_{RBT} = -0.67 + 0.41 \ln(MeHg)_{H2O}$ **OR** $THg_{RBT} = 0.51e^{0.41}$	0.51
Composite weight (g)	3	$\ln(THg) = -2.74 + 3.34 \ln(\ln(weight - 40)) - 1.23(\ln(\ln(weight - 40)))^2$	0.79

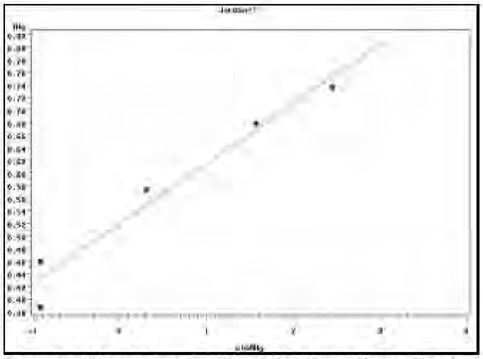

Figure 6. Observed vs. Predicted Red Band Trout, Total Mercury Concentrations Using Model #1

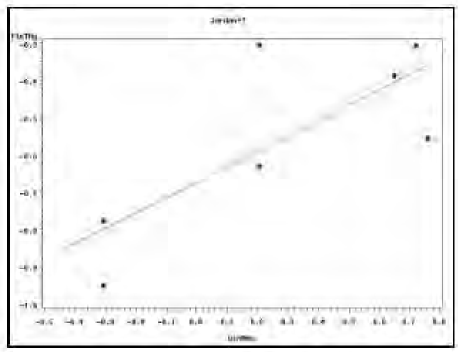

Figure 7. Observed vs. Predicted Red Band Trout, Total Mercury Concentrations Using Model #2

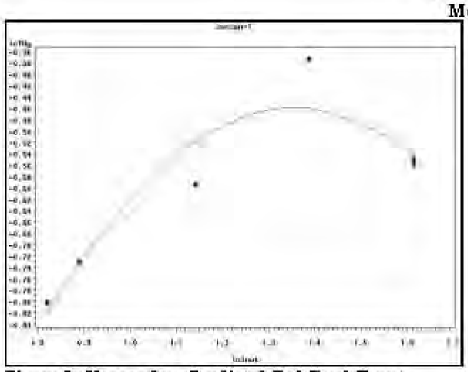

Figure 8. Observed vs. Predicted Red Band Trout, Total Mercury Concentrations Using Model #3

Table 4 summarizes the predicted mean red band trout mercury levels with a 95% CI using the chosen models. The weight model (Model 3) is good for red band trout heavier than 40 grams. This is equivalent to red band trout of approximately 5.8 inches long. The weight-length relationship was developed using the 2005 monitoring data. Red band trout length and weight are predictable by each other by using the power function:

$$fish\ weight = 0.164\ (length\ )^{3.12}$$

Where: fish weight is in grams and fish length is in inches

The model's R^2 is 0.91, indicating good model fit. Extrapolation of the weight model (Model 3) for younger fish should be done cautiously. The summary of fish sizes in the 1973 study for the 2005 monitoring sites can be found in the appendix.

Table 4. Predicted Mean Total Mercury Concentrations in Red Band Trout in Jordan Creek Site JC-2005-01 and Site JC-2005-02.

	JC-2005-01			*JC-2005-02*		
	Model 1	***Model 2***	***Model 3***	***Model 1***	***Model 2***	***Model 3***
Mean	0.75	0.73	0.54	0.67	0.70	0.60
Lower 95% limit	0.61	0.46	0.38	0.54	0.44	0.45
Upper 95% limit	0.90	1.2	0.75	0.80	1.1	0.79

Since no statistical difference was found for the sucker's mercury levels at Jordan Creek sites, suckers total mercury concentrations for JC-2005-01 and JC-2005-02 were estimated from observations in 1973. The estimated average suckers mercury level for the two sites were 0.82 mg/kg with a 95% CI of 0.71 and 0.94 for site JC-2005-01, and 0.74 mg/kg with a 95% CI of 0.63 and 0.85 for site JC-2005-02.

References

Hill, Steve, A. Cochrane and D. Williams 1973. Study of mercury and heavy metals pollutants in the Jordan Creek drainage. University of Idaho, College of Mines, Moscow, ID.

Ingham, Michael, J. 2005, Jordan Creek Mercury Evaluation Quality Assurance Project Plan. Idaho Department of Environmental Quality. Boise, ID

Appendix: Data

Table A. Average Fish Lengths of Species Found in 1973 Silver City Study (Hill et al. 1973).

Station	Species	N	Mean Length (inches)	Median Length (inches)	Std Dev Length (inches)
FC-2005-05	RBT	14	6.0	6.0	1.2
FC-2005-05	SCP	5	2.0	2.0	0.0
FC-2005-05	SUC	6	6.8	6.5	1.0
JC-2005-01	RBT	3	11.3	11.5	1.3
JC-2005-01	RSS	4	2.3	2.0	0.5
JC-2005-01	SUC	7	9.4	10.0	2.2
JC-2005-01	SWF	2	7.5	7.5	0.7
JC-2005-02	PMC	1	6.5	6.5	
JC-2005-02	RBT	6	6.8	6.5	1.0
JC-2005-02	RSS	3	3.5	3.0	0.9
JC-2005-02	SCP	2	2.0	2.0	0.0
JC-2005-02	SUC	12	5.8	5.8	1.6
JC-2005-02	SWF	3	6.5	7.0	0.9
JC-2005-08	DAC	3	2.7	3.0	0.6
JC-2005-08	RBT	14	8.5	8.0	2.8
JC-2005-08	RSS	3	3.5	4.0	1.3
JC-2005-08	SUC	9	8.6	9.0	1.9
JC-2005-08	SWF	5	8.4	8.0	1.7
JC-2005-09	RBT	28	5.2	5.0	1.7
JC-2005-09	SUC	1	4.0	4.0	
JC-2005-11	RBT	9	5.4	5.0	1.0

Table B. 2005 Results; Fish Tissue, Sediment and Water Column for 2005.

Station	Site Description	Date Field	Time Field	Sediments Total Hg Dry (ng/g)	Sediments MeHg Dry (ng/g)	Water MeHg (ng/l)	Water Total Hg (ng/l)	Water Diss Hg (ng/l)	Average Fish Total Hg (mg/kg)
JC-2005-01	Jordan near Stateline	8/8/2005	11:30	4260.439	11.520	2.060	19.944	9.166	0.717
JC-2005-02	Jordan Below Boulder Cr.	8/10/2005	15:30	2046.348	4.797	1.920	31.407	13.332	0.590
JC-2005-08	Jordan Below Placer Tailings	8/9/2005	11:00	1292.407	0.399	0.736	13.347	5.226	0.461
JC-2005-09	Jordan Below Delamar Mine	8/8/2005	18:00	1384.770	31.918	1.230	35.270	19.547	0.527
JC-2005-11	Jordan Below Silver City	8/9/2005	9:00	947.547	1.366	2.140	92.680	89.460	0.551
Background Stations									
BC-2005-04	Boulder Creek	8/9/2005	16:30	12.053	0.235[a]	0.2360	1.240	1.979	NA
FC-2005-05	Flint Creek	8/9/2005	14:00	13.822	0.985	0.2770	1.219	0.839	0.154
FC-2005-06	East Fork	8/9/2005	15:30	3.192	0.303	0.0520	0.763	0.500	0.188
WC-2005-13	Williams Creek	8/8/2005	12:30	5.241	0.029	0.2140	1.804	1.065	NA
LC-2005-07	Louse Creek	8/8/2005	15:30	16.442	0.231	0.103	1.397	0.779	0.166

a Original sample contained high amounts of organic matter resulting in a MeHg result that exceeded the Total Hg result for a single sample. The sample was re-run without the root mass and the aliquot yielded this result, in which DEQ has greater confidence.

Table C. Individual Fish Tissue Results 2005.

Type	Species	Station ID	Sample ID	RESULT	UNIT
WB-COMP	DAC	JC-2005-01	05264152	0.77460317	mg/kg-wet
WB-COMP	NPM	JC-2005-01	05264158	0.70250209	mg/kg-wet
WB-COMP	RSS	JC-2005-01	05264161	0.6258159	mg/kg-wet
WB-COMP	SUC	JC-2005-01	05264178	0.73633333	mg/kg-wet
WB-COMP	CMS	JC-2005-01	05264164	0.74734188	mg/kg-wet
				0.71731928	
WB-COMP	SUC	JC-2005-02	05264150	0.78376812	mg/kg-wet
WB-COMP	RSS	JC-2005-02	05264182	0.52570175	mg/kg-wet
WB-COMP	CMS	JC-2005-02	05264185	0.50242672	mg/kg-wet
WB-COMP	DAC	JC-2005-02	05264188	0.68740376	mg/kg-wet
WB-COMP	NPM	JC-2005-02	05264191	0.77678995	mg/kg-wet
WB-COMP	SUC	JC-2005-02	05264194	0.57366667	mg/kg-wet
WB-COMP	LND	JC-2005-02	05264197	0.42863877	mg/kg-wet
WB-COMP	RSS	JC-2005-02	05264199	0.52487773	mg/kg-wet
WB-COMP	BLS	JC-2005-02	05264200	0.60475799	mg/kg-wet
WB-COMP	SCP	JC-2005-02	05264202	0.48834188	mg/kg-wet
				0.58963733	
WB-COMP	DAC	JC-2005-08	05264166	0.49960177	mg/kg-wet
WB-COMP	DAC	JC-2005-08	05264166	0.53177778	mg/kg-wet
WB-COMP	DAC	JC-2005-08	05264166		% Rec
WB-COMP	DAC	JC-2005-08	05264166		% Rec
COMP-IND	RBT	JC-2005-08	05264157	0.35558685	mg/kg-wet
COMP-IND	RBT	JC-2005-08	05264160	0.41734234	mg/kg-wet
WB-COMP	NPM	JC-2005-08	05264169	0.43699592	mg/kg-wet
WB-COMP	SUC	JC-2005-08	05264172	0.77241126	mg/kg-wet
COMP-IND	SUC	JC-2005-08	05264163	0.14632212	mg/kg-wet
WB-COMP	RSS	JC-2005-08	05264175	0.53129752	mg/kg-wet
				0.46141694	
WB-COMP	DAC	JC-2005-09	05264154	0.58184956	mg/kg-wet
COMP-IND	RBT	JC-2005-09	05264168	0.24579646	mg/kg-wet
COMP-IND	RBT	JC-2005-09	05264171	0.57773423	mg/kg-wet
COMP-IND	RBT	JC-2005-09	05264174	0.57173516	mg/kg-wet
COMP-IND	RBT	JC-2005-09	05264177	0.44794118	mg/kg-wet
COMP-IND	SUC	JC-2005-09	05264151	0.73688073	mg/ kg-wet
				0.52698955	
COMP-IND	RBT	JC-2005-11	05264153	0.55165939	mg/kg-wet
COMP-IND	RBT	JC-2005-11	05264156	0.48072414	mg/kg-wet
COMP-IND	RBT	JC-2005-11	05264159	0.68798701	mg/kg-wet
WB-COMP	RBT-YOY	JC-2005-11	05264162	0.48516129	mg/kg-wet
				0.55138296	

Table C (cont.). Individual Fish Tissue Results 2005.

Type	Species	Station ID	SAMPLE ID	RESULT	UNIT
WB-COMP	SCP	FC-2005-05	05264167	0.142318182	mg/kg-wet
COMP-IND	RBT	FC-2005-05	05264176	0.365535714	mg/kg-wet
COMP-IND	RBT	FC-2005-05	05264179	0.122133333	mg/kg-wet
COMP-IND	RBT	FC-2005-05	05264180	0.070442478	mg/kg-wet
WB-COMP	RBT	FC-2005-05	05264183	0.099286364	mg/kg-wet
WB-COMP	SCP	FC-2005-05	05264170	0.125591837	mg/kg-wet
				0.154217985	
WB-COMP	RBT-YOY	FC-2005-06	05264184	0.021702439	mg/kg-wet
WB-COMP	RBT-YOY	FC-2005-06	05264190	0.0125	mg/kg-wet
COMP-IND	RBT-YOY	FC-2005-06	05264192	0.022143564	mg/kg-wet
COMP-IND	RBT-YOY	FC-2005-06	05264195	0.019476389	mg/kg-wet
COMP-IND	RBT-YOY	FC-2005-06	05264198	0.018275674	mg/kg-wet
				0.018819613	
COMP-IND	RBT	LC-2005-07	05264203	0.126427966	mg/kg-wet
WB-COMP	RBT	LC-2005-07	05264214	0.130282297	mg/kg-wet
COMP-IND	RBT	LC-2005-07	05264205	0.118832653	mg/kg-wet
COMP-IND	RBT	LC-2005-07	05264209	0.121423077	mg/kg-wet
COMP-IND	RBT	LC-2005-07	05264209	0.119375664	mg/kg-wet
WB-COMP	BLS	LC-2005-07	05264206	0.079201681	mg/kg-wet
COMP-IND	Sucker	LC-2005-07	05264207	0.124696356	mg/kg-wet
WB-COMP	RSS	LC-2005-07	05264210	0.159526749	mg/kg-wet
COMP-IND	LND	LC-2005-07	05264211	0.47764878	mg/kg-wet
WB-COMP	SCP-Short Head	LC-2005-07	05264212	0.44735545	mg/kg-wet
WB-COMP	RBT-YOY+1	LC-2005-07	05264204	0.038115385	mg/kg-wet
WB-COMP	RBT-YOY+1	LC-2005-07	05264204	0.046531532	mg/kg-wet
				0.165784799	